Estimation of Non-Genetic Factors Affecting Birth Weight and Reproductive Traits of Pure Jersey Dairy Cattle at Adea Berga Research Station, Oromia, Ethiopia

Mekuryaw Wubie[1,*], Yosef Tadesse[2], Direba Hunde[3] and Million Tadesse[3]

[1]Ministry of Agriculture, Ethiopia; [2]Ethiopian Meat and Milk Industry Development Institute, Ethiopia;
[3]Ethiopian Institute of Agricultural Research, Ethiopia;
*Correspondence: mekuryawwubie@gmail.com

ABSTRACT

This study was conducted to estimate the effect of non-genetic factors on birth weight and reproductive traits of pure Jersey dairy cattle at Adea Berga Research Station. A total of 9,207 pure Jersey dairy cattle performance records collected during 1986 to 2019 were used for the study. General Linear Model (GLM) procedures of SAS software were used to determine the effects of fixed factors. The results indicated that the overall least squares means (± SE) of age at first calving (AFC), calving interval (CI), number of service per conception (NSC) and birth weight (BW) were 32.68 ± 0.1 9 months, 479.80 ± 4.45 day, 2.01 ± 0.02 and 22.3 ± 0.0 9 kg, respectively. The results obtained for CI and NSC performance of pure Jersey dairy cattle at Adea Berga farm were high indicating the need of better management and selection. Year of birth had significant ($p < 0.001$) effect on AFC and BW. Similarly, the season of birth had significant ($P < 0.001$) effect on AFC. Postpartum cow weight (PPW) and parity of dam had also significantly ($p < 0.05$) influenced calf BW and CI. Furthermore, calving interval was significantly ($p < 0.001$) affected by year of calving. Therefore, improving the level of farm management system is essential for optimal reproduction performance of pure Jersey breed in the farm.

Keywords: *Adea Berga, Jersey, Birth weight, Reproductive performance*

INTRODUCTION

As a result of the low reproductive and production performance of indigenous cattle in Ethiopia, the genetic improvement of dairy cattle has been mainly based on crossbreeding and adoption of improved exotic breeds (Direba *et al*., 2015; Destaw and Kefyalew, 2018). Even though both pure Friesian and Jersey cattle breeds have been selected for temperate climate, they have been also reared in Ethiopia to serve as a genetic pool for national crossbreeding. Jersey cattle have desirable characteristics such as small body size, hardy and adaptable, low maintenance requirement, high feed conversion efficiency, high milk fat content, and good reproductive performance (Cunningham and Syrstad, 1987; Njubi*et al*., 1992). Thus, it has been selected in different tropical countries for milk production and genetic improvement of the indigenous breeds through crossbreeding (Direba *et al*., 2015).

Reproductive efficiency is expressed by the extent of reduction of reproductive wastage and it affects lifetime milk and meat production (Nuraddis, 2011). Reproductive performance is a combination of many traits. Studies indicate that the main indicators that would be considered in evaluating reproductive performance are age at first calving (AFC), calving interval (CI) and number of service per conception (NSC) (Assemu and Dilip, 2014). Appropriate periodical evaluation of factors affecting the growth and reproductive performance of the dairy cattle is very important for future improvement planning and management. Previous studies have been conducted to evaluate productive and reproductive performances of pure Jersey cattle at Adea Berga dairy farm (Yosef, 2006; Direba *et al*., 2015) and Wolaita Sodo dairy farm (Habtamu *et al*. 2010). However, there is limited information on growth performance and reproductive performance in recent years in Ethiopia to consider the current change due to selection, climatic change, and breeding program followed.

Having the current information on the growth and reproduction performance of pure Jersey cows in Adea Berga Jersey dairy herd would help to assess the present status and suggest the future management improvement intervention for this herd. Therefore, the objective of this study was to estimate non-genetic factors affecting reproductive performance and birth weight of pure Jersey dairy cattle in Adea Berga dairy farm.

MATERIALS AND METHODS

Study Area

The current research was conducted at Holetta Agricultural Research Center, Adea Berga Dairy Research Station which is found in West Shewa Zone of Oromia Regional State, Ethiopia. Adea Berga is situated in the central highlands of Ethiopia at 9^0 16' N latitude and 38^0 23' E longitude, 70 km West of Addis Ababa and 35 km North West of Holetta. It lies at an altitude of 2500 meter above sea level. Adea Berga is characterized by a cool sub-tropical climate with the annual temperature and rainfall ranging from 18 °C to 24 °C and 1000 to 1225 mm, respectively. Vegetation is mainly composed of perennial grasses and sedges. Clovers, Pennisetum and Andropogon are the most common species dominating the pasture in the area (Tamirat *et al*., 2016).

Description of the Farm

Adea Berga dairy farm was established in 1986 as one of the government state farms. 400 pure Jersey pregnant heifers and two sires were imported from Denmark to use as foundation stock. The initial objective of the farm was commercial milk production and milk supply to Addis Ababa. Parallel to this, the farm had been serving as a bull dam for the former national animal genetic improvement institute (NAGII) and the present livestock development institutes (LDI). Thereafter, in 2007, the farm was transferred to Holeta Agricultural Research Center as a genetic improvement research station.

Study Animal and Breeding Program

Data collected from pure Jersey calves, heifers and cows were used for this study. The herd management practices depend on sex, age and physiological status or Pregnancy and lactation status. Bucket feeding system was followed for calves, except for the first 5 days that calves allowed to suckle colostrum. During the dry and short rainy season, all cows (except late pregnant) and heifer were allowed to graze natural pasture for about 4-6 hours a day. Then, supplemental feeds (concentrate composed of wheat bran, wheat middling, noug cake and salt) and hay were provided up on return to the barn. However, all animals were restricted from grazing and managed indoor during the main rainy season except for 1-2 hours of exercise. There was regular over flood of river in the pasture land as a result of heavy rains during this period and the farm has a regular plan to harvest and stock up hay for dry and short rainy season supplementation. The farm has disease prevention and control practices. There was scheduled deworming and acaricidal treatment against internal and external parasites and vaccination against Blackleg, Anthrax, Pasteurellosis, Foot and mouth disease and Lumpy Skin Disease.

Pure line selection with controlled mating has been carried out in the farm. Mating was mainly based on artificial insemination and conducted throughout the year. Few male calves were recruited each year by the NAGII/LDI for national crossbreeding activities. Thus, most of the male calves were culled at an early age. The main source of semen for this herd was NAGII/LDI. However, worldwide sires semen have been used since 2009 to further improve this herd.

Statistical Analysis

Before data analysis screening of data was made to avoid man made errors during data entry and data management on the computer. During data clearing CI, based on average of 285 days gestation length and additional 45 days voluntary waiting period after calving (minimum CI of 330 days), cows that recorded below 330 days calving interval (CI) were removed from the analysis. The animals that have abnormal calving, i.e., abortion and stillbirths were excluded from the data analysis.

The General Linear Model (GLM) procedures of SAS version 9.1 (SAS, 2008) were used to determine the effects of non-genetic factors on the study traits (AFC, CI, NSC and BW). The presence of any significant difference among means of different traits was checked by using probability difference in TUKEY Kramer multiple comparison tests. The fixed effects fitted in the model were year of birth/calving/service, season of birth/calving/service, sex, parity and PPW. But, their interaction effects are not fitted in the model due to the absence of significant effects in the preliminary analysis

Based on the number of observations, year of birth/calving/service were grouped in to 10 classes for BW and CI, and 11 classes for AFC and NSC; each year group represents three years. Based on pattern of annual rainfall distribution, season was grouped in to three classes, namely, dry period (October to February), light rain (March to May) and main rain (June to September); Sex of animal (male and female), PPW (grouped in to three weight classes based on deviation from the mean of observations as group1 (record with less than 1 SD (standard deviation) from population mean), group 2 (record with ± 1 SD from population mean and group 3 (record with greater than 1 SD standard from the population mean). Parity of cows has seven levels for CL and NSC, while it has six levels for BW.

Because of the small number of observation, parities seventh and above were pooled together as parity seven for CI and NSC and parities sixth and above, were pooled together as parity six for BW.

The statistical model fitted for birth weight was as follows **(Model 1):**

$Y_{ijklm} = \mu + A_i + S_j + X_k + P_l + C_m + e_{ijklm}$

Where, Y_{ijklm} = observation of BW, μ = overall mean, A_i = effect of i^{th} birth year group (i = 1-10), 1= 1988-1990…, 10 = 2015-2017,S_j= effect of j^{th} season of birth (j=dry, short rain, main rain), X_k= effect of k^{th} sex of calf (k = Male, Female), P_l= effect of l^{th} parity of dam (l = 1-6), C_m= effect of m^{th} *Postpartum cow weight* (m = 1-3) e_{ijklm} = random error associated with each observation.

The statistical model fitted for age at first calving (AFC) (**Model 2):**

$Y_{ij} = \mu + A_i + S_j + e_{ij}$

Where; Y_{ij} = observation of AFC, μ = overall mean; A_i = effect of i^{th} birth year group (i = 1-11); 1 = 1985-1987…, 11 = 2015-2017, S_j = effect of j^{th} season of birth (j = dry, short rain, main rain) and e_{ij} = random error associated with each observation.

The statistical model fitted for calving interval (CI) **(Model 3):**

$Y_{ijkl} = \mu + A_i + S_j + P_k + C_l + e_{ijkl}$

Where; Y_{ijkl} = observation of CI, μ = overall mean, A_i = effect of i^{th} year group of calving (i = 1-10), 1= 1988-1990…, 10 = 2015-2017, S_j = effect of j^{th} season of calving (j = dry, short rain, main rain), P_k = effect of k^{th} parity of cow (k = 1-7), C_l =effect of l^{th} *Postpartum cow weight* (l = 1-3) e_{ijkl} = random residual error term associated with each observation.

The statistical model fitted for number of service per conception (NSC): **(model 4):**

$Y_{ijk} = \mu + A_i + S_j + P_k + e_{ijk}$

Where; Y_{ijk} = observation of NSC, μ = over all mean, Ai = effect of i^{th} year group of service (i = 1-11), 1 = 1987-1989, 11= 2017-2019, S_j= effect of j^{th} season of service (j = dry, short rain, main rain), P_k = effect of k^{th} parity of cow (k = 1-7), e_{ijk} = random error associated with each observation.

RESULTS AND DISCUSSION

Non-Genetic Factors Affecting Birth Weight (BW)

As shown in Table 1, the overall least squire mean estimated for BW was 22.30 ± 0.09 kg. This value is comparable to 22.51, 22.87 and 22.1 kg reported by Olson *et al*. (2009), Habtamu *et al*. (2010) and Dhaka *et al.* (2013) for Jersey breed, respectively. However, it is lower than the value (23.69 kg) reported by Ali *et al*. (2019) in Pakistan and higher than 20.87 and 20.97 kg estimated by Akdag *et al*. (2011) and Fernando *et al*. (2016) for pure Jersey breed in Turkey and Srilanka, respectively. The difference of the present result from other results reported elsewhere could be associated with herd management (feeding practice, health control) and climate difference in which animals were managed.

The result revealed that birth weight was significantly affected by year of birth, parity, postpartum cow weight and calf sex, and not influenced by season of birth. The variation birth weight over year indicates that, there was no uniform management practice across study period. The significant (p <0.001) effect of year of birth on BW in the present study is in line with previous studies on Jersey and other breeds (Olson *et al*., 2009; Getinet *et al*., 2009; Habtamu *et al*., 2010; Assemu, 2015). The trend of BW showed declining pattern from year group 1988-1990 to 1997-1999, and then followed an irregular trend. The year trend of BW in present study was inconsistently fluctuated across the years, which might be related to the fluctuation of management (for instance feed availability) and climatic conditions at different years.

Parity of dam had a significant effect (p < 0.001) on BW of Jersey calf. Calves born from cows with the first parity were lighter at birth than those born from other parities. The contributing factor may be the good maternal environment provided by the mature cows to newly developing fetus since competition for nutrients between fetal development and maternal growth is high in younger dams than older ones. This is supported by other studies in some tropical countries (Habtamu *et al*., 2010; Dhaka *et al*., 2013; Getinet *et al*. 2009) for Jersey. For instance, Getinet *et al*. (2009) and Habtamu *et al*. (2012) found similar effect for Ogaden breed and crosses of with Holstein Friesian and Jersey cattle, respectively.

Least squares mean analysis indicated that there was a significant difference (p < 0.001) between male and female calves in which the former was heavier by 1.02 kg than the later at birth. This was consistent with the study of Habtamu *et al*. (2010), Dhaka *et al*. (2013) and Fernando *et al*. (2016). Similarly, a significant effect of sex was found by Habtamu *et al*. (2012) for Horro and their crosses with Holstein Friesian and Jersey calves and Assemu (2015) for Fogera calves in Ethiopia. The variation of sex effect on birth weight might be due to the physiological and gestation length difference between male and female calves. Male calves have longer gestation length and higher intensity of androgen hormone in the fetus serum, which contributes to more growth (Uzmay *et al*., 2010; Manzi *et al*., 2012).

Table 1. Least square means and standard errors of birth weight (kg)

Effects	N	BW(kg)
		LSM ± SE
Overall	2696	22.30 ± 0.09
CV (%)		13.78
Birth year group		***
1988-1990	727	22.98 ^{b} ± 0.18
1991-1993	331	20.35 ^{d} ± 0.19
1994-1996	239	20.26 ^{d} ± 0.21
1997-1999	251	19.95 ^{d} ± 0.20
2000-2002	331	22.70 ^{b} ± 0.18
2003-2005	303	25.37 ^{a} ± 0.19
2006-2008	113	23.26 ^{b} ± 0.30
2009-2011	135	23.46 ^{b} ± 0.27
2012-2014	199	21.60 ^{c} ± 0.23
2015-2017	67	23.03 ^{b} ± 0.39
Birth season		NS
Dry season	1420	22.37 ± 0.11
Short rain	591	22.40 ± 0.14
Main rain	685	22.12 ± 0.13
Parity		***
1	707	21.5 ^{b} ± 0.16
2	668	22.75 ^{a} ± 0.15
3	469	22.32 ^{a} ± 0.17
4	322	22.44 ^{a} ± 0.19
5	225	22.37 ^{a} ± 0.22
≥6	305	22.34 ^{a} ± 0.19
PPW group		***
1 (<mean-SD)	385	21.20 ^{c} ± 0.19
2 (≥ mean-SD and ≤ mean+SD	1867	22.15 ^{b} ± 0.09
3 (>mean+SD)	444	23.54 ^{a} ± 0.17
Sex		***
Male	1409	22.81 ^{a} ± 0.10
Female	1287	21.79 ^{b} ± 0.11

N= number of observation; CV= coefficient of variation; SE = standard error SD= Standard deviation; PPW = Postpartum cow weight*;* ***= highly significant (p<0.001); NS= Non-Significant. Means with the same letter are not significantly different.

Postpartum cow weight (PPW*)* had a significant effect (p < 0.001) on their calf birth weight which was similar to the result of Bahashwan and Alfadli (2016) for Dhofari cattle breed.

The significant effect Postpartum cow weight on calf birth weight associated with the variation of maternal environment (age and body condition) during pregnancy. The present study indicated that those cows that had weight less than one standard deviation from the mean (342 kg) give birth to calves with a lighter weight as compared to calves born from cows within plus or minus one standard deviation from the mean. On the contrary, those cows that weigh greater than one standard deviation from mean give birth to calves with heavier weight (2.3 4kg) as compared to calves born from cows weigh less than one standard deviation from the mean. These indicate the positive correlation between PPW and calf birth weight as cows with better body condition can allocate more nutrients to the development of the calf during fetal development. From this it can be noted that better management should be provided for cows to have better weighted and body condition calves to enhance survival growth of calves.

The non-significant effect ($p > 0.05$) of birth season on BW of Jersey calves in this study was supported by Getinet *et al*. (2009) and Addisu *et al*. (2010) who noted similar results for Ogaden and Fogera cattle breed, respectively. In contrast to the present study significant effects were reported by Habtamu *et al*. (2010) for Jersey calves and (Melaku *et al*., 2011a; Assemu, 2015) for Fogera calves. The non-significant effect of seasons on BW for on-station dairy herds may indicate the absence of seasonal difference or similarity of herd management for all the seasons on the farm. It might be due to the extended period of good and bad seasons sum effect makes season to have none significant effect. In addition the fetal growth faces almost all seasons. Thus, all seasons could have equal effect and so one season may not affect fetal growth separately.

Non-Genetic Factors Affecting Reproductive Traits

Age at first calving (AFC)

The least square mean and standard error of AFC are summarized in Table 2. The overall least squares mean of AFC was 32.68 ± 0.19 months, which is comparable with the value of 972.45 days (32.41 months) Yosef (2006). The value of the present figure is higher than the report of Muller *et al*. (2014) who found 26.4 months. But it was lower than 1010.73 days (33.69 months), 1065 days (35.5) and 41.94 months estimated by Syed *et al*. (2010), Nandolo (2015) and Fernando *et al*. (2016), respectively for the same breed in other tropical countries.

The result revealed that AFC was significantly ($p < 0.001$) affected by both year and season of birth indicating the inconsistent management practice. The significant effect of birth year in the present study is in line with some other studies in the tropics (Yosef, 2006; Syed *et al*., 2010; Direba *et al*., 2015; Nadolo, 2015). In contrast to this study, non-significant effect of year was reported by (Habtamu *et al*. 2010). Animals born during 1985-1987 showed the shortest (25.77 ± 0.28) AFC compared to other groups. This is attributed to the management and environmental difference as this group of heifers was pregnant when imported.

The significant effect of season of birth on AFC found in the current study agrees with Yosef (2006) and Direba *et al*. (2015) but contradictory to Habtamu *et al*. (2010) and Seyed*et al*. (2010) for the same breed in Ethiopia and Pakistan, respectively. Cows born during the dry and main rainy seasons attained AFC earlier than those born during the short rainy season by about 1.3 and 1.26 months, respectively. This might be due to post-weaning stress of the main rainy season on calves born during short rainy season because of low temperature and shortage of feed during the rainy season as the pasture land was restricted from grazing.

Table 2. Least square means and standard errors of age at first calving (AFC)

Factors	N	AFC (month)
		LSM ± SE
Overall	1180	32.68 ± 0.19
CV (%)		16.44
Year group of birth		***
1985-1987	396	25.77^{f} ± 0.28
1988-1990	110	32.29^{cd} ±0.49
1991-1993	44	34.86^{bc} ± 0.76
1994-1996	102	29.74^{e} ± 0.50
1997-1999	96	31.64^{de} ± 0.52
2000-2002	105	32.75^{cd} ± 0.49
2003-2005	104	36.00^{b} ± 0.49
2006-2008	59	38.83^{a} ± 0.66
2009-2011	47	36.12^{ab} ± 0.73
2012-2014	86	35.29^{b} ± 0.54
2015-2017	31	26.14^{f} ± 0.90
Season of birth		***
Dry season	646	31.88^{b} ± 0.23
Short rain	181	33.70^{a} ± 0.38
Main rain	353	32.44^{b} ± 0.29

N = number of observation; CV = coefficient of variation; SE = standard error; *** = highly significant ($p < 0.001$); Means with the same letter are not significantly different.

Calving interval (CI)

The overall least square mean and standard error for CI of pure Jersey cows was estimated to be 479.80 ± 4.45 days. The present estimate is lower than the studies of Yosef (2006), Syed *et al.* (2010), Direba *et al*. (2015) and Nandolo (2015) who found CI of 499.59, 487.31, 497 and 491, respectively for Jersey breed. In the contrary, shorter calving intervals (382 to 450 days) were estimated for Jersey cows and Jersey crosses in Ethiopia and other tropical countries (Habtamu *et al*., 2010; Fernando *et al*., 2016; Sisay, 2015). The difference in CI observed with literature may be due to differences in animal management across the farm, climate of the area and heterosis effect for the crossbred cattle. The result also showed that pure Jersey breed in the tropical environment of Ethiopia exhibited higher CI indicating the need of management improvement.

Analysis of variance revealed that CI was significantly affected by calving year and season, PPW and parity. The observed significant effect of year of calving ($p < 0.001$) was consistent with some other studies in Ethiopia (Yosef, 2006; Habtamu *et al*., 2010; Direba *et al*., 2015). The highest calving interval (597.55 days) was recorded during 1991-1993. These could be attributed to management problems like shortage of feed because these years were the period of regime/government change and hence might be attributed to financial scarcity as the farm was funded by the government.

The significant effect ($p < 0.05$) of calving season on CI is also noted by previous studies conducted on Holstein Friesian cows and their crosses with Boran breed (Destaw and Kefyalew, 2018; Kefyalew *et al*., 2019). Unlike the present study, non-significant effect of season of calving on CI was reported by other studies (Yosef, 2006; Habtamu *et al*., 2010; Syed *et al.*, 2010; Direba *et al*., 2015; Vinothraj *et al.*, 2016). Seasonal variation of CI might be due to the difference of rainfall and forage availability. The longest CI (491.51 ± 6.35 days) was observed from cows give birth during the main rain season because of the shortage of feed during the main rain season as pasture land is restricted from grazing.

The significance effect ($p < 0.05$) of parity on CI in this result was supported by different literatures (Yosef, 2006; Habtamu *et al*., 2010; Direba *et al*., 2015), but disagree with Alewya (2014) who reported non-significant effect of parity. There was no clear trend of CI observed with parity. CI in 1st parity was significantly ($p<0.05$) lower than 3rd, 4th and 5th parities but there is no significant difference between 2nd, 6th and 7th parities. Cows in the 5th parity require 32 more days to give birth to the next calf than those cows in the first parity.

Postpartum cow weight had a significant effect ($p < 0.05$) on their length of next CI. In the present study, higher CI was observed from cows that weight less than and greater than one standard deviation from the mean (345.75 kg) as compared from cows weighing within plus or minus one standard deviation from the mean. This means cows which have too light and heavy postpartum weight increase the length of their calving interval which indicated that poor body condition and over weighting is undesirable for CI. The significant effect of postpartum cow weight in the present study was supported by (Henkes *et al*. 2004). As the author noted that shorter CI are expected for cows with optimal body weights and appropriate nutritional status is essential to increase postpartum cow weight since body condition at calving is one of the most important components influencing reproductive performance.

Table 3. Least square means and standard error of Calving interval (CI)

Factors	N	CI (days)
		LSM ± SE
Overall	1655	479.80 ± 4.45
CV (%)		23.39
Calving year group		***
1988-1990	499	472.10[bc] ± 8.47
1991-1993	120	597.55 [a] ± 11.17
1994-1996	152	501.23 [b] ± 9.52
1997-1999	160	462.28[bcd] ± 9.18
2000-2002	207	438.02 [d] ± 8.12
2003-2005	193	459.67 [cd] ± 8.39
2006-2008	63	448.00 [cd] ± 14.23
2009-2011	88	482.36[bc] ± 12.08
2012-2014	133	467.33[bcd] ± 10.04
2015-2017	40	469.45[bcd] ± 17.83
Calving season group		*
Dry season	920	475.35 [b] ± 5.37
Short rain	324	472.54 [b] ± 6.89
Main rain	411	491.51 [a] ± 6.35
Parity		*
1	516	465.05[ce] ± 7.06
2	418	476.12[abc] ± 6.64
3	247	493.73 [b] ±7.94
4	187	486.56[abd] ± 8.77
5	137	497.14 [ab] ± 9.90
6	85	463.15[dce] ± 12.41
≥ 7	65	476.86[abe] ±1 4.14
PPW group		**
1(< mean - SD)	236	491.52 [a] ± 8.95
2(≥ mean - SD and ≤ mean + SD	1153	466.94 [ab] ± 4.23
3(> mean + SD)	266	480.95 [b] ± 7.60

N = number of observation; CV = coefficient of variation; SD = standard deviation; SE = standard PPW = Postpartum cow weight error; NS = non-significant (p > 0.05); *** = highly significant (p < 0.001); ** = significant (p<0.01); * = significant (p < 0.05); Means with the same letter are not significantly different.

Number of service per conception (NSC)

The least square mean and standard error of NSC are shown in Table 4. The overall least square mean of NSC for Jersey dairy cattle breed in this study was 2.01 ± 0.02. NSC in the present study is higher than the range of 1.6 to 1.8 recommended as satisfactory for well managed dairy herd (Borkowska *et al*., 2012). Thus, indicating the need of management improvement intervention of the herd.

The current estimate is almost similar to the report of Direba *et al*. (2015) and Fernando *et al*. (2016) who found 2.02 and 2.1 for Jersey breed in the central highland of Ethiopia and Sri Lanka, respectively. But it is lower than the studies of Yosef (2006) and Vinothroj *et al*. (2016), who noted 3.07 and 2.5 for Jersey in Ethiopia and Jersey and Red Sindhi crossbred in India. On the other hand, our estimate is higher than 1.79 and 1.55 for Jersey cattle reported by Habtamu *et al*. (2010) and Muller *et al*. (2014) in Ethiopia and South Africa respectively.

The analysis of variance revealed that NSC was significantly ($P < 0.001$) affected by service year, service season and parity. The significant effect of service year observed in the present study agree with the finding of Yosef (2006), Habtamu *et al*. (2010) and Direba *et al*. (2015) for Jersey breed in Ethiopia. But disagree with Vinothroj*et al*. (2016), who reported a non-significant effect of service year on NSC for Jersey and Red Sindhi crossbred cows in India.

The mean number of services per conception was the lowest (1.49 ± 0.05) for cows inseminated during 1987 -1989, while it was highest (2.69 ± 0.07) during 1993-1995 and significantly increase from year group 1987-1989 to 1993-1995 then statistically remains constant from 1996 onward. The variation NSC over year might be due to the fluctuation of management and climatic conditions that could be mainly affected feed availability.

The significant effect of service season on NSC ($p < 0.001$) obtained in the present study is in line with the findings of Habtamu *et al*. (2010) and Direba *et al*. (2015). Opposite to the present study, Berihulay and Mekash (2018) reported non-significant effect of season on Holstein Frisian and Kefyalew *et al*. (2019) for Holstein Frisian and Boran crosses. The effect of service season on NSC might be attributed to management or environmental difference such as feed availability across season. Cows inseminated during main rain season required more service than dry and short rain seasons. This might indicate that the level of management in this farm was not similar between seasons and restricting animal from grazing during rainy season could cause shortage of feed and affect the trait.

The significant effect of parity on NSC obtained in the present study was in agreement with other reports (Yosef, 2006; Direba *et al*. 2015; Vinothraj *et al*., 2016). But disagree with Habtamu *et al*. (2010) and Kefyalew *et al*. (2019). Number of service per conception significantly ($p < 0.05$) increased from 1^{st} to 2^{nd} parity then remains constant from 2^{nd} up to 7^{th} parities. This was in agreement with the report of Yosef (2006) and Direba *et al*. (2015). The higher NSC for later parity (older) cows than the first parity may be due to lactation stress.

Table 4.Least square means and standard errors of number of service per conception (NSC)

Effects	N	NSC
		LSM ± SE
Overall	3676	2.01 ± 0.02
CV (%)		58.04
Service year group		***
1987-1989	779	1.49 ^{c} ±0.05
1990-1992	495	1.99 ^{b} ± 0.06
1993-1995	230	2.69 ^{a} ± 0.07
1996-1998	300	2.15 ^{b} ± 0.06
1999-2001	390	2.00 ^{b} ± 0.06
2002-2004	362	2.08 ^{b} ± 0.06
2005-2007	341	2.09 ^{b} ± 0.06
2008-2010	179	1.83 ^{b} ± 0.08
2011-2013	223	1.98 ^{b} ± 0.07
2014-2016	253	2.01 ^{b} ± 0.07
2017-2019	124	1.79 ^{bc} ± 0.09
Service season		***
Dry season	1613	1.94 ^{b} ± 0.03
Short rain	1055	1.97 ^{b} ± 0.04
Main rain	1008	2.12 ^{a} ± 0.04
Parity		***
1	1044	1.67 ^{b} ± 0.04
2	901	2.11 ^{a} ± 0.04
3	647	2.04 ^{a} ± 0.05
4	417	1.96 ^{a} ± 0.06
5	267	2.08 ^{a} ± 0.07
6	181	2.18 ^{a} ± 0.08
≥ 7	219	2.03 ^{a} ± 0.07

N = number of observation; *** = highly significant ($p < 0.001$); Means with the same letter are not significantly different; CV = coefficient of variation; SE = standard error.

CONCLUSION AND RECOMMENDATION

Calf BW and AFC in Jersey dairy herd at Adea Berga farm was good and comparable with the studies conducted in other tropical countries. However, the CI and number of services required for pregnancy were high indicating the need for management and genetic improvement interventions. The significant influence of year, season, PPW and parity implies that Jersey cows face difficulty to express some of their genetic potentials due to the inconsistent management practices in the farm. In addition, keeping dam in better body condition is important to have better calf birth weight which is critical for calf survival and growth. Thus, design and implementation of appropriate farm management and genetic improvement for reproductive traits are essential for the sustainable use of this herd.

ACKNOWLEDGMENT

The authors are grateful to Ministry of Agriculture, Haramaya University and Ethiopian Institute of Agricultural Research for supporting this study.

REFERENCES

Addisu Bitew, Mengistu Taye, Adebabay Kebede, Getinet Mekuriyaw, Asaminew Tasse, Tezera Mulugeta and Gebeyehu Goshu (2010). Milk yield and calf growth performance of Cattle under partial suckling system at Andassa Livestock Research Centre, North West Ethiopia. *Livestock Research for Rural Development, 22 (8):2010.*

Akadag, F. Arslan, S., Caynak, A. and Teke, B. (2011).The relationship of phenotype, genotype and some environmental factors with birth weight in Jersey calves. African Journal of Biotechnology, 10 (37):7308-7313.

Alewya Heyredin. (2014). Comparative Study of Reproductive and Productive Performance of Holstein Frisian Dairy Cows at Holeta Bull Dam Station and Genesis Farms. M.Sc Thesis, Addis Ababa University, Bishoftu, Ethiopia.

Ali, I., Muhammad Suhail, S. and Shafiq, M. (2019). Heritability estimates and genetic correlations of various production and reproductive traits of different grades of dairy cattle reared under subtropical condition. Reproduction in Domestic Animals, 54(7): 1026-1033.

Assemu Tesfa (2015).Estimation of Genetic and Non Genetic Parameters for Growth and Reproductive Performance Traits of Fogera Cattle Breed, M.Sc. Thesis, Bahir Dar University, Bahir dar, Ethiopia.

Assemu Tesfa and Dilip, K G. (2014). Genetic and Non-Genetic Parameter Estimates of Dairy Cattle in Ethiopia: A Review. Online Journal of Animal and Feed Research, 4(4): 83-90.

Bahashwan, S. and Alfadli, S. (2016). Dam weight, udder score and body condition score effect on calf birth weight and pre weaning daily gain in Dhofari cattle breed. Livestock research for rural Development, 28(3): 41.

Berihulay Haile and Mekash Yoseph (2018). Reproductive Performance of Holstein Friesian Dairy Cows at Alage Dairy Farm, Ethiopia. Journal of Dairy and Veterinary Sciences, 7(3).

Borkowska, D., Piatek, D., Janus, E. and Mucha, J. (2012). Fertility indices of cows in a high-yielding herd. Roczniki Naukowe Polskiego Towarzystwa Zootechnicznego, 8(3).

Cunningham, E P.andSyrstad. O. (1987). Types and breeds of tropical and temperate cattle. In cross breeding Bos indicus and Bos Taurus for milk production in the Tropics. Food and Agriculture Organization of the United Nations (FOA), Rome. Paper 68.

Destaw Worku and Kefyalew Alemayehu (2018).Evaluation of the reproductive performance of Holstein Friesian dairy cows in Alage ATVET College, Ethiopia. International Journal of Livestock Production, 9(6): 131-139.

Dhakal, K., Maltecca, C., Cassady J. P., Baloche, G.,Williams, C. M., and Washburn, S.P. (2013).Calf birth weight, gestation length, calving ease, and neonatal calf mortality in Holstein, Jersey, and crossbred cows in a pasture system. Journal of Dairy Science, 96(1).

Direba Hunde, Gabor, M. Tadelle Dessie, Getnet Assefa, Million Tadesse and Johan, S. (2015). Milk yield and reproductive performance of pure Jersey dairy cattle in the Central Highlands of Ethiopia. Journal of Livestock Research for Rural Development, 27(130).

Fernando, P.R.P., Sinniah, J. and Thatchaneshkanth, S. (2016). Productive and Reproductive Performance of Jersey Cattle in the Hill Country of Sri Lanka. Global Veterinary Journal, 17 (4): 392-400.

Getinet Mekuriaw, Workneh Ayalew and Hegde, B.P. (2009). Growth and reproductive performance of ogaden cattle at Haramaya University, Ethiopia. Ethiopian Journal of Animal Production, 9 (1):13-38.

Habtamu Abera, Solomon Abegaz and Yoseph Mekasha (2012). Influence of non-genetic factors on growth traits of Horro (Zebu) and their crosses with Holstein Friesian and Jersey cattle. International Journal of Livestock Production, 3(7): 72-77.

Habtamu Lemma, KelayBelihu and DesieSheferaw (2010). Study on the reproductive performance of Jersey cows at Wolaita Sodo dairy farm, Southern Ethiopia. Ethiopian Veterinary Journal, 14 (1):53-70.

Henkes, L.E., Benavides, M.V., Oliveira, J.F.C., Moraes, J.C.F. and Weimer, T.A. (2004). Maternal inheritance on reproductive traits in Brangus-Ibagé cattle. Ciencia Rural, 34(4): 1163-1167.

Kefale Getahun, Direba Hunde, Million Tadesse and Yosef Tadesse (2019). Reproductive performances of crossbred dairy cattle at Holetta Agricultural Research Center. Livestock research for rural development, 31(9).

Manzi, M., Junga, JO, Ebong, C. and Mosi R. (2012). Factors affecting pre and post-weaning growth of six cattle breed groups at Songa Research station in Rwanda. Journal of Livestock Research for Rural Development, 24: 4.

Melaku Minale, Zeleke Mekuriya, Getinet Mekuriya and Mengistie Taye (2011a). Pre-weaning growth performances of Fogera calves at Metekel cattle improvement and multiplication ranch, North West Ethiopia. Journal of Livestock Research for Rural Development, 23 (182).

Muller, C.J.C., Potgieter, J.P. and Cloete, S.W.P. (2014). Fertility of South African Holstein and Jersey Heifers. Proceedings, 10th World Congress of Genetics Applied to Livestock Production, Vancouver, British Columbia, Canada.

Nandolo, W. (2015). The performance of Jersey cattle at Naming'omba Tea and Coffee Estate in Malawi. Livestock Research for Rural Development, 27(1).

Njubi, D., Rege, J. E.O., Thorpe, W., Collins- Lusweti, E. and Nyambaka, R. (1992). Genetic and environmental variation in reproductive and lactation performance of Jersey cattle in the coastal lowland semi-humid tropics. Tropical Animal Health Production.24 (4):231-241.

Nuraddis Ibrahim, Shebir Abraha and Shiferaw Mulugeta (2011). Assessment of reproductive performance of crossbred dairy cattle (Holstein Friesian X zebu) in Gondar town. Global Veterinaia, 6(6): 561-566.

Olson, K. M., Casse, B. G., Allister, A. J., and Washburn, S.P. (2009). Dystocia, stillbirth, gestation length, and birth weight in Holstein, Jersey, and reciprocal crosses from a planned experiment. Journal of Dairy Science, 92 (12).

SAS (statistical analysis software) Institute (2008). SAS®/STAT Software, Release 9.1. SAS Institute, Inc., Cary, NC. USA.

Sisay Eshetu (2015). Productive and reproductive performance of dairy cows (Horro, Horro X Friesian and Horro X Jersey) at Bako agricultural research center, M.sc Thesis, Haramaya University, Haramaya, Ethiopia.

Syed Muhammad, Ijaz Ahmed, Abdul Hafeez, Sohail Ahmed, Dawood Jan, Sarzamin, K. and Altaf-ur-rehman (2010). Genetic study of some reproductive traits of Jersey cattle under subtropical conditions. Sarhad Journal of Agriculture, 26(1).

Tamirat Siyoum, Aster Yohannes, Yosef Shiferaw, Zerihun Asefa and MeleseEshet (2016). Major reproductive disorders on Jersey breed dairy cattle at AdeaBerga dairy farm. West Shewa Zone, Oromia Region,, Ethiopia. Ethiopian veterinary Journal, 20(1): 91-103.

Uzmay, C., Kaya and Ayylmaz, T. (2010). Analysis of risk factors for dystocia in a Turkish Holstein herd. Journal of Animal and Veterinary Advances, 9(20):2571-2577.

Vinothraj, S., Subramaniyan, A., Venkataramanan, R., Joseph, C. and Sivaselvam, S.N. (2016). Genetic evaluation of reproduction performance of Jersey× Red Sindhi crossbred cows. Veterinary world, 9(9): 1012-1017.

Yosef Tadesse (2006). Genetic and non-genetic analysis of fertility and production traits in Holetta and AdeaBerga dairy herds in Ethiopia, M.Sc Thesis, Haramaya University, Haramaya, Ethiopia