EVALUATION OF FERTILITY TRAITS OF FRIESIAN X BUNAJI DAIRY COWS

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ABSTRACT

Data from 13 primaparous and 47 multiparous Friesian-Bunaji (F_1) crossbred cows were used to evaluate the reproductive performance of Friesian x Bunaji dairy cows. Four fertility traits; days to first insemination (DFI), days open (DO), Non-return rate 56 days after first insemination (NRR56) and numbers of insemination per conception (NIC) were analysed . The results revealed that the average days to first insemination (DFI), days open (DO) , number of insemination per conception (NIC), and non- return rate 56 days after first insemination (NRR56) were 122.29 days, 171.18 days, 1.64, and 61%, respectively. These traits were highly variability (CV = 54.01-80.90%). The effects of sire and sex of calf on the reproductive characteristics were not significant (p>0.05). The dam body condition score (BCS) had significant effect on all the reproductive characteristics. The DFI, DO and NIC decreased with increase in BCS. Dams with BCS of < 2.50 had longer DFI and DO, and required higher number of inseminations before conception (NIC), while those with BCS of >3.50 had shorter DFI and DO with minimum number of insemination per conception (1.00). Dam parity had no significant effect (p>0.05) on the reproductive characteristics except on NRR56 and NIC. However, the heifer had longer days to first insemination (DFI), and days open (DO) and required higher number of inseminations per conception than the older cows. Season of calving had no significant effect (p>0.05) on the reproductive characteristics except on NRR56. The cows that calved during the wet seasons (early and late dry) had higher NRR56 (69 – 71%), than those of the dry (early and late wet) seasons (40 – 59%). The reproductive performance of the cows depreciated significantly (p<0.05) within the 3 years (2010 - 2012) of this study; DFI increased from 88.47 to 131.49 days, DO increased from 80.39 to 269.14 days, NIC increased from 1.01 to 2.72, while the percentage non-return rate (NRR56) decreased from 86% to 42%.The heritability (h^2) estimates for fertility traits was very low ranging from 0.014 to 0.087. Dam body condition score, parity, season and year of calving are important sources of variation in fertility traits of dairy cows. These results illustrate that environmental effects makes larger contributions to the variability of fertility traits than direct genetic effects, thus reproductive health and feeding management are very important determinant of reproductive performance of dairy cows.

Keywords: Fertility, Friesian x Bunaji cows, Parity, Body condition score, Season, Year

INTRODUCTION

The increasing demand for milk and dairy products in Nigeria due to increasing population and improved standard of living may worsen if the bulk of milk production is still based on the use of multipurpose indigenous cows with genetically low productive potentials. This is because milk production depends on the reproductive efficiency of the cows, with the best cows being those that calf at early age with little number of services per conception and with minimum calving interval thereafter (Ngodigha *et al.,* 2009).

Reports have shown that the rapid means of improving milk production and reproductive efficiency is to combine the adaptability and hardiness of the *Bos indicus* with the genetically high reproductive and milk yield potentials of the *Bos taurus* through crossbreeding (Richard, 1993; Ngodigha *et al.,* 2009). To utilize the genetic advantage of the crossbreeding, many decades ago, Nigeria imported several Holstein Friesian (HF) sires for crossbreeding with the local breeds, especially Bunaji (White Fulani) cows. This effort resulted in a considerable improvement in milk production (Adulli, 1992; Richard, 1993; Oni *et al.,* 2001). The results of studies conducted at the National Animal Production Research Institute (NAPRI), Shika, Nigeria, on the performance of Friesian-Bunaji crossbreds indicated an improvement of about 60% in milk yield of the first cross, and further increase in the level of Friesian blood resulted in an additional gain in yield, but with decreasing magnitude and marked reduction in calving interval and age at first calving (Oni *et al.,* 2001). Since then, there has been increasing interest in the use of pure Holstein Friesian or their imported frozen semen to upgrade the indigenous dairy cows. However, knowledge of the effects of upgrading indigenous dairy cows on the reproductive performance of the crossbred cows has not been studied, this is important in realizing the goal of increasing the production and reproductive efficiency of the indigenous crossbred cows. Therefore, the objective of this study was to evaluate the reproductive performance of Friesian x Bunaji dairy cows

MATERIALS AND METHODS

Experimental Site: The study was conducted on the dairy herd of the National Animal Production Research Institute (NAPRI) Shika, Nigeria, located between latitude 11^0 and 12^0N at an altitude of 640 m above sea level, and lies within the Northern Guinea Savannah Zone (Oni *et al.,* 2001). The mean annual rainfall in this zone is 1,100 mm, which commenced from May and last till October, with 90% falling between June and September. The *harmattan* period of dry, cool weather that follows, marks the onset of the dry season and extends from mid – October to January. The dry season (February – May) is characterized by very hot weather conditions. At this period daily temperature range from 21 to 36^OC, the mean relative humidity is 21 and 72% during *harmattan* and the rainy season, respectively (Malau–Aduli and Abubakar, 1992).

Animals and Managements: Data for this study were collected from 13 primiparous and 47 multiparous (F1) Friesian x Bunaji cows. The cows were raised during the rainy season on both natural and paddock–sown pasture, while hay or silage supplemented with concentrate of cotton seed cake, were offered during the dry season. They had access to water and salt lick *ad-libitum*. Unrestricted grazing was allowed under the supervision of herdsmen for 7 – 9 hours per day. Routine spraying against ticks and other ecto-parasites was done, while vaccination was carried out against endemic diseases.

Measurement of Fertility Traits: In National Animal Production Research Institute (NAPRI), artificial insemination records are well kept, therefore insemination dates are reliable and accurate, and thus these records were used to calculate the fertility traits. The fertility traits measured were the number of inseminations per conception (NIC); days from calving to first insemination (DFI), non-return rate 56 days after first insemination (NRR56) and days open (DO). These were computed using insemination and calving records as follow: non return rate 56 (NRR56) was a binary trait, coded 1 if a cow had only the first insemination date and no second insemination within 56 days after first insemination in a given lactation. Otherwise, NRR56 was coded "0" if a cow had two consecutive inseminations within 12 days, those inseminations were considered to be for the same heat and code remained as 1. Days to first insemination (DFI) was computed as number of days between calving and first insemination date in a given lactation (Kadarmideen *et al*., 2003). Non return rate and DFI covers the two most important aspects of female fertility: the ability of cow to cycle and conceived normally (Kadarmideen *et al.,* 2000) and has been recommended by EU concerted action on genetic improvement of functional traits (GIFT) in cattle (Cameron*,* 1997) for national genetic evaluation. In addition, number of insemination per conception (NIC) and days open (DO) were also recorded. The NIC was defined as the number of times a cow was inseminated before conception in a particular lactation, while days open (DO) was taken as the number of days from calving to successful conception.

Statistical Analysis: The data collected were analysed to determine the effects of sire of dam, dam body condition, sex of calf, parity, season and year of calving on the fertility traits using Least Square Procedure of SAS (2000). The statistical model used is as follows: $Y_{ijklmn} = \mu + S_i + BC_j + P_k + SX_l + SC_m + Yn + e_{ijklmn},$ Where: Y_{ijklmn} = dependent variables (fertility traits), μ= over all mean, S_i= random effect of i^{th} sire (i = 1, 2, 3, 4), BC_j= fixed effect if j^{th} dam body condition score (j = < 2.5, 2.5-3.5, >3.5), P_k = fixed effect of k^{th} parity (k= 1,2….4 5+), SXl = fixed effect of l^{th} sex of calf (l = male or female), SC_m= fixed effect of m^{th} season of calving (m= 1…4), Y_n= fixed effect of n^{th} year of calving (n= 2011, 2012, 2012) and e_{ijklmn} = random or residual error.

Heritability Estimates: The variance components used for the estimation of heritability (h^2) of each milk yield and fertility traits were obtained by variance component procedure (PROC VARCOMP) of SAS (2000), using restricted maximum likelihood (REML) method. The fitted random model for paternal half sib heritability estimation was as follows: $Y_{ij} = \mu + \alpha_i + e_{ij;}$ where Y_{ij} = records of milk and fertility characteristics of cows of each sire, μ = over all mean, α_i = random effect of i^{th} sire and e_{ij} = the uncorrelated environmental and genetic deviations attributed to individual cows within each sire group (Khan and Singh, 2002).

RESULTS AND DISCUSSION

Fertility Traits: The descriptive statistics of fertility traits of Freiesian x Bunaji cows indicated that the overall mean DFI in this study (122.29 ± 12.48 days) (Table 1) was higher than the 102.5 days reported by Kassab and Salem (1993) and 88.4 days reported by Hammoud *et al*. (2010) both on Fresian herd in Egypt. Also Paluci *et al*. (2007) reported DFI of 89.8 days in Canadian Holstein cows. Days open (DO) is a part of calving interval that can be shortened by improved herd management (Hammoud *et al.,* 2010). This could also be affected by accurate heat detection. Therefore, DO is primarily a management decision, with the length of DO depending largely on the operators attitude and reproduction goals. The average DO (171.18 ± 21.78 days) obtained in this study compared favourably with the 177 days reported by Goshu *et al*. (2007) in Ethiopia, but lower than the 181 days reported by Yohannes and Hoddinott (2001) in commercial farm, and also the 205 days reported by Asinwe and Kifaro (2007) in Holstein Friesian (HF) dairy herd in Tanzania. However, the DO value in this study was higher than the 148 and 150 days reported by Tadesse *et al*. (2010) in HF commercial dairy farm in Turkey, 130.70 days reported by Hammoud *et al.* (2010) and 141 days reported by Shalaby *et al*. (2001) in Friesian herd in Egypt. Number of insemination per conception (NIC) is a widely used index of fertility. The average number of insemination per conception (NIC) reported in this study (1.64 ± 0.17) is similar to the 1.62 reported by Lobago (2007) in small holder dairy farms but higher than the range of 1.30 – 1.50 given by Radostits (2001) and Goshu *et al*. (2007), and the 1.30 reported by Akpa *et al*. (2011). However, the values obtained in this study were lower than the estimates of 2.15 reported by Yohannes and Hoddinott (2001) in Asela dairy farm, and 2.00 obtained by Ngodigha *et al.* (2009) in commercial dairy farms. The average NIC of 1.64 in this study was lower than the 2.3 reported by Eid *et al.* (2012) for imported cows and also higher than the 2.0 reported for Fresian dairy cattle in Nigeria (Ngodigha *et al.,* 2009) and 2.11 for

Table 1: Descriptive statistics of reproductive characteristics of Friesian x Bunaji dairy cows [n]

Characteristics	Mean	Min	Max	CV
Days to first insemination (DFI)	122.29± 12.48	30.00	265.00	54.01
Days open (DO)	177.18± 21.78	67.33	366.00	67.33
Number of insemination per conception (NIC)	1.64 ± 0.17	1.00	5.00	62.15
Non return rate 56 days (NRR56)	0.61 ± 0.08	0.00	1.00	80.90

n = number of cows examined (60), Min = minimum value recorded, max = maximum value recorded, cv = coefficient of variation

Table 2: Least square the effect of sire, sex of calf and dam body condition score on reproductive parameters of Friesian x Bunaji dairy cows

Factors		N	DFI	DO	NIC	NRR56
Sire	**1**	10	161.06± 30.76^{a}	234.11±48.20^{a}	2.26±0.51^{a}	0.64±0.21^{a}
	2	28	131.11±24.48^{a}	170.62±38.37^{a}	1.59±0.36^{a}	0.71±0.15^{a}
	3	9	81.87±92.05^{a}	271.93±144.27^{a}	2.02±1.54^{a}	0.73±0.65^{a}
	4	13	63.65±39.63^{a}	112.03±62.12^{a}	1.61±0.62^{a}	0.33±0.26^{a}
Sex of calf	**Male**	28	99.31 ± 32.02^{a}	205.34±50.18^{a}	1.71±0.51^{a}	0.59±0.21^{a}
	Female	32	119.53 ± 31.48^{a}	189.01±49.35^{a}	2.03±0.49^{a}	0.61±0.20^{a}
Dam BCS	**<2.5**	3	126.12±13.48^{c}	174.42±23.17^{c}	1.72±18.0^{c}	0.51±0.20^{a}
	2.5-3.5	46	101.50±47.66^{b}	101.50±83.56^{b}	1.06±0.72^{b}	0.78±0.21^{c}
	>3.5	11	68.00±67.41^{a}	68.00±18.17^{a}	1.00±0.72^{a}	0.74±0.22^{b}

Different number in a column for a factor significantly different means at p<0.05 and p<0.001, DFI = days to first insemination, DO = days open, NIC = number of inseminations per conception, NRR56 = non return rate 56 days after the first insemination

Fresian cows in Pakistan (Niazi and Aleem, 2003). The disparity in the number of insemination required per conception is probably due to one or more of the following reasons; viability of the semen and skill of the inseminator (Buckley *et al*., 2000a), reproductive health of the cows and variation in environment and herd management (Niazi and Aleem 2003; Ngodigha *et al.,* 2009).

Non return rate at 56 days after first service has been reported as the most widely used trait in genetic improvement of fertility in dairy cattle (Jamrozik *et al*., 2005; Konigsson *et al.,* 2008). It is define as the proportion of cows that is not subsequetly re-bred within a specified period of time after an insemination (Miglior *et al.,* 1994). It provides a fast evaluation for fertility where the subsequent calving has not yet occurred. The change in the definition of non return rate from 90 to 56 days was made for international harmonization of fertility traits (Liu *et al*., 2008). The percentage NRR56 of 61% in this study was similar to 62.1% reported by Bielfeldt *et al*. (2004) and 65% reported by Kadarmideen (2004) but higher than the 56% reported by Sun *et al.* (2009).

Effect of Sire of dam Sex of calf and Dam Body Condition Score: The least square means for the effect of sire of dam, sex of calf and dam body condition score (BCS) on the reproductive characteristics of dairy cows indicated that the effects of sire and sex of calf on the reproductive characteristics were not significant (p>0.05) (Table 2). The not significant effect of sire on all the fertility traits measured was probably due to the fact that all the sires used in the study were from the same breed and might not vary genetically in terms of their reproductive performance. However, contrary to this study, Hammoud *et al.* (2010) and Wolff *et al*. (2004) reported significant effect of sire on DFI and DO in Holstein heifers of Brazil. Also, other authors had earlier confirmed the significant effect of sire on DO (Oudah *et al*., 2001; Shalaby *et al.,* 2001; Oudah *et al.,* 2008).

Sex of calf had no significant (p>0.05) effect on the fertility traits of the cows. Although there was no literature found that confirmed or disputed the present finding, but it might be suggested that the fertility of the cows was independent of the sex of calf. The dam body condition score which reflects the body reserves and energy balance status of the cows (Kadarmideen, 2004) showed significant (p<0.01) influence on all the fertility traits. This corroborated the earlier findings of many researchers that BCS significantly correlated with fertility traits in cows (Buckley *et al*. 2000a; Pryce *et al.,* 2001; Wall *et al*., 2003; Berry *et al*., 2005; Patton *et al*., 2007). Cows with low BCS of less than 2.50 takes longer days to first insemination (DFI: 126.12 days), and required more than one insemination per conception (NIC: 1.72). This confirmed the observation made by Patton *et al*. (2007) that cow in poor BCS at first service had lower first service conception rate than those with higher BCS during the same time. Also, Buckley *et al*. (2000b) reported significant effect of very low BCS (<2.5) on the likelihood of pregnancy at first service. A study by Domecq *et al*. (1997) showed that cows that lost 0.50 to 1.00 point of BCS had 53% rate of conception at first service and cows that lost greater than 1.0 points of BCS between parturition and insemination had first service conception rate of 17%. In the present study, about 53.33% of the cows had only one NIC, while 23.34% had two inseminations per conception and only 10% had 3 or more inseminations before conception (Figure 1). The high percentage of first insemination conception rate was probably related to the good body condition score of the majority of the cows used for the study; about 76.19% of the cows had moderate BCS of between 2.50 – 3.00, while 4.80% had >3.50 points and only 19.01% had BCS of less than 2.50 (Figure 2). Also, the percentage non return rate which is the proportion of cows that are not subsequently re-bred within a specified period of time (in this case 56 days) after an insemination (Miglior *et al*., 1994) was low (51%) in the cows with low BCS (<2.50) but

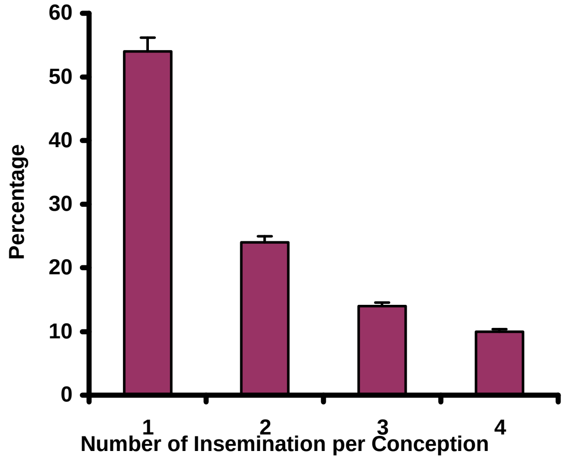

Figure 1: Distribution of experimental animals according to number of insemination per conception

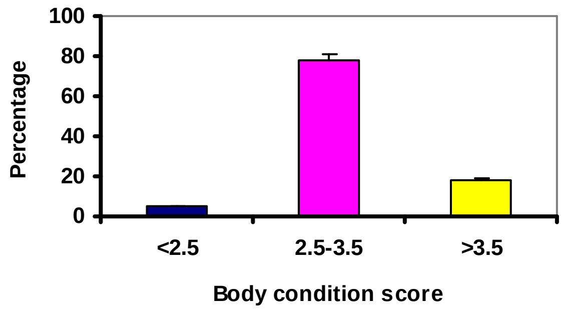

Figure 2: Distribution of experimental animals according their body condition score

high (78%) in those with moderate BCS (2.50 – 3.50). Also, cows with moderate (2.50 – 3.50) or high (>3.50) BCS takes relatively shorter days (101.50 and 68.00, respectively for moderate and high BCS) to first insemination and required minimum (1.00 – 1.06) insemination per conception. It was also observed that increase in dam BCS reduces the interval to first insemination (DFI) from 126.12 days (<2.50) to 68.00 days (>3.5) as well as the number of insemination per conception from 1.72 to 1.0. This corroborate the findings of Pryce *et al*. (2001) that a unit increase in BCS of dam at week 10 of lactation was associated with reduction in the interval to first service by 6.2 days and increase the first service conception rate by 9.0%.

Also, increase in dam BCS increases the percentage non return rate from 51% (for BCS of <2.50) to 78% (for BCS of 2.50 – 3.50) and 74% (for BCS of >3.50). This observations suggested that the optimum BCS for dairy cows ranged between 2.50 and 3.50 points, this corroborated the findings of Paputungan and Makarechian (2000) that BCS of 2.50 and 3.50 (on a 1 to 5 points scale) represents normal and desirable BCS for high birth weight and milk yield.

Days open is a part of calving interval that can be shortened by improved herd management (Hammoud *et al.,* 2010), thus, DO is primarily a management decision, with the length of DO depending largely on the operators attitude and reproduction goals. Herd management especially feed resources, is a major factor that influence the BCS of the dam, and BCS is a major factor that determine the period required for resumption of ovarian activity of cows after calving (Beam and Butler, 1999; Diskin *et al*., 2003; Chagas *et al*., 2006). There was a trend in this study that showed the tendency of DO decreasing with increase in BCS of the dams.

Effect of dam parity, Season and Year of calving: The effect of parity, season and year of calving indicated that the dam's parity had no significant (p>0.05) effect on the reproductive characteristics except on non return rate 56 days after the first insemination and on the number of insemination per conception (Table 3). The not significant effect of dam parity on DFI and DO in this study agreed with the findings of Yohannes and Hoddinott (2001), but contradicted the reports of Abou-Bakr *et al*. (2006) whom reported significant effect of parity on DFI, Asimwe and Kifaro (2007), Goshu *et al*. (2009) and Tadesse *et al*. (2010) whom reported significant influence of parity on DO and Haugana *et al*. (2005) that reported significant effect of parity on NRR56.

Although the effect of parity on the DFI and DO in this study was not significant, there was however, a tendency for these traits to increase with parity. The heifers had longer days to first insemination (DFI), and days open (DO) and required higher number of insemination per conception (NIC) than the cows. This trend is consistent with the findings of Berry *et al*. (2011) who reported a decline in average number of days from calving to first service for cows in parity 1 to 5. Also, Murray (2003) reported that fertility tend to get poorer with increase in number of lactation with a slight decrease from first to third lactation. The possible reasons for this trend could be due to differential in physiological development between the younger and older cows, in which the physiological stress of first calving could affect the resumption of ovarian activity of the young cows (heifers) thus, prolonged the intervals of days to first insemination and days open. The second plausible explanation is the fact that after the first parity, animals continues to grow whereby the dietary energy intake is partition to meet the requirement for maintenance, growth, lactation and reproduction and this might affect the energy stability of the cows required for optimum performance. A report by Stahl *et al*. (1999) showed that first lactation cows had lower energy balance (EB) because they eat less and have energy requirement for growth in addition for lactation, and that lower energy balance in first lactating cows is associated with delays ovulation (prolong interval to first ovulation). Also Lucy (2001) observed that negative EB causes a delay in ovulation.

There was a phenotypic trend in DFI and DO from first to fifth parity in which DFI and DO decreased with parity order with differences of approximately 50 days and 68 days, respectively between 1st and 5th parity. This finding was in agreement with the findings of Van Raden *et al*. (2004) that DO decreased with parity order with differences of approximately 20 days between 1st and 5th lactation.

Season of calving had no significant (p>0.05) effect on the fertility traits of the cows except on NRR56 and NIC. The not significant effect of season on the fertility traits confirmed the earlier findings of Kassab and Salem (1993) and Goshu *et al*. (2009) who reported not significant effect of season on DO and DFI, respectively.

Table 3: Least square effect of parity, season and year of calving on reproductive parameters of Friesian x Bunaji dairy cows

Factors		N	DFI	DO	NIC	NRR56
Parity	**1**	14	144.06± 59.18 [a]	239.02±60.79[a]	2.73±0.75[a]	0.45±0.23[bc]
	2	12	93.58±38.55[a]	190.71±60.41 [a]	1.48±0.62[b]	0.66±0.26[b]
	3	13	106.26± 38.79[a]	211.72±92.75 [a]	1.81±0.65[b]	0.54±0.27[b]
	4	11	101.35±34.42[a]	201.42±53.95 [a]	1.91±0.55[b]	0.51±0.31[b]
	5+	10	101.88±41.31[a]	143.00±64.74 [a]	1.41±0.68[b]	0.84±0.29[a]
Seasons of calving	**Early wet**	15	74.07±3.09[a]	112.69±56.57[a]	1.51±0.57[b]	0.59±0.24[b]
	Late wet	13	101.49±36.29[a]	204.81±56.89[a]	1.56±0.41[b]	0.40±0.27[c]
	Early dry	17	145.42±74.45[a]	312.97±116.69[a]	2.19±1.00[a]	0.69±0.42[a]
	Late dry	15	116.71±24.39[a]	158.22±38.24[a]	2.21±0.64[a]	0.71±0.17[a]
Year of calving	**2010**	20	88.47±34.24[c]	80.39±53.67[c]	1.01±0.59[ab]	0.86±0.25[a]
	2011	24	108.31±42.04[b]	214.99±65.89[b]	1.87±0.63[ab]	0.51±0.27[b]
	2012	16	131.49±42.73[a]	269.135±66.97 [a]	2.72±0.66[a]	0.42±0.28[c]

Different number in a column for a factor significantly different means at p<0.05 and p<0.001, N = number of animals tested, DFI = days to first insemination, DO = days open, NIC = number of inseminations per conception, NRR56 = non return rate 56 days after the first insemination

Table 4: Additive genetic variance (σ^2_s), residual variance (σ^2_e) and heritability (h^2) estimates for fertility traits using univariate sire model on the whole data set of Friesian x Bunaji dairy cows

Items	Fertility traits				
	DFI	DO	NRR56	NIC	GL
σ^2_s	63.48	1572.80	0.0023	0.0067	2.36
σ^2_e	18360.20	53510.10	0.264	1.1081	53.34
h^2	0.014	0.029	0.035	0.024	0.087

DFI = days to first insemination, DO = days open, NRR56 = non-return rate 56 after first insemination, NIC= number of insemination per conception, GL= gestation length

The not significant influence of season of calving on the fertility traits might be associated with the system of management used. The animals in this study were managed under semi-intensive system in which supplementary feeds and water were provided in addition to shelter, these probably minimized the effect of seasonal variation on the dairy herd. Contrary to the findings in this study, Hammoud *et al.* (2010) reported significant effect of season on DFI. Although the effect of season was not significant, there was however, a phenotypic trend in which cows that calved during the dry seasons (early and late dry) had longer DFI (116.71 – 145.42 days) than the wet (early and late wet) seasons (74.07 – 101.49 days). Also, the NIC was low during the wet (early and late wet) seasons (1.51 – 1.56) and higher in the dry (early and late) seasons (2.19 – 2.21). This corroborated with the report of Stetshwaelo and Adebambo (1992) that number of service per conception (NSC) was significantly less during the wet than the dry season. Cows that calved in the wet seasons (early and late wet) had higher percentage non-return rate (69 – 71%) than those that calved during the dry seasons (early and late dry; 40 – 59%). This is probably due to the abundant feed resources and availability of water during the wet season.

The observed significant effect of year of calving on the fertility of the cows had earlier been reported in literatures (Yohannes and Hoddinott, 2001; Goshu *et al.,* 2007), this is probably a reflection of changes in both environmental and management factors. Of particular significant amongst the environmental factors is heat stress. It is one of the main factors related to low fertility rate in dairy cows of warm areas of the world (Klinedinst *et al.,* 1993; St-Pierre *et al.*, 2003). The location of this study falls within such zones with hot climatic condition whose temperature and humidity rises to as high as 40°C and 72% during the hot season. More so, over the recent years there have been reports of global warming with its attending consequences on fertility of dairy cows (McGovern and Bruce, 2000; West 2003; Jordan, 2003).

On the other hand, management presents one of the factors with largest effect on female fertility. For example, cows with low level of BCS at the beginning of lactation could suffer from extreme negative energy balance (NEB) with reduction in ovulation rate, increase calving to first insemination and increase in calving intervals (Berry *et al*., 2003; Roche *et al.,* 2009).

In this study it was observed that the reproductive performance of the cows declined significantly within the 3 years (2010 to 2012). Days to first insemination increased from 88.47 days to 131.49 days, indicating an average increase of 14.34 days per year. Days open increased from 80.39 days to 269.135 days that is an average increase of 62.915 days per year. Number of inseminations per conception increased from 1.01 to 2.72, while the percentage non return rate decreased from 86% to 42%. It is clear that there was a negative trend in the reproductive performance of the cows over the years under study. This negative trend in the fertility of the dairy herd is not peculiar to the herd used for this study, but it is a world-wide phenomenon that has also been reported by many researchers in different herds around the world. Van Doormal (2002) reported a decrease in NNR56 from above 69% to 67% between 1999 and 2001, and Mee *et al*. (2004) reported an increase in NIC from 1.54 to 1.75 between 1990 to 2000.

Heritability of Fertility Traits: Heritability indicates the proportion of observed variance that is due to genetic influence, while the reciprocal is assumed to be due to environmental influences. Genetic improvement in female fertility is an important issue in dairy cattle breeding. However, the heritability estimates of fertility traits are very low. In this study (Table 4) the h^2 estimates for the four fertility traits were 0.014 (DFI), 0.024 (NIC), 0.035 (NRR56) and 0.029 (DO). These estimates were comparable to the 0.087, 0.033, 0.010 and 0.029 for DFI, NIC, NRR and DO, respectively, reported by Sun *et al*. (2009) in Danish dairy cows, and the 0.058, 0.046 and 0.076 forDFS, NRR and DO, respectively, reported by Ghiasi *et al*. (2011) in Iranian Holstein cows. Kadarmideen (2004) reported very low h^2 for DFS (0.12), and NRR56 (0.06) in Switzaland Holstein cows. Furthermore, Gonzalez-Recio *et al.* (2006) and Liu *et al*. (2008) reported very low h^2 for fertility traits in Holstein cows. The low h^2 estimates suggested that environmental effects makes larger contribution to the variability in fertility traits than direct genetic effects.

Conclusion: The results of this study illustrate that management and environmental effects like dam body condition score, parity, season and year of calving makes larger contributions to the variability of fertility traits than direct genetic effects, thus reproductive health and feeding management are very important determinant of reproductive performance of dairy cows

REFERENCES

ABOU-BAKR, S., ALHAMMAD, H. O. A., SADEK, R. R. and NIGM, A. A. (2006). The productive and reproductive characteristics of Holstein cows raised under intensive farming system in Egypt. *Egyptian Journal of Animal Production,* 43: 91 – 98.

ADULI E. O. M. (1992). *Dairy Performance of Friesian-Bunaji Crosses and their Growth to Yearling Age*. M.Sc. Thesis, Ahmadu Bello University, Zaria, Nigeria.

AKPA, G. N., UMAR, M. L. and ALPHONSUS, C. (2011). Evaluation of fertility and calving ease of small holder indigenous cattle herds in semi-arid zone of Nigeria. *Iranian Journal of Applied Animal Science*, 4(1): 235 – 243.

ASIMWE, L. and KIFARO, G. C. (2007). Effect of breed, season, year and parity on reproductive performance of dairy cattle under smallholder production system in Bukoba district, Tanzania.

Livestock Research for Rural Development, 19, article #152. Retrieved October 5, 2009 from http://www.lrrd.org/lrrd19/10/asim19152.htm.

BEAM, S. W. and BUTLER, W. R. (1999). Effects of energy balance on follicular development and first ovulation in postpartum dairy cows. *Journal of Reproduction and Fertility,* Supplement 54: 411 – 424.

BERRY, D. P., BUCKLEY, F. and DILLON, P. (2011). Relationship between live weight and body condition score in Irish Holstein-Friesian dairy cows. *Irish Journal of Agricultural and Food Research,* 50: 141 – 147.

BERRY, D. P., BUCKLEY, F., DILLON, P. and VEERKAMP, R. F. (2005). Dairy cattle breeding objectives combining production and non production traits for pasture based system in Ireland. *Dairy Production Research Centre Moorepark*, Netherlands.

BIELFELDT, J. C., BADERTSCHER, R., TÖLLE, K. and KRIETER, J. (2004). Influence of systematic effects on fertility traits in Swiss brown cows. *Archive Tierz Dummerstorf*, 47(6): 537 – 549.

BUCKLEY, F., DILLON, P., CROSSE, S., FYNN, F. and RATH, M. (2000a). The performance of Holstein-Friesian dairy cows of high and medium genetic merit for milk production on grass based feeding systems. *Livestock Production Science*, 64: 107 – 119.

BUCKLEY, F., DILLON, P., RATH, M. and VEERKAMP, R. F. (2000b). The relationship between genetic merit for yield and live-weight, condition score and energy balance of spring-calving Holstein-Friesian dairy cows on grass-based system of milk production. *Journal of Dairy Science,* 83: 1878 – 1886.

CAMERON, N. D. (1997). Selection indices and prediction of genetic merit in animal breeding. CAB International Wallingford, United Kingdom.

CHAGAS, L. M., RHODES, F. M., BLACHE, D., GORE, P. J. S., MACDONALD, K. A. and VERKERK, G. A. (2006). Precalving effects on metabolic responses and postpartum anestrus in grazing primiparous dairy cows. *Journal of Dairy Science*, 89: 1981 – 1989.

DISKIN, M. G., MACKEY, D. R., ROCHE, J. F., SREENAN, J. M. (2003). Effects of nutrition and metabolic status on circulating hormones and ovarian follicle development in cattle. *Animal Reproduction Science,* 78: 345 – 370.

DOMECQ, J. J., SKIDMORE, A. L., LLOYD, J. W. and KANEENE, J. B. (1997). Relationship between body condition scores and conception at first artificial insemination in a large dairy herd of high yielding Holstein cows. *Journal of Dairy Science,* 80: 113 – 120.

EID, I. I., ELSHEIKH, M. O. and YOUSIF, I. A. (2012). Estimation of genetic and non-genetic parameters of Friesian cattle under hot climate. *Journal of Agricultural Science,* 4(4): 95 – 102.

GHIASI, H., PAKDEL, A., NEJATI-JAVAREMI, A., MEHRABANI-YEGANEH, H., HONARVAR, M., GONZÁLEZ-RECIO, O., CARABAÑO, M. J. and ALENDA, R. (2011). Genetic variance components for female fertility in Iranian Holstein cows. *Livestock Science,* doi:10.1016/j.livsci.2011.01.020.

GONZALEZ-RECIO, O., ALENDA, R., CHANG, Y. M., WEIGEL, K. A. and GIANOLA, D. (2006). Selection for female fertility using censored fertility traits and investigation of the relationship with milk production. *Journal of Dairy Science,* 89: 4438 – 4444.

GOSHU, G., BELIHU, K. and BERIHUM, A. (2007). Effect of parity, season and year on reproductive performance and herd life of Friesian cows at Stella Private Dairy Farm, Ethiopia. *Livestock Research for Rural Development,* 19(7), article #98. Retrieved October 5, 2009, from (http://www.lrrd.org/lrrd19/7/gosh19098.htm).

HAMMOUD, M. H., EL-ZARKOUNY, S. Z. and OUDAH, E. Z. M. (2010). Effect of sire, age at first calving, season and year of calving and parity on reproductive performance of Friesian cows under semiarid conditions in Egypt. *Archiva Zootechnica,* 13(1): 60 – 82.

HAUGANA, T., REKSEN, O., GROHN, Y. T., KOMMISRUD, E., ROPSTAD, E. and SEHESTED, E. (2005). Seasonal effects of semen collection and artificial insemination on dairy cow conception. *Animal Reproduction Science,* 90: 57 – 71.

JAMROZIK, J., FATEHI, J., KISTEMAKER, G. J. and SCHAEFFER, L. R. (2005). Estimates of genetic parameters for Canadian Holstein female reproduction traits. *Journal of Dairy Science,* 88(6): 2199 – 2208.

JORDAN, E. R. (2003). Effects of heat stress on reproduction. *Journal of Dairy Science,* 86(E. Suppl.): E104 – E114.

KADARMIDEEN, H. N. (2004) Genetic correlations among body condition score, somatic cell score, milk production, fertility and conformation traits in dairy cows. *Animal Science,* 79: 191 – 201.

KADARMIDEEN, H. N., THOMPSON, R., COFFEY, M. P. and KOSSAIBATI, M. A. (2003) Genetic parameters and evaluations from single- and multiple-trait analysis of dairy cow fertility and milk production. *Livestock Production Science,* 81(2-3): 183 – 195.

KADARMIDEEN, H. N., THOMPSON, R. and SIMM, G. (2000). Linear and threshold model genetic parameters for disease, fertility and milk production in dairy cattle. *Animal Science,* 71: 411 – 419.

KASSAB, M. S. and SALEM, A. Y. (1993). Some factors affecting reproductive Efficiency and its relationship with milk production in Friesian cows. *Alexandria Journal of Agricultural Research,* 38(2): 105 – 121.

KHAN, F. H. and SINGH, A. (2002). *Principles of Genetics and Animal Breeding.* Jaypee Brothers Medical Publishers (Pvt) Limited, New Delhi, India.

KLINEDINST, P. L., WILHITE, D. A., HAHN, G. L. and HUBBARD, K. G. (1993). The potential effects of climate change on summer season dairy cattle milk production and reproduction. *Climate Change,* 23: 21 – 36.

KONIGSSON, K., SAVOINI, G., GOVONI, N., INVERNIZZI, G., PRANDI, A., KINDAHL, H. and VERONESI, M. C. (2008). Energy balance, leptin, NEFA and IGF-I plasma concentrations and resumption of postpartums ovarian activity in Swedish red and white breed cows. *ACTA Veterinaria Scandinavica,* 50(3): 1 – 7.

LIU, Z., JAITNER, J., REINHARDT, F., PASMAN, E., RENSING, S. and REENTS, R. (2008). Genetic evaluation of fertility traits of dairy cattle using a multiple-trait animal model. *Journal of Dairy Science,* 91: 4333 – 4343.

LOBAGO F. (2007). *Reproductive and Lactation Performance of Dairy Cattle in the Oromia Central Highlands of Ethiopia with Special Emphasis on Pregnancy Period.* Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala.

LUCY, M. C. (2001). Reproductive loss in high-producing dairy cattle: where will it end? *Journal of Dairy Science,* 84: 1277 – 1293.

MALAU-ADULI, A. E. O. and ABUBAKAR, B. Y. (1992). Estimation of 305-day yield from milk yield in Bunaji and Friesian-Bunaji crosses. *Nigerian Journal of Animal Production,* 19(2): 141 – 145.

MCGOVERN, R. E. and BRUCE, J. M. (2000). A model of the thermal balance for cattle in hot conditions. *Journal* of *Agricultural Engineering Research,* 77(1): 81 – 92.

MEE, J., ROSS, E. and DILLON, P. (2004). Is Irish dairy herd fertility declining? *Proceedings of the 23rd World Buiatrics Congress, Quebec, Canada*.

MIGLIOR, F., KEMP, R. A. and BURNSIDE E. B. (1994). Genetic parameter Estimates of conformation and performance traits in station-tested Limousine bulls. *Canadian Journal of Animal Science,* 74(2): 379 – 383.

MURRAY, B. (2003). Balancing act – Research shows we are sacrificing fertility for production traits. *Publication 81-093. Ontario Ministry Agriculture and Food,* Toronto, Canada.

NGODIGHA, E. M., ETOKEREN, E. and MGBERE, O. (2009). Evaluation of age at first calving and number of service per conception traits on milk yield potentials of Holstein Frisian x Bunaji crossbred cows. *Research Journal of Animal Science*, 3(1): 6 – 9.

NIAZI, A. A. K. and ALEEM, M. (2003). Comparative studies on the reproductive efficiency of imported and local born Friesian cows in Pakistan. *Journal of Biological Sciences*, 3(4): 388 – 395.

ONI, O. O. I. A. ADEYINKA, R. A. AFOLAYAN, B.I NWAGU, A. E. O. MALAU-ADULI, C. B.I ALWA AND O. S. LAMIDI (2001). Relationships between milk yield, postpartum body weight and reproductive performance in Friesian x Bunaji Cattle. *Asian-Australasian Journal of Animal Sciences,* 14(11): 1516 – 1519.

OUDAH, E. Z. M.; SHALABY, N. A. AND MUSTAFA, M. A. (2001). Genetic and non genetic factors affecting days open, number of service per conception and age at first calving in a herd of Holstein-Friesian cattle. *Pakistan Journal Biological Sciences*, 4(6): 740 – 744.

OUDAH, E. Z. M., MOSTAFA, M. A., EL-ARIAN, M. N. and ISMAIL, R. F. (2008). Productive and reproductive performance of Russian black pied cows in the first three lactations under hot climate conditions in Uzbekistan. *Journal* of Agricultural Science, *Mansoura University,* 33(6): 4063 – 4075.

PALUCI, V., LAWRENCE, R., SCHAEFFER, F. M. and OSBORNE, V. (2007). Non-additive genetic effects for fertility traits in Canadian Holstein cattle. *Genetics Selection Evolution,* 39: 181 – 193.

PAPUTUNGAN, U. and M. MAKARECHIAN. (2000). The influence of dam weight, body condition and udder scores on calf birth weight and preweaning growth rates in beef cattle*. Asian-Australasian Journal of Animal Sciences,* 13: 435 – 439.

PATTON, J., KENNY, D. A., MCNAMARA, S., MEE, J. F., O'MARA, F. P., DISKIN, M. G. and MURPHY, J. J. (2007). Relationships among milk production, energy balance, plasma analytes, and reproduction in Holstein-Friesian cows. *Journal of Dairy Science,* 90: 649 – 658.

PRYCE, J. E., COFFEY, M. P. and SIMM, G. (2001). The relationship between body condition score and reproductive performance. *Journal of Dairy Science,* 84: 1508 – 1515.

RADOSTITS, O. M. (2001). *Herd Health: Food Animal Production Medicine*. Third Edition, W. B. Saunders Company, Philadelphia, USA.

RICHARD, W. M. (1993). *Dairying.* CTA Number 526, The Tropical Agriculturalist, CTA Macmillan, Oxfam, Oxford.

ROCHE, J. R., FRIGGENS, N. C., KAY, J. K., FISHER, M. W., STAFFORD, K. J and BERRY, D. P (2009). Invited review: Body condition score and its association with dairy cow productivity, health, and welfare. *Journal of Dairy Science*, 92(12): 5769 – 5801.

SAS (2000) SAS User's Guide Version 8.1. Statistical Analysis System Institute Incorporated, Cary, NC, USA.

SHALABY, N. A., OUDAH, E. Z. M. and ABDEL-MOMIN, M. (2001). Genetic analysis of some productive and reproductive traits and sire evaluation in imported and locally born Friesian cattle raised in Egypt. *Pakistan Journal Biological Sciences,* 4(7): 893–901.

STAHL, T. J., CONLIN, B. J., SEYKORA, A. J. and STEUERNAGEL, G. R. (1999). Characteristics of Minnesota dairy farms that significantly increased milk production from 1989–1993. *Journal of Dairy Science*, 82: 45 – 51.

STETSHWAELO, L. L. and ADEBAMBO, A. O. (1992). *Genetic Conservation of*

Domestic Livestock. CAB International, Wallingford, United Kingdom.

ST-PIERRE, N. R., COBANOV, B., SCHNITKEY, G. (2003). Economic losses from heat stress by US livestock industries. *Journal of Dairy Science*, 86(Supplement 1): 52 – 57.

SUN, C., MADSEN, P., LUND, M. S., ZHANG, Y., NIELSEN, U. S. and SU, G. (2009). Improvement in genetic evaluation of female fertility in dairy cattle using multiple-trait models including milk production traits. *Journal of Animal Science,* 88(3): 871 – 878.

TADESSE, M., THIENGTHAM, J., PINYOPUMMIN, A. and PRASANPANICH, S. (2010). Productive and reproductive performance of Holstein-Friesian dairy cows in Ethiopia. *Livestock Research for Rural Development,* 22(2), article #34. Retrieved October 5, 2009, from (http://www.lrrd.org/lrrd22/2/tade22034.htm).

VAN DOORMAL B. (2002). Effet de l'âge et du mois d'insémination sur la fertilité, 4 pages. www.cdn.ca/articles/fertility-f.2002.

VAN RADEN, P. M., SANDERS, A. H., TOOKER, M. E., MILLER, R. H., NORMAN, H. D., KUHN, M. T. and WIGGANS, G. R. (2004). Development of a national genetic evaluation for cow fertility. *Journal of Dairy Science,* 87(7): 2285 – 2292.

WALL, E., BROTHERSTONE, S., WOOLLIAMS, J. A., BANOS, G. and COFFEY, M. P. (2003). Genetic evaluation of fertility using direct and correlated traits. *Journal of Dairy Science,* 86: 4093 – 4102.

WEST, J. W. (2003). Effects of heat stress on production in dairy cattle. *Journal of Dairy Science,* 86: 2131 – 2144.

WOLFF, M. C. C., MONARDES, H. G. and RIBAS, N. P. (2004). Environmental factors that influence the age at the first calving, days open and calving interval in Holstein cows of the Castrolanda, State of Paraná. *Archives of Veterinary Science*, 9(2): 35 – 41.

YOHANNES, Y. and J. HODDINOTT (1999). *Classification and Regression Tress: An Introduction.* International Food Policy Research Institute, Washington DC, 20006 USA.