

# Effect of Cow Parity and Calf Characteristics on Milk Production and Reproduction of Friesian Dairy Cows

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## Abstract

Viability and profitability of livestock enterprise is evaluated by the percentage of pregnant females over a period of time after exposure to bulls and amount of milk yield per lactation. This attribute was tested using 20 seven-month in calf Friesian dairy cows. Effect of parity on; gestation period, calf birth weight, milk production, lactation length, and postpartum heat were tested in this study. Effect of calf sex and calf birth weight on milk production and postpartum heat of the dam was also studied. Parity highly influenced gestation period with Cows at parity 4 taking significantly the least number of days (269.5 days). The cows at parity 4 delivered calves that recorded the highest calf birth weight mean (39.0 kg). Milk production per day was significantly higher in the cows at parity 4 (17.0 L). There was significant positive correlation ( $r^2=0.86$ ,  $P<0.001$ ) between milk production and time to taken to exhibit postpartum heat Calf birth weight highly influenced milk production with dams of heavier calves producing significantly more milk than dams of lighter calves. Dams of heavier calves had significantly delayed postpartum heat. Calf sex significantly influenced milk production and postpartum heat. There was significant ( $r^2=0.79$ ,  $P<0.001$ ) positive correlation between calf birth weight and time to postpartum heat. Adoption and use of these findings will improve dairy industry through reducing calving intervals. Calf Birth weight should be used as important traits in performance testing of dairy cattle.

**Keywords:** parity, Friesian cow, milk production

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## 1. Introduction

In Kenya, dairy industry is the single largest agricultural sub-sector than tea (Muriuki *et al.*, 2004). It contributes 14 percent of agricultural GDP and 3.5 percent of the total GDP (Government of Kenya, 2008). The industry has tremendously grown since its liberalization in 1992 which increased informal milk trade that mainly consists of small-scale operators dealing in collection of raw milk, processing and marketing (KDB, 2009). Current milk consumption is 145 litres per person per year more than five times milk consumption in other East African countries (SDP, 2005) The consumption is bound to go up due to increased urbanization and wages (Government of Kenya, 2006). If production has to keep pace with demand then all factors that affect production must be identified and addressed.

Reproductive performance of dairy cows is affected by many factors including birth season, mangemental factors as well as the sex of birth calve. The postpartum period constitutes an important period that affects dairy cows' fecundity (Elmetwally *et al.*, 2004). It is well known that the birth season has an effect on ovarian resumption (Crowe, *et al.*, 2014), days open (Hammoud *et al.*, 2010), milk yield as well as number of services per conception (Mham; *et al.*: 2010). The onset of normal ovarian cyclic activity is one of the most important events for dairy cow to regain her maximum breeding potential following parturition. To attain a recommended calving interval of 12 months (Dijkhuizen *et al.*, 1994)), cows should conceive within 85 days after parturition. This requires normal cyclicity within few weeks after calving. The interval in several herds could be reduced by breeding cows on first heat after 45 days postpartum and/or next to first examining the cows for normal reproductive tracts. Hamdi *et al.*, (2012) reported many factors that caused prolonged days open in dairy cows (i.e. feeding season and milk production, silent estrus, frequency and timing of estrus detection, missed estrus due to weak symptoms). The objective of this study was therefore to determine the influence of parity, calf birth weight, and calf sex on dairy cow milk yield and on time taken to exhibit postpartum heat.

## MATERIALS AND METHODS

### Study site

KALRO -Lanet (0° 27' 09' S and 39° 38' 45' E (Oliveira, 2018), is located in Nakuru County, Kenya at an elevation of 1600 meters above sea level. The area has a bimodal rainfall pattern with an annual mean rainfall of 800mm ranging from 534 to 1,049mm and 83% relative humidity. Temperature ranges between 8 to 20°C (Pratt and Gwyne, 1977). Soils are deep sandy loam with good water holding capacity with pH range of 5.5 to 6.5 (Mwangi *et al.*, 2017).

### *Experimental animals*

Twenty ranches Friesian dairy cows were randomly selected using a table of random digits and were enrolled in this study. Criteria for selection included Friesian cow that were seven months in-calf. The cows were grazed for 8 hours on established pastures of *Elmba Rhodes* grass leys interspersed with natural *Themeda Triandra* and star grass (*Cynodon Dactylon*). The cows were supplemented at milking with 2 kg of Total mixed ration of *Brachiaria ruziziensis* mutant line K600 and *Dolichos lablab* mutant line D600 leaves and conserved in multi-nutrient feed block form. Details of milk produced, parity, gestation period, sex of calf, calf birth weights, time to postpartum heat, and lactation period were recorded.

Five milliliters of milk was collected thrice a month from each cow by aseptically stripping 10 mls of evening milk into sterile milk container and one tablet of sodium azide was added to the milk as preservative and the container was sealed. The milk was stored at 4°C until assaying. The milk was analyzed for presence of progesterone using radioimmunoassay technique; self-coating procedure (FAO/IAEA, 1999).

### *Preparation of multi-nutrient block*

If the feed block is too hard it may not be consumed at all (Kunju, 1986). A binder is necessary in order to solidify the blocks, bentonite clay has many advantages over other binders. Bentonite is one of the common natural clays used in animal diets to improve digestibility of nutrients and daily gain and feed intake (Salem *et al.*, 2001). Bentonite can absorb toxic products of digestion and decrease the accumulation of toxic substances in tissues, thus decreasing the incidence of internal disorders (Khadem *et al.*, 2007). The addition of bentonite to the diet can partly equalize the supply of nitrogen to the rumen microorganisms.

Bales of *Brachiaria* grass were half ground whereas *Dolichos lablab* leaves were completely ground using a grinder (hammer mill). The ingredients used for making multi-nutrients feed blocks were ground *Brachiaria*, and *Dolichos lablab* leaves, lemon rind, common salt, mineral premix, cement, bentonite and molasses binder (Table.1). Water was taken at the rate of one third of binder in a plastic basin of about 10 litres capacity. To this salt, lemon rind, mineral premix, was thoroughly mixed then the ground feed was added. After this, binder was gradually poured in the same basin. The whole mass was thoroughly stirred with the help of a wooden rod by adding gradual amount of molasses in the plastic basin. After that whole mixed feed was transferred into sets of open ended molds placed on flat even ground and gently pressed using filled 2 litre water plastic bottles. Well compacted the feed blocks were gently removed from the molds by lifting the molds up and leaving the blocks on polythene paper. The resultant feed blocks were left in a well aerated place for 3 days to cure then transferred to a greenhouse where they were placed on grills for 3 days to dry. The dry feed blocks were kept in a well aerated raised dry ground for complete drying and long storage. All the dried blocks were poly-packed and thereafter keeping quality of blocks was assessed using ELISA technique.

**Table1. Physical composition of solid multi-nutrients block**

<b>Ingredient</b>	<b>Amount (%)</b>
Ground <i>Brachiaria</i>	55
Round <i>Dolichos</i> leaves	15
Common Salt	1
Bentonite Clay	5
Lemon Rinds	8
Mineral Premix (Unga ltd)	1
Portland Cement	5
Molasses	10

### *Determining Feed Nutritional Composition*

The pastures were sampled monthly from the grazing fields. This was done by randomly throwing a 1m<sup>2</sup> quadrant diagonally across the field and the swath within the quadrant was cut using a sickle. After mixing the various quadrant swaths, a sub sample from the mixture was picked in duplicate then prepared for laboratory analysis. The forage and feed block samples were oven dried at 106°C for 12 hours after which DM, NDF, ADF, ADL and CP were determined using the Van Soest method (AOAC, 1995). The muffle furnace was used to determine the ash content of the established forage and feed blocks fed to the experimental cows.

### *Statistical analysis*

Data collected were subjected to Analysis of variance (ANOVA) and treatment means were separated using Duncan multiple range test at  $\alpha=0.05$ . Descriptive statistics was done using the Proc Univariate procedure in SAS. Statistics analysis software (SAS) Version 9.3 was used for the analysis (SAS 2010).

## RESULTS AND DISCUSSIONS

### Feed Analyses

The nutritive values of forage and feed blocks fed to experimental cows are summarized in Table 2. These values are higher than those obtained in the East African region as reported by Smith *et al.* (2006) in Ethiopia and Irungu and Mbugua (1998) in Kenya. They reported a mean crude protein of 15.8% and 8.3%, while crude fibre was 9.6% and 32.3% for dairy meal and pasture respectively. High values for NDF as indicated below reflect the good pastures used, and were suitable in enhancing rumen function (Russel *et al.* 1992). The aflatoxin level was 7.4 ppm after 9 months of keeping. This level were below the threshold of 10 ppm and therefore safe to be used as animal feed (FAO, 2004)

**Table 2: Mean±SD of Nutritional Values of Forage and Concentrate Fed to Cows**

Nutritional Component:	Forage (%)	Feed block (%)
Dry Matter	36.8±2.5	86±3.7
Crude Protein	4.7±2.2	26±1.1
Neutral Detergent Fiber	41.7±6.7	72.7±9.5
Acid Detergent Fiber	42.6±2.5	38.4±4.9
Acid Detergent Lignin	4.7±1.6	4.1±0.6
Ash	8.9±1.3	20±2.1
Total aflatoxin (ppm)	-	7.4020±0.3

### Effect of cow and calf characteristics on the cow performance

The analysis of variance (ANOVA) indicated that parity, and calf sex had an effect on the cow performance. Parity had a significant ( $P < 0.05$ ) effect on gestation period. There was no significant ( $P > 0.05$ ) parity effect on the calf birth weight, lactation period and months to heat after calving (Table 3). The sex of the calf had a significant effect on the calf weight, milk production and months to next heat (Table 3).

**Table 3: ANOVA mean square values for the factors affecting the cow performance**

Source of variation	df	Calf birth weight	Milk production	Lactation period	Months to next heat	Gestation to period
Parity	3	49.9 <sup>ns</sup>	18.8 <sup>**</sup>	1.3 <sup>ns</sup>	0.46 <sup>ns</sup>	7.1 <sup>**</sup>
Calf sex	1	434.1 <sup>**</sup>	31.5 <sup>***</sup>	1.4 <sup>ns</sup>	2.94 <sup>*</sup>	0.5 <sup>ns</sup>
Error	5	26.3	0.6	5.0	0.21	0.4
Total	19					

<sup>\*</sup>, <sup>\*\*</sup>, <sup>\*\*\*</sup> - Significant at  $p \leq 0.5$ , 0.1 and 0.001 respectively; <sup>ns</sup>- not significant; df- degrees of freedom

### Effect of parity on cow performance

#### Effect on gestation period

Cows at parity 4 took significantly the least number of days (269.5 days) followed by parity 3. No significant difference was observed in the gestation period between parity 1 and 2 (Table 2). There was significant ( $P < 0.05$ ) difference in gestation period with gestation period reducing with increased parities (Table 2). This finding was similar with the finding of Nogalski *et al.* (2012) who reported optimal gestation length in the range of (275–277) days based on calving ease and stillbirth values for parities 1 and 2 but the gestation period of parities 3 and 4 differed with his findings. This could be due to non-still birth cases reported in this study. Still birth cases increase gestation length (Nogalski *et al.*, 2012).

#### Effect on calf weight

The cows at parity 4 delivered calves that recorded the highest calf weight mean (39.0 kg) while the cow at parity 2 recorded the least calf weight (29.2 kg). However, these differences in calf weights were not statistically significant from each other among the four parities (Table 2). It was expected that calf birth weights increase with increased parity due to less competitive demand on nutrients between calf and dam. This finding differed with the results of Adeneye *et al.* (1977) that Friesian dams with three or more parities and Holstein dams that were 3 years old and above produced calves that were significantly ( $P < 0.01$ ) heavier at birth than calves of younger dams.

#### Effect of parity on milk production

The milk production per day was significantly higher in the cows at parity 4 (17.0 L) that was significantly different from the parities 1-3 (Table 2). This finding agreed with the finding of Koc (2011) who reported increased trend in milk yield up to third parity in Friesian crosses. This also agreed with the finding of Ríos-Utrera *et al.* (2013) who reported that Milk yield traits and cow weight showed a significant increasing trend from first to fourth lactation. This was expected since the udder is physiologically fully developed in higher parity cows than in lower parity cows. Competition on feed for growth is lower in higher parity cows than lower parity cows this is coupled with greater feed intake in older cows than young ones (Johnson *et al.*, 2002) hence the difference in the amount

of milk produced. Cows at parity 4 could have contributed to increased milk production through higher numbers of newly produced active secretory cells. Afzal *et al.* (2007) reported that milk production was significantly lower in the first lactation than the yield in the 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> lactation ( $p < 0.05$ ). However, the yield of first lactation was not different from that of 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> lactation.

#### Effect on lactation length

Cows at parity 2 and 4 took slightly longer period in milk as compared to parity 1 and 3. There was no significant difference in lactation length among the parities considered. This non-significant difference in lactation length among different parities agreed with finding from previous studies (Koc, 2011; Usman *et al.*, 2012; Zewdu *et al.*, 2013) who reported insignificant effect of parity on lactation length but differed with the finding of Licitra *et al.* (1990) who reported significant effect of parity on lactation length. Calf sex did not influence lactation length, this finding agreed with the results of Afzal *et al.* (2007) who reported that lactation length was not affected by calf sex. It was expected that dams with bull calves which produced more milk would have an extended lactation length compared to dams of heifer calves. The results of this study could be due to limited parities available for the study.

#### Effect of parity on postpartum heat

The cows at parity 4 took the longest time (4.1 months) to show heat after calving, though not significantly different from the other parity levels (Table 4). This disagreed with the finding of Mohammed *et al.* (2016) who reported longer days open ( $177.65 \pm 69.22$ ) in multiparous Friesian dairy Cow after first parturition and shorter ( $95.66 \pm 35.97$ ) after the 6<sup>th</sup> parity. It agreed with the finding of Folnožić *et al.* (2016) who concluded that primiparous cows are more susceptible to metabolic stress during the transition period, and that their metabolic and endocrine profiles are more unbalanced as compared to the multiparous cows, which results in more severe and prolonged recovery from negative energy balance. This could explain the non-significant difference obtained between parities in this study since the study did not enroll cows at parity 6. However the finding

**Table 4: Effect of parity on cow performance**

Parity	Calf weight (kg)	Milk production (kg)	Lactation period (months)	Months to next heat	Gestation period (days)
1	31.0 <sup>a</sup>	11.3 <sup>b</sup>	10.5 <sup>a</sup>	3.2 <sup>a</sup>	273.4 <sup>a</sup>
2	29.2 <sup>a</sup>	11.7 <sup>b</sup>	11.0 <sup>a</sup>	3.4 <sup>a</sup>	273.0 <sup>a</sup>
3	30.0 <sup>a</sup>	11.3 <sup>b</sup>	9.5 <sup>a</sup>	3.2 <sup>a</sup>	271.0 <sup>b</sup>
4	39.0 <sup>a</sup>	17.0 <sup>a</sup>	11.0 <sup>a</sup>	4.1 <sup>a</sup>	269.5 <sup>c</sup>

Means followed by the same superscript letter within a column are not significantly different from each other at  $\alpha = 0.05$ .

#### Effect of calf sex on cow performance

Significantly higher calf weights were observed in the male calves (37.1 kg) as compared to the female calves (25.2 kg). The cows that gave birth to male calves produced significantly higher amount of milk than those with female calves (Table 5). This finding agreed with the finding of Hinde *et al.* (2014) who reported that U.S. Holstein dams that gave birth to daughters had higher milk yields than dams that gave birth to sons, and that first parity calf gender affected milk yield in subsequent lactations. The finding of this study differed with the results of Afzal *et al.* (2007) who reported buffaloes with heifer calves gave more milk than buffaloes with male calves.

The months to next postpartum heat were significantly ( $P < 0.05$ ) higher for cows with male calves than those with female calves. This could be due to larger body size of male calf leading to longer time to clear postpartum fluids from the uterus or presence of the Y antigens in the male fetus and a local immune reaction towards the fetal testosterone.

The lactation period was statistically similar for cows with male and female calves (Table 5). This finding agreed with results of Afzal *et al.* (2007) who reported no significant difference in lactation length of buffaloes with male and female calves.

**Table 5: The effect of calf sex on cow performance**

Calf sex	Calf weight	Milk production (daily)	Lactation period (months)	Months to next heat	Gestation period
Male	37.1±1.3	14.3±0.21	11.0±0.53	3.9±0.03	271.9±0.48
Female	25.2±1.5	9.7±0.59	10.2±0.73	2.7±0.12	271.3±0.26

Values are means of the calf sex  $\pm$  the standard error of the means

There was a significant ( $r^2 = 0.73$ ,  $P < 0.001$ ) positive correlation between the calf weight and milk production (Table 6). This finding agreed with the results of Rahba *et al.* (2016) who reported that birth weight is a significant parameter in cow milk production trait. Therefore, birth weight could be considered as an important trait in dairy cattle breeding programs.

There was significant ( $r^2 = 0.79$ ,  $P < 0.001$ ) positive correlation between calf birth weight and postpartum heat

(Table4) with postpartum cows having heavier calves taking longer period to show heat than dams with lighter calves. This was expected due to longer time taken for uterine involution by dams with heavier calves. This differed with the finding of Guedon *et al.* (1999) who reported that calf birth weight was not related to time of first ovulation. The difference could be due to different breeds used, he used beef cows and the present study used Friesian cows.

There was a significant ( $r^2 = 0.86$ ,  $p \leq 0.001$ ) positive correlation between the milk production and the months to next heat signs. This was expected due to energy partitioning which favours milk production in early lactation. During early part of lactation, dry matter intake remains suboptimum thus dairy cow is unable to meet production requirements though intake, hence the little energy she gets through converting her body fats to energy is prioritized for milk production for her calf, the extra is converted to heat exhibition later hence the delay in postpartum heat exhibition. There was non-significant correlation of the factors considered with lactation period and gestation period (Table 6).

Table 6: Correlation of the cow performance indicators

	Calf weight	Milk production	Lactation period	Months to next heat	Gestation period
Calf weight	1	0.73 <sup>***</sup>	0.21 <sup>ns</sup>	0.79 <sup>***</sup>	-0.15 <sup>ns</sup>
Milk production		1	0.35 <sup>ns</sup>	0.86 <sup>***</sup>	-0.34 <sup>ns</sup>
Lactation period			1	0.41 <sup>ns</sup>	0.13 <sup>ns</sup>
Months to next heat				1	-0.13 <sup>ns</sup>
Gestation period					1

\*\*\*- significant at  $p \leq 0.001$ , ns- not significant

## 5. Conclusion

The cow parity affected the gestation period, daily milk production, but did not affect; calf birth weight, neither lactation length nor time to postpartum heat. The calf sex affected the calf birth weight, time to postpartum heat, and daily milk production, but did not affect the lactation length, time to postpartum heat, gestation period. There was significant positive correlation between milk production and time to postpartum heat. There was significant positive correlation between calf weight and postpartum heat. We therefore recommend that parity and calf birth weight should be used as important traits in performance of dairy cattle. Further work should include designing experiment to validate the importance of calf birth weight in dairy cattle breeding programs since we found a high correlation between birth weight and milk production.

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