INFLUENCE OF SIRE AND DAM BREED ON SOME REPRODUCTIVE AND GROWTH CHARACTERISTICS OF SMALL HOLDER CATTLE HERDS IN JIGAWA STATE OF NIGERIA.

BY

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DECLARATION

I declare that the work in the thesis entitled "**Influence of sire and dam breed on some reproductive and growth characteristics of small holder Cattle herds in Jigawa State of Nigeria"** has been performed by me in the department of Animal Science under the supervision of Prof. G.N.Akpa and Dr. G.S.Bawa. The information derived from the literatures has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

Umar Muhammad Lawal

| --- | --- | --- |
| Name of student | Signature | Date |

CERTIFICATION

This thesis titled "INFLUENCE OF SIRE AND DAM BREED ON SOME REPRODUCTIVE AND GROWTH CHARACTERISTICS OF SMALL HOLDER CATTLE HERDS IN JIGAWA STATE OF NIGERIA" by Umar Muhammad Lawal meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, Nigeria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

I humbly dedicate this work to my parents Alhaji Umar Muhammad and late Fatima Abdullahi, my late grandparent Harira and Muhammad, my late brother Muhammad Sani for their moral and financial support that made positive impact to the conclusion of this work.

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ABSTRACT

This study had the objectives of determining the fertility and calving ease of small holder indigenous cattle herds inseminated with imported semen from proven sires, as well as to determine the effects of non genetic factors, and sire and dam breed on birth weight and growth rate of the crossbred calves. The results showed that the mean age, parity, body condition score, number of inseminations per conception and gestation length of cows and birth weight of calves were 6.2years, 2.3, 3.8, 1.3, 286.1 days and 29.5kg, respectively. Age, parity and number of insemination per conception were highly variable (CV=32-47%) while body condition score and gestation length of cows and birth weight of calves were less variable (CV=3-17%). Fifty four percent (54%) of the cows had normal calving while 46% were assisted. Amongst the assisted calving, 89% of the calves survived while 11% died. The age, parity and dam body condition had significant effect ($P< 0.01$) on calving ease of the dams. Calving ease increased with age, parity and body condition of the dam. The effect of sex of calf, season and year of calving on calving ease was significant ($P<0.01$). The female bearing dams had higher calving ease (73%) than the male bearing ones (37%).The male bearing dams recorded the highest percentage (63%) of assisted calving with 46% mortality, while their female counterpart recorded none. Calving ease was highest during the late wet (72%) followed by the late dry (62%) and early wet (57%). The sire breed had no significant ($p>0.05$) effect on the number of insemination per conception but significantly influenced gestation length. Dam breed origin significantly (<0.05) influenced number of insemination and gestation length. The male calves had significantly ($P<0.01$) higher body weight than their female counterparts. Season of calving had significant ($P<0.05$) influence on birth weight,3 and 24 months body weight but not on weaning weight, 6, 12 and 18 month body weight. Birth weight, weaning age,12 months weight,18months weight gain increased with parity up to parity 3 and then declined. Age of dam had no significant ($p>0.05$) effect on the weight characteristics except at 3 and 24 months of age. Sire breed origin significantly ($p<0.01$-0.05) influenced the body weight of the crossbred calves from 3 to 24 months of age. Dam breed had significant ($p<0.01$-0.05) effect on weight at 3 and 6 months of age of calves. Sire breed significantly ($P<0.05$) influenced weaning weight but not birth weight and weaning age of the calves. Sire-Dam breed combinations significantly ($p<0.01$-0.05) influenced the body weight characteristics of calves from 3 to 24 months of age. Generally, the correlation amongst the body weight characteristics was positive except between weaning age and weight at 6 and 12 month of age, respectively.The coefficient of determination (R^2) for the estimation of the body weight using birth weight ranged from 14% to 41%, while that of the weaning weight ranged from 0% to 58%.Therefore, results of this study on *Bos taurus* cattle and their crosses (*Bos Taurus x Bos indicus*) showed that age, parity, body condition score (BCS), sex, season and year of calving as well as sire and dam breed origin, and sire-dam breed combination of *Bos taurus* and *Bos indicus* had significant effect on calving ease, gestation length of the dam and growth characteristics of calves. Thus, these factors should be taken into consideration in any breeding programme aimed at improving the reproductive and growth performance of the indigenous cattle.

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CHAPTER ONE

1.0 INTRODUCTION

The increase in size, number or mass of tissues with time is the primary definition of growth but does not include the phenomenology and etiology of growth, such as the energy transactions in the growing animal in terms of the processes of metabolism, nutrition and genetics (Parks, 1982).Growth includes not only increase of body size per se, but also biological phenomenon at the cellular level in terms of increase in the number (hypertrophy) and size (hyperplasia) of cells and in changes of form and chemical composition resulting from the differential growth of different components of the body, especially muscle and fat (Berg and Butterfield,1976). Growth is continuous during an animal's life, from zygote formation until the adult stage (mature weight), and therefore, should be evaluated by growth rate or by weight and size increases during different stages of life, such as: prenatal growth, pre-weaning growth, post weaning growth and mature size. Body weight measures represent one of the most important economic traits in beef cattle. In addition, body weight is strongly associated with other economic characters including production and reproductive traits. Therefore selection program designed to alter growth in cattle will ultimately cause permanent change in the associated traits (Hassan *et al.,* 2004).

Body growth is determined by genetic and non - genetic factors. The genetic make up of the individual includes additive and non - additive genetic combinations that determine growth. These combination interact with environmental conditions such as climate, nutrition, and management and intrinsic factors such as sex, age, physiological status, as well as

other extrinsic factors such as maternal effects and random environmental factors to determine the ultimate phenotypic expression of growth.

Cattle vary widely in body size, with the optimum mature weight for life time production differing importantly among breeds (Johnson *et al.,* 1990). Efficiency of growth is more important in cattle than other meat animals because of the low rate of reproduction and high maternal maintenance cost per animal. In general, within breed, efficiency is associated with different measurement of body size (Arango and Van Vleck, 2002). Milk Production also is a vital component of efficiency. For example, differences in milk production explained 23% of variation in maintenance requirements when beef cows of different breed composition were fed to maintain constant body weight (Montano - Bermudez *et al.,* 1990). Positive relationships between growth rate and mature size with milk yield have been reported in cattle (Anderson, 1978). Body size can have both biological and economic effects on the efficiency of production. The proportion of total energy intake required solely for body maintenance is over 50% in adult cattle and represents the most important factor that determines biological efficiency and maintenance overhead (Arango and Van Vleck, 2002).

Breeds selected for milk production reach puberty earlier than breed of similar mature size and lean growth potential that do not have a history of selection for milk production (Cundiff *et al.,* 1993). On the other hand, biological types with high milk production potential, medium to large body size, and relatively high reproduction rates, require a favourable nutrient environment to meet requirements for growth, lactation and maintenance, as was the case of some breed groups evaluated in the germ evaluation project at the meat animal

research centre (Cundiff *et al.*. 1998). In a simulation study, Brinks and Miller (1990) found that when feed resources were not limited, large cows with high level of milk production and low management - labour requirement showed optimum net return. Brinks and Bourdon (1993) defined mating systems to match biological type of cow (Mature size and milk production) to feed resources for the cow herd (high to low). However, they also indicated that there is more flexibility for choice of cow size - milk level with a high level of feed resources (Brinks and Bourdon, 1993).

Genetic origin has also been identified as having an important effect on efficiency. Research has shown substantial advantages of *Bos indicus* Vs *Bos taurus* crosses over *Bos taurus* purebred cows for efficiency in the Germ plasma evaluation programme at the US meat animal research center (Green *et al.,* 199la; Cundiff *et al.,* 1993). Zebu crosses benefit from a greater level of heterosis for milk production, feed utilization and longevity, *Bos indicus* cattle also seem to have superior longevity for maternal performance (Green *et al., 1991a).*

Cross breeding has been identified as one of the main strategies for genetic improvement of indigenous cattle for milk production in the tropics (Agyemang and Nkhonjera, 1990); Rege *et al.,* 1994; Makinnon *et al.,* 1996; Tawah *et al.,* 1999). Crossing indigenous Zebu cattle and exotic dairy cattle generally produces dual purpose (milk and meat) genotypes. Dual purpose cows, under the circumstance are expected to produce milk and meat for the resource poor people (Tawah *et al.,* 1999). The effects of cow age, management, milk yield, breeding and maternal ability of the dam as well as

sex, age at weaning, management and breeding of the progeny on pre- and post-weaning growth in beef and dairy calves have been extensively studied (Rahnefeld *et al.*, 1990; Sawyer *et al.,* 1991; Papatungan and Makerechian, 1999; Tawah *et al,* 1999; Akpa *et al.*, 2007). Based on these results it was established that at least 50% of the variation in pre-weaning growth of the calf is due to the milk yield of its dam (Rahnefeld *et al.*, 1990; Arthur *et al.,* 1997). This explains the use of dairy cattle breeds in crossbreeding with beef breeds (Tawah *et al.,* 1999). Such dairy – beef crosses are expected to produce more milk and, hence wean heavier calves relative to their "traditional" beef. The pre-weaning growth of these dual purpose genotypes cannot be ignored because, besides being correlated with post-weaning growth (Tawah *et al*.1999), it plays an important role in their milk production (Christian *et al*., 1965). The early growth traits such as birth weight, weaning weight, 200 day and 400 day weights of the calves are related to their mature size (Meyer, 1995).

Research findings generated in the indigenous cattle breed in the tropics on the reproductive and growth performance will help both breeders and producers to orientate their management systems to new alternative of production for improving dual purpose cattle in tropical condition. Growth is continuous during an animals life, from zygote formation until the adult stage (mature weight), and therefore, should be evaluated by growth rate or by weight and size increase during different stages of life. Information on parent's mature weight and body condition could be helpful in estimating the mature size of the progeny as well. As already indicated, crossbreeding beef and dairy breeds usually

result in dual-purpose genotypes. Information on growth and reproductive potentials of crossbred calves of our indigenous cattle is lacking. The growth pattern and fertility of crossbred cows compared with that of local breeds might be significantly different.

Objectives

The study therefore is aimed at achieving the following objectives

i. To determine the fertility and calving ease of small holder indigenous cattle herds inseminated with imported semen from proven sires.

ii. To determine the non genetic factors that affect birth weight and growth performances of crossbred calves of different sire breed.

iii To determine the effect of sire and dam breed on birth weight and growth rate of crossbred calves.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 FACTORS AFFECTING GROWTH OF CALF

2.1.1 Effect of Sire Breed origin on calf growth

Breed differences in performance characteristic are important genetic resource for improving efficiency of both dairy and beef production. Cross breeding is a widely accepted means of incorporating desirable traits from various breeds, since no single breed excels in all traits of importance (Agyemang and Nkhonjera,1990; Makinnon *et al.,* 1996; Tawa *et al.,* 1999; Lustra and Cundiff, 2003). No evaluation of unique beef cattle genotypes would be completed without specification of calf growth and carcass composition because this more fully describes the effect of the genotype on life cycle productivity (Newman *et al.,* 1993).

Many authors have reported the effect of sire breed on growth of calf. Lustra and Cundiff (2003) reported that sire breed had significant effect on birth weight, weaning weight, yearling weight, weight at puberty and average daily gain (ADG) at puberty of F1 bulls. In general, differences in body weight at puberty reflected breed differences in ADG from weaning to puberty. Also, Browning *et al.* (1995), Harring *et al*. (1996), Thrift (1997), Cundiff *et al.* (1998), Chase *et al.* (2000) and Isea *et al*. (2002) reported significant effect of sire breed on birth weight and weaning weight. Kress *et al*. (1990b) reported differences of 5kg and 4kg for birth weight and weaning weight respectively of calf sired by different breeds. Newman *et al*. (1993) reported that individual additive effects between calves sired by

different breeds were positive for birth weight, weaning weight and carcass weight. The breed differences in respect of growth from birth to weaning and weaning weight of progeny are strongly associated with the genetic potential for growth of each breed (Tawah *et al.,* 1999). However, Snowder and Duckett (2003) did not observe significant effect of sire breed on the birth weight, weaning weight or ADG at average weaning age of 118 days of three sire breed groups, but observed significant effect on the growth rate and body weight at post weaning among the sire breed groups.

2.1.2 Effect of Dam Breed on Calf Growth

Breed differences in respect of growth is an important factor for the genetic improvement of the efficiency of beef and dairy production (Tawah *et al*., 1999). Significant influence of breed on birth weight, weaning weight and yearling weight in calf has been reported (Newman *et al.,* 1993; Abanikanda and Olotogun ,1999; Isea *et al*., 2002). Lunstra and Cundiff, (2003) reported that dam breed had significant effect on average daily gain (ADG) from birth to weaning and yearling body weight of Fl bulls. Abanikanda and Olotogun (1999) and Gwaza *et al.* (2007) reported significant effect of dam on birth weight of calf. The significant effect of the dam on these traits indicated that effects like dams body condition, nutritional status ,age of dam at calving and other common maternal environmental factors which are non genetic factors equally affect the fetal development,calf weight and dams milk production (Gwaza *et al.*,2007 and FAO, 2008). Prenatal maternal effect can be carried over by the progeny to the period after birth (Tawah *et al.,* 1999). In addition, maternal effect was a significant source of variation for growth performance in both Gudali and Wadara breeds

(Ebangi *et al.*, 2002).However, Ehoche *et al.* (1992) reported that there was no significant difference between dam breed in calf body weight at birth, 3, 6 and 12 month of age. Also Akin *et al* (2005) reported that breed of dam effect was not significant for birth weight of calves.

The primary goal of commercial cow-calf enterprises is the production of high quality weaned calves. The average maternal ability of the cow herd is an important factor in such production. Cow with high genetic merit for maternal ability should produce heavy calves at weaning. However, these heavy calves may be at the expense of weight and body condition in the cows which may result in reduced reproductive performance (Buchanan *et al.*, 1993).

2.1.3 Effect of sire- dam breed combination on calf growth

A possible effect of the sire breed of dam did not result in an important source of variation on growth performance of Senepol crossbreed calves (Isea *et al.*, 2002). Nevertheless calves from F_1 Senepol cows weigh 132kg and 230kg respectively at weaning and yearling age, relatively were heavier than calves from Braham, Holstein Swiss and Criollo crossbred cows. The lack of significant effect by breed of sire of dam has also been reported by Isea *et al.*, (2002) as the maternal grand sire did not influence both pre- and post weaning growth. However this finding was contrary to the report of Cundiff *et al.* (1998) and Davis *et al.* (1998), who evaluated growth of pure and crossbreed calves in the U.S. A., the maternal grand sire significantly affected weaning and yearling weight and gains, indicating that genetic variation among breeds are convenient for desired growth complementary on selection of breed for crossbreeding. Newman *et al.* (1993) suggested that calves from first

generation (Fl) mating would grow from birth to weaning more slowly than subsequent generation because of exploitation of maternal heterosis from crossbreed dams in later generations. Similarly, F2 calves would grow more rapidly than other generations because they utilize a greater degree of individual and maternal heterozygosity than other generation. However, Isea *et al.* (2002) suggested that great differences in results for genetic merit when classifying breed groups of cow by their offspring performance might obey more to the dam's different methods of evaluation used by researchers other than breed differences of dams themselves.

2.1.4 Effect of Dam's Age on Calf Growth

Dam's age is one of the factors that have been reported to influence the growth of calves at different ages and at various degrees. Tawah *et al.* (1999) reported that Dam's age at calving significantly affected birth weight, pre-weaning average daily gain and weaning weight of calves. He reported that the age of cow at calving showed significant linear relationship with the pre-weaning average daily gain and weaning weight, despite the fact that the calves were separated from their dam 24hours after birth. The positive relationship between the Dam's age and calf growth from birth to weaning may be an indication that prenatal maternal effects were carried over by the progeny to the period after birth (Tawah, *et al.*, 1999). Also, Sacco *et al.* (1991) and Newman *et al.* (1993) reported increased birth weight with increase in dams' age. The significant age of dam's effect for weaning weight and pre-weaning average daily gain (ADG) may have indicated differences in the maternal ability of cows when they were suckling heavier calves, it may also be possible that the carry over

effect from birth and higher pre-weaning growths rate from older cows have significant effect on the post weaning growth of the calves (Newman *et al.,* 1993). However, Ikwuegbu and Campbell, (1992) reported that Dam age had no significant effect on weight at birth, 12 and 18 month of age but had significant effect on it at 6, and 9 months of age of the calves Sacco *et-al.*(1991) and Newman *et al*. (1993) showed that calves that were heavier at birth and weaning, tended to be heavier at the end of the post weaning test. Calves from 5 years old dams expressed greater post weaning average daily gain (ADG) than calves from 2 years old dams (Newman, 1993).

2.1.5 Effect of Dam's Weight on Calf Growth

Dam's weight at calving may also influence birth weight and pre-weaning growth rate of the calf. Spitzer *et al*. (1995) reported that cows with heavier body weight at parturition gave birth to heavier calves. Pre-weaning calf growth is emphasizing in cow-calf production as it directly affects weaning weight. The early growth traits such as birth weight, weaning weight, 200-day and 400-day weights of the calves are related to their mature size (Meyer, 1995). The positive significant effect of dam weight at calving on the birth weight and pre-weaning growth rate of calf indicated that the heavier cows had allocated more nutrient to the development of the calf during the fetal period, resulting in heavier calves at birth and produced relative more milk, which had positive effect on growth rate of the calves during the pre-weaning period (Paputungan and Makarechian, 1999). In addition the maternal effect was observed to be a significant source of variation for growth performance in both Gudali and Wakwa breeds (Ebangi *et al.,* 2002). This can be attributed to the fact that pre-weaning

development of the calf is greatly influenced by maternal genetic and environmental variation (Paputungan and Makarechian, 1999), especially when the calf suckles its dam from birth to weaning and beyond. The growth performance of the calf will therefore be determined by the dam's potential for milk production by any other related mother behaviour, and by all factors that pertain to motherhood. These factors include among others mothering ability, foraging ability, temperament and immunity of calf and adaptation to diversity (Ebangi *et al.*, 2002).

2.1.6 Effect of Dam Body Condition Score (BCS) On Calf Growth

Information on parent's mature weight and BCS could be helpful in estimating the mature size of the progeny as well (Meyer *et al.,* 1990). Body condition score was a significant source of variation in calf birth weight as well as calf growth rate at the age of 60,90 and 180 days (i.e 3, 6, and 9 months) of age. Higher BCS which represent greater body reserves are associated with higher calf birth weights and generally lower pre-weaning growth rates (Paputungan and Makarechian, 1999). The effect of dam's BCS on the calf birth weight was not sufficient. However, cows with average BCS of 2.5 or 3.0 (On a scale of 1 to 5 points) which represent normal and describable body condition score of the dam gave birth to calves that had higher pre weaning growth rate up to weaning than

those born to calves with higher body condition score (Paputungan and Makarechian, (999). The result may be attributed to the lower milk production of dams with higher body fat reserves compared to those with lower body condition score (Paputungan and Makarechian, 1999). This is in agreement with the results of some earlier researchers who reported that higher BCS were

associated with lower milk production (Jeffery *et al.,* 1971). Spitzer *et al*.(1995) reported that calf birth weights were progressively heavier for cows with body condition score of 4, 5 and 6, respectively (score from 1 to 9). They also reported that cow BCS at calving had no effect on weaning weight of the calves and concluded that fat reserves did not have a major role in milk production. Vargas *et al.* (2000) reported significant effect of dam's BCS on birth weight and weaning weight. He reported that BCS tended to affect birth weight in the first parity dams, but did not affect birth weight of calves from 2^{nd} and 3^{r} or greeter parity dams. Absolute values for mature cows from their research showed a tendency for the birth weight of the calves to decrease with increased BCS. Also BCS affected weaning weight in the first parity dams in the older dams as BCS increased, weaning weight of their calves increased numerically (Vargas *et al*.,2000). This may reflect the ability of older cows to maintain more fat reserves that could be mobilized for milk production. Papatungan and Makerechain, (1999) reported that dam's BCS had a negative effect on the calf s weaning weight.

2.1.7 Effect of Number of Calving (Parity) On Calf Growth

The effect of dam parturition number was significant at all ages from 3 month to 18 months. At 3, 6, 9, 12, 15 and 18 months calves from first parturition cows were 12%, 7%, 6%, 12%, 10% and 9% higher than the mean weight of calves from the three other parturition groups (FAO, 2008). However, Ikwuegbu and Campbell (1992) reported that parity had no significant effect at birth, 9, 12, and 18 months of age of Bunaji cattle. Also parity of dam was reported (Akpa *et al.,* 2007) to have no significant effect on birth weight, average daily weight gain (ADG) at 3, 6, 9 and 12 months and first lactation milk yield in

Friesian x Bunaji cows. Other researchers (Licitra *et al.*, 1990; Mbap and Ngare 1991; Kahi *et al.*, 1995) reported significant effect of parity on growth of calves.

2.1.8 Effect of Season of Calving On Calf Growth

Season of birth had no significant effect at birth, 12 and 18 months, but significantly affected weight at 3 and 6 and 9 months of age in cattle (Ikwuaegbu and Campbell, 1992). Also season of birth is reported (Malau - Adulli *et al.*, 1993) to have significant effect at 3 and 6 months weight but not at 9 and 12 months of age. Orunmuyi *et al*. (2001) reported that season of 12 months had significant effect at birth, 3 and 12 months but not significant at 6 months of age. Other researchers (Adulli, 1992; Hamilton, 1996a; Akpa *et al.*, 2002a; Catillo *et al.*, 2002; Akpa *et al.*, 2007) observed significant effect of calving season and year of calving on birth weight, average daily weight gain, at 3, 6, 9, and 12 month. The variation in birth weight values and average daily gain at 3, 6, 9, and 12 months of age could be due to seasonal fluctuation in forage availability (Akpa *et al*., 2007).

Calves born during the late dry and early wet season had the lowest weight, while their counterpart born during the late wet and early dry season had the highest weight, the highest, average daily gain at 3 months of age was recorded for calves born during the late dry season, while calves of late wet and early dry seasons had the highest average gain, with the lowest average gain coming from those that attained the age of 6 months at late dry season (Akpa *et al.*, 2007). Likewise, Ehoche *et al.* (1992) reported that season of birth had no significant effect on birth weight of calves. However, calves born during the harmattan had the highest mean birth weight. The effect of season of birth on calf growth rate was not

significant except at 6 months of age, while calves born during the wet season were significantly heavier than those born during the harmattan (Ehoche *et al.,* 1992). The effect of season of birth on later body weight is usually related to the stage in the wet season and dry season cycle at which an animal reaches a given age (Carew *et al.,* 1986). Thus the significantly higher body weight at 6 months of age observed for calves born during the wet season might have been due to high milk production by dams from good quality forage available at that time. Ebangi *et al.* (2002) reported significant effect of season on birth weight, weaning weight, yearling and eighteen (18) months of age. They observed that calves born in the dry season though lighter than those born in the rainy season had the advantage of growing faster and being heavier at weaning, yearling and eighteen months of age. It may be therefore necessary in smaller husbandry systems to design a breeding programme where by cows calve towards the end of the dry season, since late dry season will reduce dystochia incidence. The cows would also benefit from early rainy season nutritious pastures favourable for higher milk production and optimum profitability as a result of rapid growth and heavier calves at weaning yearling and eighteen months (Ebangi *et al.,* 2002).

2.1.9 Effect of Year of Calving on Calf Growth

The significant effect of year of calving on growth of calves has been reported by many authors such as Ebangi *et al.* (2002) for purebred Gudali and two-breed synthetic Wakwa beef cattle; Tawah *et al.*(1999) for three quarter breed monbeliard and three quarter bred Holstein calves and tropical high land of Cameroon; Rust and Van Der Westhinzen (1994) for segmental calves; Kars *et al*., (1994) for Nguni calves, Kahi *et al.,* (1995) for

crosses of Ayshire- Brown Swiss calves; Ehoche *et al.* (1992) for Friesian - Bunaji crosses; Ikwuegbu and Campbell (1992) for Bunaji cattle; Abanikanda and Olotogun (1999) for N'dama calves; Akpa *et al*. (2007) for Friesian x Bunaji Heifers; and FAO, (2008) who reported significant effect of year at birth, 3, 6, 9, 12, 21, 24, 30 months of age except 15 months. Also Akpa *et al.* (2007) reported highly significant effect of year of birth on birth weight, average daily gain at 3, 6, 9, and 12 month and first lactation milk yield. Ebangi *et al*. (2002) reported significant effect of year on pre-weaning and post weaning growth performance traits. However, Tawah *et al*. (1999) reported that year of birth did not have significant effect on birth weight, daily gain, weaning weight and adjusted weaning weight. This is contrary to the findings of Mbap and Ngere (1991) who reported significant effect of year of birth on the birth weight of Friesian cattle. Likewise, Ehoche *et al* .(1992) reported that year of birth had a highly significant effect on calf weight from birth to 12 month of age. Malau-Aduli *et al.* (1993) also reported significant effect of year of birth at 3, 6, 9, and 12 months of age. Ikwuegbu and Campbell (1992) observed significant effect of year of birth on birth weight and at 9, and 12 months but not 18 months of age in Bunaji cattle. The significant effect of year of birth on pre-weaning and post weaning growth performance traits may be explained in terms of fluctuation in rainfall patterns as they affect the quantity and quality of forage available for the cows and calves (Ehoche *et al.*, 1992; Ebangi *et al.*, 2002; Gwaza *et al.*, 2007). The quality and quantity of milk production by the dam are essential component for the calf growth (Ebangi *et al.*, 2002). Non - significant factors such as changes in management techniques and introduction in latter years of supplementary feeding in the form of cotton seed

cake and rice bran in the dry season could be responsible for fluctuations in growth patterns; improvement as a result of improvement in herdsman skills over the years could equally contribute to the significance of the animals. Long time selection period could equally be responsible for differences in growth (Ebangi *et al* .,2002).

2.1.10 Effect of Sex of Calf on Calf Growth

Sex of calf has been reported (FAO,2008) to have significant effect from birth to 30 months of age in calves. At birth, 3, 6, 9, 12, 24, and 30 months males were 5%,4%, 7%, 11%, 10%, 14%, 15%, 12%, and 8% heavier than females. Also Tawah *et al*. (1999) reported that males were heavier than their females counterpart at birth (7.2%) and weaning (5.1%) likewise Ehoche *et al.* (1992) reported that sex of calf had significant effect on calves weight at birth 3 and 6 months but not at 12 months of age with the males being heavier at birth than the females by 1.23kg or 5.6% of the mean body weight. Other researchers (Abanikanda and Olotogun, 1999; Gwaza *et al.*, 2007) reported significant effect of sex on birth weight with male calves weighing heavier than the females. Jeffrey *et al.* (1971) and Abassa *et al.* (1993) reported that males are usually heavier than females at all ages of the growth curve. The superiority in body weight by male calves may be due to the fact that male fetuses grow faster during gestation and will have heavier weight at birth than females calves (Gwaza *et al.*, 2007).

However, Ikwuegbu and Campbell (1992); Orunmuyi *et al.* (2001) reported that sex of calf had no significant effect at 6 and 9 month of age. Also sex of calf had no significant effect on birth weight, pre-weaning average daily gain (ADG), weaning weight, and adjusted weaning weight (Tawah *et al.*, 1999). Other authors (Thorp *et al*,1980; Lubout, 1987) had

reported similar results. The lack of significant sex differences between these traits may be an indication that feeding was not adequate enough to elicit the expression of sexual dimorphism in these genotypes (Tawah *et al*., 1999).

2.1.11 Effect of Birth Weight on Growth of Calf

The birth weight is related to pre-weaning growth (ADG) and the weaning weight (Vaccaro and Dillard, 1966). Pre-weaning growth is positively correlated with the post weaning growth of calf (Tawah *et al.,* 1999), Also Newman *et al.* (1993) reported that calves that were heavier at birth and weaning tended to be heavier at the post-weaning stage. Therefore, a reduction in birth weight may result to a decrease in growth from birth to weaning and a reduction in the weaning weight. For example estimates of the genetic correlation between direct effects on birth weight and yearling weight are approximately 0.5(Koots *et al*., 1994) and 0.58 in miles city line 1 Herefored (MacNeil *et al.,* 1998). This genetic relationship among direct effect results in a situation where selection based on phenotypes or breeding values for greater yearling weight may also significantly increase birth weight.

2.1.12 Effect of gestation length on growth of calves

Gestation length has been reported to have influence on birth weight of calf. BLCS (2008) reported that gestation length affected birth weight and consequently calving ease (that is shorter gestation length result in easier calving because birth weight are lower). A shorter gestation length is also important because it increases the interval between calving and the start of mating which gives the cow more time to recover. Also FAO (2008) reported that relatively low birth weight is a consequence of a relatively short gestation length. In the

same vein David *et al.* (1996) reported that longer gestation length can be one of the factors that could influence the birth weight of heavier calves.

2.2 CORRELATED RELATIONSHIP

Phenotypic correlation between birth weight, body weight at 3, 6 and 12 month of age of Friesian x Bunaji male and female calves as reported by Ehoche *et al.,* (1992) showed that the calf birth weight was significantly correlated with body weight at 3, but not at 6, and 12 month of age. Correlations between body weight at 3, 6 and 12 months of age were positive and highly significant. Also, Malau Aduli *et al.* (1993) reported that the phenotypic correlations among body weight at birth 3, 6, 9, and 12 months of age were all positive and highly significant , ranging from 0.30 to 0.79. This is in agreement with the earlier study conducted by El-Bushra *et al.* (1989) to study the growth patterns of dairy calves from birth to 90 days of age. They concluded that body weight at birth and thereafter are highly correlated. The phenotypic correlations between calf weight at birth, 3, 6, 9, 15, 18, 21, 24 and 30 month were all positive, with the correlations between birth and early weight being lower than those between all other later ages (FAO, 2008). Other earlier authors like Christian *et al.* (1965); and Vaccaro and Dillard (1966) also reported positive correlation of pre-weaning with the post weaning growth of calves. Newman *et al.* (1993) reported that the regression coefficient of weaning weight and final weight were linear indicating that older animals tended to be heavier at weaning and also to express heavier final weights.

2.3 COMBINING ABILITIES OF SIRE-DAM BREED

The knowledge of combining ability in animal breeding has been based principally upon swine experiments. However, with the ever increasing interest in heterosis and cross breeding in beef and dairy' cattle, there is a need to explore this area. Gaines *et al*.(1970) conducted a cross breeding experiment involving crosses among the Angus, Hereford and shorthorn breed borne by straight bred cows, with the purpose of assessing the degree to which the measurable effects of combining ability and maternal influence are important. The traits studied include birth weight, weaning weight, weaning grade, feed lot average daily gain, and slaughter grade and slaughter weight. They reported that estimates of general combining ability for birth weights were significantly different among the three breeds, as measured in the two breed and backcross calves. There was essentially no difference resulting from the two types of crosses that provided the estimates. The general combining ability for weaning weight was different among the three breeds. Demon *et al*. (1961) used four breeds that were more divergent genetically and found significant general combining ability differences for 180-day weight, slaughter grade and weight per day of age. Newman *et al* (1993) reported that individual breed additive effects (differences between calves sired by C and T sires mated to RA dams) were positive for birth weight, weaning weight and carcass weight.

With respect to the average daily gain (ADG) neither the general combining ability (GCA) nor the maternal effect were significant. The interactions of both GCA and maternal ability with years were high in both sexes, making it appear that the GCA and material effect of the three breeds ranked differently across the 5 years (Gaines *et al.,* 1970).

The GCA by making system interaction was highly significant in heifer's data, indicating a dependence of GCA effects on the mating system in which they were

measured. The maternal effect by mating system interaction was large, indicating the maternal abilities of the breeds were not the same in the two mating systems. The steers showed relatively more variation than the heifers among the various systems of mating and less in the interactions. The GCA of the breeds was different for the steers, but not different in the heifers. The maternal abilities of the breeds were not significantly different for slaughter weight of either sex. Damon *et al.*(1961) reported highly significant differences due to breed of dam for both general combining ability and maternal ability.

Furthermore, Gaines *et al.* (1970) reported that since their experiment involved three breeds, it was impossible to measure the specific combining ability. However these effects are included, with any other non additive effects in the residual variation remaining in the crosses. Although this residual was not highly significant in any case, trends of differences were indicated in weaning weight and in all post weaning data on the steer.

High negative relationship has been reported between GCA and maternal effects for birth weight, weaning weight and post weaning weight (Gaines *et al.*,1970). They pointed out that since GCA is estimated from the combination of sire and dam effects, while the maternal ability is estimated by subtracting the sire effect from the dam effect, thus negative correlation is expected.

Genetic diversity among the breed was measured by the variation in general combining ability. This diversity was sufficiently large to be significant for two pre-weaning traits (birth weight and weaning weights). This indicates greeter variability among the breeds in the genes

influencing weight. The GCA interaction with system of mating was generally found to be non significant, indicating that the additive effects following the same pattern whether in two breed cross or back cross combinations. The effect of the breed of dam on the two breed and back cross calves was found to be highly significant for weaning weight and non significant in the other cases. Moreover, weaning weight, for the maternal effects were significantly different in the two systems of mating including breed of dam differences depending on the kind of calves they were rearing (Gaines *et al.*,1970).

2.4 MEASURES OF REPRODUCTIVE PERFORMANCE

Fertility is the ability of male and female animals to produce viable germ cells, mate, conceive and deliver normal living young. The lifetime productivity of a cow is influenced by age at puberty, age at first calving, calving interval and number of services per conception and calving to conception interval (Mukasa-Mugerwa *et al.*, 1991; Malau-Aduli *et al.,* 1993). Reproductive ability is the primary source of all benefits derived from livestock, but earlier selective breeding in these herds has focused on increased animal production traits (Oni *et al*., 1988; Shehu *et al.,* 2005). The practice has resulted in substantial genetic progress in these herds. However, the above practice might lead to reduced fertility in the herds. The reproductive performances of a herd have been shown to be one of the most important starting points in any animal improvement package (Mukasa-Mugerwa *et al.,* 1991). This implies that, whatever the goal of the production system is, reproductive traits appear to be economically important in cattle improvement programmes.

2.4.1 Age at first Calving

First calving marks the beginning of a cow's productive life. Age at first calving is closely related to generation interval and, therefore, influences response to selection (Mukasa-Mugerwa *et al.*,1991). Under controlled breeding, heifers are usually mated when they are mature enough to withstand the stress of parturition and lactation. This increases the likelihood of early conception after parturition. In traditional production systems, however, breeding is often uncontrolled and heifers are bred at the first opportunity. This frequently results in longer subsequent calving intervals (Roche *et al.*, 2000).

The average age at first calving in *Bos indicus* cattle is about 44 months, compared with about 34 months in *Bos taurus* and *Bos indicus* x *Bos taurus* crosses in the tropics (Roche *et al.*, 2000). Roche *et al.* (2000) studied the effect of season on the reproductive performance of Brahman heifers that first conceived at between 15 and 37 months old in the Mexican Gulf coast. Of 111 heifers that first conceived at 15 to 24 months of age, significantly more did so during the dry season than during the wet season. However, among heifers that first conceived at more than 24 months old, most conceived during the rainy season and overall there was no significant difference between the percentages of heifers conceiving first during the rainy or dry season. Lobo (1998) observed that Nellore cows in Brazil that calved first in the dry season were younger than those that calved first in the rainy season. The author found that age at first calving in Brazilian Nellore heifers was significantly affected by year and month of birth: calves born from January to May tended to be younger at first calving than those born between June and December. Sahoo *et al.* (2004) found a year-of-birth effect among Nagauri

cattle in India. However. Nivsarkar *et al.*(1999) found that breed differences had a significant effect on age at first calving in Haryana, selected Haryana, Tharparkar and Sahiwal heifers in India. Breed differences probably reflect differences in management conditions. The time taken by an animal to attain puberty and sexual maturity depends on the quality and quantity of feed available, which affects growth rate. Osei *et al*. (2004) found a mean age at first calving of 50.2 ±9.1 months in 146 Fulani-type dams in Niger. None of the factors tested for in the least squares analysis (herd, season and year of birth of dam, sex of the calf) significantly affected this parameter.

Mature body weight, calving age and growth rates are all linked to each other. Body weight at calving is as a result of the growth rate and age at first calving. Calving age on the other hand depends on the growth rate, since puberty is not reached until the heifer attains a certain body weight (Veerkamp and Brotherston, 1997).

2.5 Artificial Insemination

Artificial insemination (AI) is an assisted reproductive technology that is very important in intensive breeding and production of cattle. High reproductive performance is a key factor for optimal economic success in cattle and swine production (Gröhn and Rajala-Schultz, 2000). AI is the oldest and currently most common assisted reproductive technology and an important tool in animal production (Vishwanath, 2003). Originally AI was introduced as a means of preventing spread of venereal diseases. Today AI represents a much more cost-effective means of disseminating superior genes (Roca *et al.*,2006). AI has been most widely used for breeding dairy cattle; 253 million frozen AI doses and 11.7 million liquid doses are produced worldwide every year (Thibier and Wagner, 2002).

In cattle, the AI is usually performed using cryopreserved semen as bull spermatozoa maintain their viability very well during the freezing-thawing process. To achieve acceptable results with AI, one needs to be successful in every procedural step from semen collection, dilution and storage to inseminating at the optimal time regarding estrus and ovulation.

Assessment of *in vivo* fertilizing capacity of semen represents a challenge because it is influenced not only by semen-related factors but also by female fertility and by many other factors that may or may not be determinable (Amann and Hammerstedt, 2002). Due to the complexity of the fertilization process, several sperm attributes are required for successful fertilization, such as the ability to undergo capacitation, hyperactivation, the acrosome reaction, binding to the *zona pellucida*, and oocyte penetration. Despite the limitations as predictors of fertility, evaluation of sperm morphology and progressive motility is the most common method used to assess viability of fresh and frozen-thawed semen at AI stations.

The AI industry has to deal with a time lag between semen collection and insemination and subsequent fertilization. Storage of semen doses for a certain time is necessary for their distribution and to optimize efficient use of semen for AI. It is of practical and economic importance that the semen storage time does not negatively influence fertility. However, the natural ageing process cannot be prevented in liquid diluted boar semen, not even during the first days of storage (Waberski *et al.*,1994b; Johnson *et al.*, 2000). Spermatozoa progressively lose viability when stored in a semen extender at ambient temperature. As a generalization, some 40-50% of the sperm population in mammals does not survive cryopreservation even with optimized protocols (Watson, 2000)

2.5.1 Number of Services per Conception

The number of services per conception (NSC) depends largely on the breeding system used. It is higher under uncontrolled natural breeding and low where hand-mating or artificial insemination is used. Mandel and Sachdela (2001) estimated the repeatability

of NSC to be 19% from 2152 records for Haryana cattle. The NSC was 2.81 ±0.03 and was significantly affected by herd, season, placenta expulsion time, lactation length and milk yield. Since heritability can be broadly estimated from repeatability, this study indicates that heritability of NSC is low and most of the variation in NSC is attributable to environmental factors. Banerjee (1991) noted that Haryana heifers needed more services per conception than cows.

Stetshwaelo and Adebambo (1992), using 3 local Ethiopian breeds, the Barca, Horro and Boran, found that NSC was lower for animals from wet areas than for those from drier areas (1.74 ±0.6 vs 1.98 ±0.07). Crossbred cows required 0.12 and 0.14 fewer services per conception than local zebu cows in wet and dry areas, respectively. Mandel and Sachdela (2001) concluded that NSC did not differ significantly between Red Butana and Red Butana crosses (average 2.6) but was influenced by month of calving. NSC increased over the study period, probably due to changes in management. This is partly supported by an analysis by Busch and Furstenberg (1984) of 483 600 inseminations performed by 379 technicians on 623 farms in the USA, which showed that the 90- and 120-day non-return rate differed significantly among inseminators and the inseminator effect was greater than the farm effect. However, non-return rate did not differ among bulls.

2.6 FACTORS AFFECTING NUMBER OF SERVICES PER CONCEPTION

2.6.1 Timing of Service and Estrous Detection Errors

For maximum conception rate, cows should be bred at a time that will ensure that healthy, living sperm are present at the site of fertilization when the unfertilized egg arrives. Thus, to accurately "time" the insemination one needs to predict when ovulation

will occur. Other factors which influence the timing of insemination are the amount of time sperm must be in the cow's reproductive tract before they develop the ability to fertilize the egg, transport of the sperm from the uterus to the site of fertilization in the oviduct and the fertile life spans of both the sperm and the egg. Estrous detection errors are an individual herd problem and should always be considered as a possible cause of low conception rates (Buckley *et al.,* 2003b)

2.6.2 Semen Quality, Bull Fertility and Insemination Technique

Semen quality at the time of breeding is dependent on the quality of semen at the time it was purchased, storage conditions on the farm, thawing procedures and handling techniques (Buckley *et al.,* 2003b).Research shows that fertility differences among bulls can be influenced by the skill of the inseminator. Highly skilled inseminators obtain good results from bulls with a wide range of fertility. Less skilled inseminators obtain acceptable results only when high fertility bulls are used. Their results with lower fertility bulls are much lower than those obtained by highly skilled inseminators (Buckley *et al.*, 2003b).

2.6.3 Interval from Calving to Breeding, Level of Milk Production and Nutrition

The results from many studies have shown that conception rates are reduced in cows bred before 50 days after calving. Conception rates increased but only slightly after 50 days (Farzin *et al.,* 2003).Many studies on the relationship between level of production and fertility in dairy cattle have been reported. Some suggested that the higher producing cows in a herd have lower conception rates. Other studies indicated that level of production had no effect on conception rate. The antagonism between milk production

and conception rate was most extreme in a New York field study of 125 Holstein herds (Farzin *et al.*, 2003).

2.6.4 Environment, Age and Genetics

Low conception rates are observed when temperatures and humidity are high. To minimize the environmental effects on fertility, producers should reduce heat stress during dry season by providing shade if cows are outside. During wet season extra attention must be given to semen handling procedures (Salem *et al.*, 2006).

Conception rate is generally lower in older cows. In a Virginia study conception rate remained constant (50%) during the first 3 lactations. Conception rates were 10% higher in virgin heifers and 10% lower in 4th lactation and older cows (Buckley *et al.*, 2003b).

Extensive research at Iowa State University has recently confirmed earlier reports that reproductive traits have very low heritability. The same study indicated that as production increased, so did days to first and last breeding, days open and conception rate. However, the effect was small; one additional day open for each 200 to 400 pound genetic increase in milk yield (Rege, 1998)

2.6.5 Calving Interval

Calving interval can be divided into three periods; gestation, postpartum anoestrus (from calving to first oestrus) and the service period (first postpartum oestrus to conception). The following therefore relates to factors that influence the length of the postpartum anoestrous and service periods. This is sometimes also called the "days open", period and is the part of the calving interval that can be shortened by improved herd management (Buckley *et al.*, 2003b)

The "days open" period should not exceed 80-85 days if a calving interval of 12 months is to be achieved (Banerjee, 1991). This requires re-establishment of ovarian activity soon after calving and high conception rates. The duration of this period is influenced by nutrition (Wiltbank *et al.*, 2000), season, milk yield, parity, suckling and uterine involution. At any time, the effects of one or more of these factors may be confounded.

Calving interval has been extensively analyzed and reported. It is probably the best index of a cattle herd's reproductive efficiency. Resumption of ovarian activity in the postpartum period does not necessarily lead to conception and methods of stimulating oestrus must be considered in relation to their effect on conception (Banerjee, 1991) and, indirectly, calving intervals.

Mrode and Akinokun (1985) quoted previous work in which it was estimated that only about 4% of Nigerian zebu cattle calved each year, 22% calved every other year and 73% calved irregularly. Oyedipe *et al.* (1982) suggested that, in N'Dama, Sokoto Gudali and West African Shorthorn cows, calving intervals shorter than 410 days (13.6 months) are very good, those of 411-460 (13.6-15.3 months) are satisfactory and those greater than 461 days (15.3 months) are unsatisfactory'. Estimates of calving interval in zebu cattle range from 12.2 to 26.6 months. By Oyedipe *et al.* (1982) standards, many of the calving intervals given are unsatisfactory. Most of the longer calving intervals were from traditionally raised animals.

2.7 FACTORS AFFECTING CALVING INTERVAL

2.7.1 Genetic Effects

Stetshwaelo and Adebambo (1992) observed that genotype had a significant effect on the calving interval of Brahman cows in Venezuela. In Mexico, The long calving interval of the Brown Swiss probably reflects lack of adaptation to the humid environment. Faco *et al.* (2005) reported that calving interval was affected by maternal grand sire.

2.7.2 Year and Season

Year effects on calving interval have been reported by Sarkar *et al.* (1994) in Haryana cows in West Bengal India Faria *et al.* (2001) in unspecified zebu cattle in Mexico. Lobo (1998), working with Nellore cattle, observed that animals calving in the dry season had an average subsequent calving interval of 13.9 months, compared with 14.5 months for those that calved in the wet season. Oyedipe *et al.* (1982), working with White Fulani heifers, found calving intervals of 15.3 and 18 months for the dry and wet seasons, respectively. The authors suggested that the difference was due to the fact that cows calving in the dry season could take advantage of improved nutritional conditions during the subsequent rainy season to meet their total requirements for maintenance, growth and lactation. In addition, a larger proportion of dry-season calves die due to inadequate nutrition. Both factors lead to earlier re-establishment of oestrus in cows that calve in the dry season. These suggestions were supported by Osei *et al.* (2004), who found that cows calving in October in Cote d'lvoire usually conceived again in the following January while those calving in January were unlikely to conceive during the subsequent mating period. Early death of calves also reduced calving interval by more

than 2 months and abortion shortened it by several days. The calving interval for cows whose calves died prior to fertile mating was estimated by the formula. CI - 328.3 + (0.992 x age of the calf at the time of death) days. A similar estimate by Wilson (1995) among Sudanese Fulani cattle in Mali yielded a prediction equation of CI = 499.5 + (0.318 x age at calf death) days. Although these observations involved cows that aborted or lost their calves, they indicate that calf rearing strategies, such as early weaning, bucket feeding or partial suckling, can influence subsequent dam reproduction. For example, Hove *et al.* (1991) found that partial suckling in Africander cows significantly reduced the number of cows that were anovulatory for 100 days postpartum and increased conception rates. Partial suckling reduced the interval from parturition to first ovulation by 20 days and the mean interval to conception by 21 days averaged over all cows. In a study of 6- to 10-year-old Bunaji cows, Osei *et al.* (2004) found that the interval from calving to conception averaged 232.5 and 72.6 days for suckled and non-suckled animals, respectively. The associated calving intervals were 5125 and 352.6 days with 60-90 day pregnancy rates of 21.1 % and 72.7%, respectively. Serum progesterone levels showed that suckling interfered with ovarian activity and thus conception during the postpartum period, resulting in a prolonged calving interval (Osei *et al.,* 2004).

2.7. 3 Nutrition

Underfeeding delayed puberty in taurine heifers and stopped oestrus and ovarian activity in heifers that are already cycling (Mukasa-Mugerwa *et al.,* 1991). Wiltbank, (2000) demonstrated the same effect in mature Hereford cows. The cows were fed a high- or a low-energy ration before calving; half of the animals in each group were then fed a high- or low-energy ration after calving. The resulting pregnancy rates were 95, 77, 95

and 20% on the high-high, high-low, low- high and low-low ration, respectively. These results, which agreed with those of Muasya *et al.* (2004), indicated that level of feeding after calving had a greater effect on subsequent pregnancy than level of feeding before calving. The high level of feeding after calving shortened the interval from first breeding to conception and thus reduced calving interval. In zebu cattle, Mukasa-Mugerwa *et al.* (1991) found a calving interval of 780 days (26 months) in traditionally raised Ethiopian highland Zebus. Lactation length was 239 days (8 months). Cows thus failed to conceive for more than 8 months after lactation had ceased. This may be the average period required to gain sufficient bodyweight and condition to start cycling and conceive again, given the limited nutritional resources of the traditional system.

Calving intervals also tend to be shorter in animals that are more productive in other respects. This may be a reflection of the effect of nutrition, since more productive animals are usually fed better than unproductive animals. For example, Farzin *et al.* (2003) found that the calving interval of Guzera dairy cows decreased by 17.8 days for every 1000 kg increase in lactation milk yield. Biffani *et al* .(1998) found that dam age at calving, sex of calf and location all significantly affected calving interval in Brahman cows. The location x age interaction was also significant. The differences due to location seemed to arise from differences in the length of the breeding season in a study of 5356 Brahman cows in Costa Rica.

2.7.4 Age

In zebu cattle, calving interval is longest in first-calf heifers and older cows, and shortest in cows of intermediate age (6-9 years old). Rege (1998) reported a maximum calving interval of 496 days in 12 to 16-year-old cows, with similar values for young cows 3-6 years old. The author has also earlier observed a tendency for calving intervals to shorten with increasing age in Brahman cows, as did Mario and Jose (2003) in a commercial zebu herd in Mexico.

Shefale and Parmar (2002), working with Brahman cattle in Costa Rica, also found the longest calving interval between the first and second calving, and the shortest between the fourth and fifth calving. These observations were consistent with those of Lobo (1998), working with Nellore cattle in Brazil and Banerjee (1991), working on Haryana cows in India. The last authors found that calving interval continued to shorten until after the sixth parity. Lobo (1998) noted that the first calving interval was considerably longer than the second or third interval in Nellore cattle in Peru: only 14.5% of the intervals lasted less than 400 days (13.3 months) and 49.5% exceeded 601 days (20.0 months).

2.7.5 Other Factors

Calving interval can be influenced by the sex of the calf (Faco *et al.*, 2005). In a study of zebu cows in Kenya, Muasya *et al*. (2005) observed that cows with male calves had a longer calving interval than those with female calves (430 vs 383 days). Subsequently, Banerjee (1991) found that dams stopped suckling and therefore weaned, female calves earlier than males (8.8 vs 11.3 months). The author noted that cows with male calves had a calving interval 19.1 days longer than that of cows with female calves.

Calving interval may be influenced by placenta expulsion time (Grohn and Rahaja-Schultz, 2000) and uterine pathology. Mario and Jose (2003) found a favourable mean calving interval of 383 ±3.7 days (12.8 months) in a well-managed herd in Mexico. They attributed the shortness of the calving interval to the absence of brucellosis, which reduced abortion rate, and stringent culling of infertile cows.

2.8 FERTILITY (CALVING) RATE

Fertility in cattle is affected by environmental, genetic, disease and management factors. These influence the reproductive process at ovulation, fertilization or implantation or during gestation and parturition (Meyer *et al.,* 1990). The commonest estimate of fertility rate is the percentage of mated or inseminated cows that become pregnant (pregnancy rate) or finally calve (calving rate). However, fertility can also be expressed in other ways. For example Banerjee (1991) referred to two measures of fertility: a general fertility rate, which is the ratio of calves born to females of breeding age, expressed as a percentage; and a specific fertility rate, which measures the number of births within a given group or the total fertility rates of females over their reproductive life. Net reproductive rate was given as the extent to which the female calves of one generation survive to reproduce themselves as they pass through calf-bearing age, expressed as the number of female calves that survive per 100 females of breeding age. Fertility rates can also be estimated prior to calving as the percentage non-return rate.

This is the number of cows bred that do not come back on heat and are thus assumed to have conceived. This value may be derived at 60, 90, 120, 145 or 200 days after mating (McDowell and Rogers, 1996). Where artificial insemination is employed

fertility rates can be expressed as the number of calves born per 100 inseminations (Buckley et al., 2003b). Progesterone assay now makes it possible to determine conception rates as early as 21 days after breeding. It is also ideal for estimating the magnitude of early embryonic looses.

Fertility rates in zebu cattle are generally low, particularly in animals raised traditionally under less-than-ideal management. For example, Banerjee (1991) estimated the calving rate of traditionally raised Tswana cattle in Botswana as 46.4%, compared with 74.0% for similar animals on a ranch. The higher calving rate on the ranch was probably due to the animals being better fed and managed than those under traditional management. Mrode and Akinokun (1985) calculated a calving rate of 67% for White Fulani cattle raised on government ranches in Nigeria, compared with about 34-55% for similar animals raised by local herders. Wurzinger *et al.* (2005) reported a conception rate of 79% in Ankole, Boran and unspecified zebu-type cattle in western Uganda where feed and water were abundant and diseases were controlled.

Lobo (1998), studied reproductive performance in a herd of Nellore cattle in the Amazon over six mating seasons from 1986 to 1993. No animal was culled for reproductive reasons. Calves were weaned at 250 days old and breeding was between October and December each year. Overall calving rate was 59%. The authors suggested that the low calving rate after the sixth mating opportunity (38%) was due to the small number of cows presented for breeding, but it may also have been age-related. At this time, most cows would have been 9 to 10 years old, and fertility commonly decreases in cows of this age in the tropics. Cows calved irregularly and 33% of those bred for the fifth time gave birth to only their third calf and 18% to their second, In addition, several

cows calved for the first time after the third, fourth or even fifth breeding opportunity. Although such cows would have been culled in a commercial livestock enterprise, traditional smallholders usually have only one or a few cows and cannot afford to cull extensively for infertility. Many keep their animals for long periods in the hope of eventually getting a calf. This practice is unsatisfactory because scarce feed resources are used by unproductive animals.

2.8.1 Factors Affecting Fertility

2.8.1.1 Age and Lactation

Analysing data from Botswana, McNeilly (1997) found that fertility rate increased from 69% in 2.5-year-old cows to a maximum of 82% in 6- to 7 -year-old cows and then declined. In Bolivia, Banerjee (1991) also recorded an increase in pregnancy rate from 50% in 3-year-old purebred Criollo and Criollo x zebu crossbreds to 75% in 7-year-olds. Fertility then declined to 50% among 12-year-olds. Causes of these age-related differences include lactational stress in young growing animals and the ability of older cows to gain bodyweight and condition quickly after calving. Lactation has a negative effect on cow bodyweight and thus indirectly affects animal reproduction.

In a study by Nwacharo *et al.* (2006) involving Angus, zebu and zebu-cross cattle in which all heifers were bred at 2 years, heifers had a 6.8% lower pregnancy rate after 2 services and became pregnant 4.2 days later than older cows. Three-year-old lactating animals also showed a 10.9% lower pregnancy rate than older lactating cows which suggests that lactation has a greater effect on postpartum anoestrus in young primiparous animals than in older cows. Rege (1998) confirmed this in Brahman first-calf cows:

continuous suckling significantly reduced pregnancy rate compared to suckling twice daily (46.3 ±0.08 vs 79.8 ±0.08%).

2.8.1.2 Breed

One of the few studies reporting extensively on the effect of breed on fertility in Africa was undertaken by Ngongoni *et al* (2004) in Zambabwe. They found that conception rate (averaging 82.5, 78.1 and 75.4% among 675 Angoni, 731 Barotse and 815 Boran cows, respectively) was significantly affected by year but not sire breed, although conception rate was higher in Angoni and Barotse cows when mated to bulls of their own breed. Evidence for dam breeds was also not conclusive. Among the Barotse, dry heifers had higher conception rates than lactating cows, whereas lactating Angoni and Boran cows had higher conception rates than dry cows. Perhaps the most significant observation among the Angoni and Barotse (but not the Boran) was that cows that calved early in the calving season were more likely to conceive during the following mating season than cows that calved late. This was consistent with observations by Warzinger *et al*. (2005) on Ankole and Boran cows in Uganda.

2.8.1.3 Bodyweight

Nwacharo *et al*. (2006) observed that Barotse, Angoni and Boran cows that calved were marginally heavier at the beginning and end of the breeding season than cows that did not calve. This was consistent with the findings of Hove *et al*. (1991) and in Africander, Tswana and Tuli cattle and Lobo (1998) in Nellore cattle. The last authors calculated that heifers calving at the first and second opportunity averaged 272 ±33 kg live weight, compared with 262 ±27 kg for those failing to calve.

2.8.1.4 Year and Season

Hove *et al.* (1991) attributed the significant effect of year on calving rate to differences between years in the quantity and quality of forage available. Roche *et al.*, (2000) in an analysis of 18272 births from Nguni cattle in Swaziland, observed that monthly calving frequency was correlated with previous monthly rainfall records but most of the variation was accounted for by rainfall that came 10 months earlier in both the high level (79%) and middle level(50%). Roche *et al.*, (2000) also found direct linear correlations between conception rate in Brahman cows and precipitation, pressure and temperature. These findings further emphasis the importance of nutritional effects on fertility.

2.8.1.5 Genetic Effects

Heritability of fertility rate is low. It was estimated as 0.14 ±0.19 by Holman *et al.* (1991) in Venezuela, while Cruz *et al.*, (2006) obtained values of 0.25 and 0.15 for conception rate, and 0.09 and 0.1 1 for calving rate in Brahman heifers and older cows, respectively. Conception rates often exhibit substantial heterosis after crossbreeding. Mandal and Sachdela (2001) found a relationship between fertility rates and blood groups in 645 Haryana cows randomly mated over 4 years. Cows with AA blood group had a significantly higher conception rate (67%) than cows with AB (47.5%) and BB (51.1%) blood type. Type AA cows calved significantly earlier (41.2 months) than either the AB (44.5 months) or BB (44.7 months) animals. It would be useful to investigate this further in animals from different populations, to find out if the phenomenon could be of use in identifying animals with higher inherent fertility.

2.9 DIFFICULT BIRTH OR DYSTOCIA

Literally, dystocia is referred to as prolonged labour that exceed the normal period of parturition 6-8hrs in cattle. Dystocia is also commonly known as calving difficulty. It is a major problem most dairy and beef industry encounter. Dystocia is a leading cause of calf mortality at/or shortly after birth. It causes uterine infection, more retained placenta and long calving intervals (Cady, 2004).

2.9.1 Factors affecting Dystocia

Dystocia, more commonly known as difficult calving is a problem most dairy producers encounter. Calving difficulty has received much attention in resent years primarily because of mating larger European breeds bull with local breeds of cow (Cady,2004). Dystocia is a leading cause of calf dead at shortly after birth and leads to uterine infections, more retained placenta and longer calving interval (Cady, 2004). In their study in Northern guinea savanna, Akpa *et al.* (2002a) reported that the incidence of dystocia was 13% , 7.4 and 2% in cattle, sheep and goats, respectively. Dystocia increases calf losses, percentage of weak calves, cow mortality, and veterinary costs and deteriorates cow fertility. The aim of breeders is to receive a healthy, vital calf and keep a cow in reproduction at good condition. Environment and herd management have great influence on calving difficulty. Proper breeding before, during and after calving is the key to prevent the problems. Calf death loss at birth is about 5% if calving is normal (Radostis *et al.*, 1994). Calving difficulty increases mortality to high level;20% of calving difficulties terminate with dead calf (Radostis *et al.*,1994).

A number of factors affect calving difficulty. Akpa *et al.*(2002) enumerated age, size, poor health and feeding, bullying of dam, abnormal fetal representation, sex, weight of young and multiple births in Northern guinea savanna of Nigeria. However they reported that the most frequent cause of dystocia in the study area was abnormal fetal presentation, followed by age and size of the dam, while the least was sex of young and multiple births which they observed affected only cows and does, respectively, but not sheep. Generally, most frequent causes for difficult calving are calf's birth weight and sex of calf, foetal mis-presentation, age, body weight, condition and parity of cow. Calf's birth weight is a function of genetic and environmental factors.

2.9.2 Effect of body condition of the dam at calving on calving ease

It is commonly assumed that over-conditioned cows before calving are at a greater risk for calving difficulty, on the contrary, several other researchers reported on the correlation between BCS and calving difficulty. Bastin *et al*. (2010) reported that fatter heifers had high incidences of dystocia just as severely as underdeveloped. Difficult calving could be a result of abnormal position in uterus, disproportion between foetuses or low body condition of the cow. Animals carrying excessive body condition resulting in intra pelvic fat deposition and a reduction in pelvic area (especially for first lactation heifers) are more likely to develop dystocia Gearhart *et al,* (1990). Chassagne *et al*. (1999) also indicated that having a BCS higher than 4 (using a 5-point scale) before calving posed a significant risk for dystocia. Bastin *et al,* (2010) in their recent study suggested that a genetically high BCS before calving increased the risk of dystocia by increasing the chance of the calf to be born easily, the chance of the cow to have a calf which survived and the chance of the calf to survive. The positive genetic correlation

between BCS before calving and the maternal effect for CE and CS emphasized results concerning the phenotypic link between BCS and dystocia or stillbirth as reported by Gearhart *et al.,* (1990) and Chassagne *et al.* (1999). These authors indicated that over conditioned cows would present greater risk of dystocia and stillbirth than cows with an optimal BCS at calving.

Furthermore, Bastin *et al* (2010) observed that the genetic relationship between calving traits and BCS during lactation was similar to that before calving but decreased with increasing DIM, with the exception of the correlation between BCS and calving ease. These correlations indicated that; a cow which had calved with difficulty will have a genetically high BCS during the following lactation; a cow which had a calf easily born will have a genetically low BCS during the following lactation; a cow which had a calf that survived will have a genetically high BCS during the following lactation. These results were in line with the ones reported by Bastin *et al.* (2010) on first lactating Ayrshire Canadian cows.

This seems to indicate that cows with a genetically high BCS; would have a greater chance to have a calf that survives, would transmit to the calf genes that would permit an easy birth and increased chance of survival. These last statements were in line with previous research which reported that genetically low BCS were related with less robust cows presenting impaired fertility (Dechow *et al.,* 2001; Berry *et al.,* 2003; Bastin *et al.,* 2010;) or health disorders such as mastitis (Neuenschwander *et al.,* 2009).

2.9.3 Effect of sex and type of birth on dystocia

The effect of sex on calving difficulty was not statistically significant in the experiment conducted by Barbara *et al.* (2009). On the contrary, several other researches reported on the correlation between sex and calving difficulty. Aitchison and Johnson (1985) showed 2 times more frequent calving difficulty with male calves compared to females. Ritchie and Anderson (1994) summarized that bull calves exhibited 10 to 40% higher assistance rate than heifer calves. At the same time the authors stressed that much of the influence of sex of calf is indirect, through its effect on increased male calf size, though after correction for birth weight, some differences in dystocia still remained. In the analysis the comparison between male and female animals was made at the same birth weight, and this is probably the main reason that the effect of sex on calving difficulty could not be found. Bull calves are generally heavier at birth than heifer calves. Reports indicate that bull calves outweigh heifer calves at parturition by 1.5 to 10.0 pounds and require a 10 to 40 percent higher assistance rate. For example, research from the Meat Animal Research Center (MARC) at Clay Center, Nebraska, indicated that calf losses were higher in male (22.4 percent) than in female calves (16.3 percent) when difficult births were experienced (David *et al*., 1996). In the same vein, Akpa *et al* (2002) suggested that the significant influence of sex and weight of young is associated with the size of the fetus at birth and is more prominent with the male offspring which are heavier than their female counterpart. Other researchers reported dystocia rate in mature cows carrying male calves to be twice that of cows carrying female calves (Houghton and Corah, 1989). This can partly be explained by the fact that bull calves generally have a one- to two-day longer gestation length which contributes to heavier calf birth weights.

Twin calves are small, grow slowly and also have higher mortality. Despite lower birth weight, twin calves had 4 times more problems at calving than single calves (Barbara *et al.*,2009) .The research performed by Gregory *et al.* (1996) showed that survival at birth was 13% higher for singles compared to twins, and the difference in survival in favour of singles remained also after 72 hours, 150 and 200 days.

2.9.4 Effect of age and parity

It is well documented that age and parity of dam influenced the incidence of dystocia. Houghton and Corah, (1989) summarized calving data from MARC and Colorado State University relating calving difficulty to age of dam. Although first- and second-calf heifers experience more calving difficulty, they typically had lighter birth weight calves (by 2.5 to 5.0 pounds) than mature cows. This is because matured, multiparity cows have a fully developed skeletal structure and body sizes, compared to their heifer counterparts, and are therefore capable of giving birth to heavier calves. This illustrates genetic potential for birth weight of dam when evaluating birth misinterpreted. Akpa *et al* (2002) observed that age and size of dam caused dystocia, especially amongst dams of first parity that are young. This was also reported by Arthur *et al* (1982).

However, multiparous aged dams are sometimes affected by dystocia, this is probably due to decreasing ability of the older dams to cope with the pregnancy and the associated stress. With regard to the size of dam, Akpa *et al.* (2002b) in their study with cattle, sheep and goats reported that sheep and goats had more of the difficulties than cattle.

Cady (2004) reported that first calf heifers experience problems twice as often as older cows since they usually are not fully grown. However, even large heifers experience problems because they have never before given birth.

Analysis by Barbara *et al*. (2009) showed high percentage of difficult calving at first parity, whereas among other parities there were no statistically significant differences. Difficult calving was about three times more frequent at first parity than at later parities. Dargatz *et al*. (2004) analysed 29,375 Suckler cows and established 16.7% of dystocia at heifers and 2.8% at other cows. High rates of dystocia among first-calf heifers were mostly due to the fact that they were smaller at first parturition than at subsequent calving. Fatter heifers also had high incidences of dystocia just as severely under developed. Cady (2004) published data that indicate that first calf heifers experience problems twice as often as older cows. The most frequent reason was that they were usually not full grown-up. But on the other hand,Cady (2004) stressed that heifer calves born with ease may have a difficult time giving birth later.

2.9.5 Effect of Year and Season on dystocia.

There is considerable year-to year variation in birth weight and calving difficulty using the same sires and females. This is partially, but not fully explained by nutrition and environmental conditions. Fall-born calves usually are lighter and born with less assistance than spring-born calves. This is because hot summer temperatures tend to reduce birth weights, whereas cold temperatures increase birth weights. Effect of season is mainly associated with temperature, nutrition, different sires within year (Cady, 2004). Season is correlated with birth weight of calves. Deutscher *et al*. (1999) reported that extremely low and high temperatures reduce birth weight. Akpa *et al*.(2002a) observed

that poor or low plane of nutrition during dry season especially if it coincides with the period of pregnancy increased cases of dystocia in ruminants. Similar reasons were given by Osuagwuh (1980) for incidence of dystocia and parturition losses in crossbred sheep. This indicates the importance of planning the breeding season to coincide with the period of feeds availability or increase in the plane of nutrition of the dam during the breeding season, especially during the late pregnancy. However, cows should be fed with the aim of getting good body condition necessary for the maintenance of the pregnancy without being too fat because fatter cows tend to experience more calving problems (Gearhart *et al.*,1990; Chassagne *et al.*,1999 ; Cady, 2004; Bastin *et al.*, 2009)

2.9.6 Effect of calf birth weight and foetal mis-presentation

Nazzie *et al.* (1991) reported that the effect of calf birth weight was the most important factor determining calving difficulty. Their research included 547, 2-years old beef heifers of three breeds. They concluded that the selection on lower birth weight could be the answer to calving ease. But on the other hand there was also a strong correlation between birth weight, growth rate and weaning weight. Furthermore, they established that female calves with lower birth weight had significantly more problems later when they calve. The ratio between birth weight of calf and weight of cow is also important.

Difficult calving could be a result of abnormal position in uterus, disproportion between fetuses or low body condition of the cow (Barbara *et al.*, (2009). Foetal malpresentation is one of the major causes of dystocia in ruminant farm animals. This assertion agrees with the observation by Morton and Cox (1968). In their study with ruminants in Northern guinea savanna zone of Nigeria, Akpa *et al* (2002a) reported that

farmers handled cases of feta misrepresentation mainly by introducing their hand into the birth canal after applying paste of okra fruit. The role of the okra was to lubricate the passage and ease entry of hand into the birth canal for manipulation of the foetal position.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Location:

The study was conducted in Jigawa state under the control of the Jigawa Research Institute (JRI) Kazaure, Jigawa State is located between latitude 11.00^{o} and 13.00^{o}N and longitude 8.00^{o} and10.00^{o}E and lies within the Sudan Savanna (JRI 2003). The climate is relatively dry with an average annual rainfall of 644mm, occurring between May and September. The dry season begins around the early October to late April. The average annual minimum and maximum temperatures are 19.2^{0}C and 37.4^{0}C, respectively. There are seasonal variations in relative humidity which increases during the rains and decreases during the cool dry season (Kowal and Kassam,1978*)*.

3.2 Experimental Animals and Management

Sixty one (61) indigenous cows of different breeds (Bunaji, Sokoto Gudali and Rahaji) selected from different herds across Jigawa state were used for this study. The selected dams were ear tagged, screened for brucellosis using a simple Rose Bengel Plate Test (RBPT) method, dewormed with Albendazol suspension and covered with antibiotics Oxytetracycline LA. The selected animals were grazed on natural pasture under the supervision of herdsmen for 7 to 9 hours daily, while sorghum Stover supplemented with concentrate of wheat brand, were offered during the dry season. Salt lick and water were also offered to the cows *ad-libitum* .Only animals with body scored of 3 and above were selected.

The selected dams were crossed with proven bulls of three exotic breeds (Holstein- Friesian, Brown Swiss and Guzera) using artificial insemination technique. The dams were synchronized with PGF2α to induce the animals to come on heat at almost the same time. Once the animals were synchronized, they were isolated from the herd to avoid being mounted by breeding bulls.After which, they were inseminated. Pregnancy diagnosis was conducted by rectal palpation forty-five (45) days after insemination to ascertain those that are pregnant; those that were not pregnant were re-synchronized and inseminated. The signs of heat that were observed are: Reddening of the vulva, slimy mucus discharge from the vulva, restlessness, frequent urination/ flagging of tail, mounting other females in the herd and most important the primary sign is stand to be mounted.

3.3 Equipment used

The equipment used for the artificial insemination were: Thermometer, Synchronizing agent, Liquid nitrogen container, Disposable sheath, Straws of semen Lubricant, AI gun, Hand gloves, Thermos, Straw cutter, hot and cool water.

3.4 Parameters Measured

Birth weight and Body weight: This was taken by weighing the herdsman alone and the herdsman together with the calf, and the birth weight of the calf estimated by subtracting the herdsman weight from the weight of both the calf and herdsman using weighing scale of maximum capacity of 100kg. As the animal grew older, this method became practically impossible; therefore, a weight belt was used to estimate the weight of the animals.

Fertility rate: The fertility rate of the dam was measured as the number of conceptions per service or per insemination and recorded for each cow.

Parity of dam: The parity of the dam was known by asking the farmers the number of calving the cow had undergone. This was recorded for each cow. Weaning age was recorded at the time when the calf stopped sucking the dam from birth.

Calving traits

Calving traits were calving ease (CE) and calf survival (CS). Calving ease was coded in two classes; 1 (unassisted calving) and 2 (assisted calving). Calf survival was 0 if the calf died within 24 hrs from birth and 1 otherwise.

Body condition score (BCS)

The body condition score was determined based on the methods described by Allen (1990) and Webster (1993). The method of the scoring was to grip the loin with the fingers on top and the thumb curled under the ledge formed by the transverse processes of the back bone, the inside of thumb is used to feel the fat thickness over the ends of the transverse processes. In case of doubt, additional guidance was gained by feeling fat-layer over the ribs with the flat of the hand and pressing with fingers on either side of the tailed head to feel the fat cover there. The scoring was as follows:

Score 1 (thin): Spine prominent and the transverse processes feel sharp to touch with no detectable fat over the ribs, tail head and lumber vertebrate shrunken and concave.

Score 2 (moderate): The bony transverse process can still be felt or palpable, but they are rounded due to a thin covering fat, ribs, hips and pins clearly visible, muscle mass around the tail head is concave.

Scare 3 (Good): Transverse processes can only be felt with firm pressure, because they are well covered with fatty tissue. Animal smooth and well covered.

Score 4 (fat): fat cover in critical areas can be easily seen and felt; transverse processes cannot be seen or felt even with firm pressure.

Score 5 (very fat): The cow is obviously over fat or obese, heavy deposit of fat clearly visible on tail head, hooks, pins and ribs fully covered and cannot be felt even with firm pressure.

3.5 Fixed Factors

The fixed factors that were considered are: sire breed, dam breed, sire-dam breed combination, dams' body condition, parity, sex of calf, season of insemination, season of calving, and year of calving.

The seasons were grouped into four (4) according to the weather pattern as follows: Season 1: early dry (October – December)

Season 2: late dry (January – March)

Season 3: Early wet (April – June)

Season 4: Late wet (July – September)

3.6 Data analysis

The data collected were analyzed using the least square techniques of the general linear model (GLM) procedure of SAS (1998). The model is as follows.

$Y_{ijklmnpq} = U + S_i + D_j + SD_k + B_l + X_m + P_n + SC_o + Y_q + e_{ijklmnoq}$

Where U = over all mean

S_i = effect of i^{th} sire breed (i = Holstein Friesian, Brown Swiss, Gwuzera)

D_j = effect of j^{th} dam breed (j=Bunaji, Sokoto Gudali, Rahaji)

SD_k = effect of k^{th} sire – dam breed combination

B_l= effect of l^{th} dam body condition score (l = 1, 2, 3, …5)

X_m = Effect m^{th} sex of calf (n= male or female)

P_n = Effect n^{th} parity (o= 1, 2, …. 4)

SC_o = Effect of o^{th} season of calving (o = 1, 2,3, 4)

Y_q = Effect of q^{th} year of calving

$e_{ijklmnoq}$ = random error

CHAPTER FOUR

4.0 RESULT

4.1 Dam Characteristics

The characteristics of the breeding dams are shown in Table 1. The mean age, parity, body condition score, number of inseminations per conception, gestation length and birth weight of calves were 6.2, 2.3, 3.8, 1.3, 286.1 days and 29.5kg, respectively Age, parity and number of insemination per conception were highly variable(CV=32-47%) while body condition score, gestation length and birth weight of calves were less variable (CV=3-17%). Fifty four percent (54%) of the cows had normal calving while 24% were assisted. Amongst the assisted calving, 89% of the calves survived while 11% died.

Table 4.1: Characteristics of breeding dams in Kazaure and environs

Characteristics	N	Mean(±Se)	CV(%)	Range
Age (years)	61	6.2±0.25	32	5(4-9)
Parity	61	2.3±0.14	47	3(1-4)
Body condition score	61	3.8±0.08	17	2(3-5)
No of inseminations per conception	61	1.3±0.06	36	1(1-2)
Gestation length(days)61	61	286.1±0.94	3	30 (271-301)
Birth weight of calves(kg)	61	29.5±0.42	11	12(23.5-35.5)
Calving status:				
Normal calving	33	54		
Assisted calving	28	46		
Assisted and survived	(25)	89		
Assisted and died	(3)	11		

4.2 Factors Affecting Calving Ease

The distributions of calving ease according to sire and dam breed are shown in Table 4.2. More than half of the dams sired by Brown Swiss (BS),Holstein Friesian (HF) and Guzera (GZ) had normal calving. However, dams sired by HF had the highest percentage of normal calving of 58%, while BS had the lowest percentage (8%) of calf mortality for the assisted calving. Dams sired by HF were 6 and 5% better than BS and GZ sired dams, respectively. Survival of assisted calving was best for BS (92%) which was 4 and 6% respectively higher than HF and GZ. For the dam breed, Sokoto gudali dams had the highest percentage of normal calving (70%) with 100% survival of the assisted calving, while Red Bororo dams had the highest percentage of assisted calving (65%) with 8% mortality. The assisted white Fulani dam had the highest mortality (25%) while Sokoto gudali dams did not record any mortality. The sire-dam breed combination showed that HFWF combination dams produced the highest number of normal calving (83%), followed by BSSG(70%),GZSG(57%)and GZRB(50%). All other sire-dam breed combinations produced less than 50% normal calvings(17-43%). HFRB had the highest percentage (83%) of assisted calving followed by BSRB and GZWF which had 60% assisted calving, while HFWF had the least (17%) calving difficulty. Survival of calves from the assisted calving from sire-dam combinations was complete except for HFRB, BSWF and GZWF combinations which had 20%, 25%, and 25% mortality respectively.

Table 4.2: Distribution of calving ease according to sire and dam breed and their combinations

Factor		Calving situation (%)		Assisted calving (%)	
	N	Normal	Assisted	Survived	Died
Sire Breed:	61				
Brown swiss(BS)	27	52	48	92	8
Holstein Friesian (HF)	19	58	42	88	12
Guzera (GZ)	15	53	47	86	14
Dam Breed:					
White Fulani (WF)	18	56	44	75	25
Red Bororo (RB)	20	35	65	92	8
Sokoto Gudali (SG)	23	70	30	100	0
Sire-Dam Breed Combination:					
BSWF	7	43	57	75	25
BSRB	10	40	60	100	0
BSSG	10	70	30	100	0
HFWF	6	83	17	100	0
HFRB	7	17	83	80	20
HFSG	7	71	29	100	0
GZWF	5	40	60	67	33
GZRB	4	50	50	100	0
GZSG	6	57	33	100	0

BSWF = Brown Swiss x White Fulani; BSRB = Brown Swiss x Red Bororo; BSSG = Brown Swiss x Sokoto Gudali; HFxWF = Holstein Friesian x White Fulani, HFRB = Holstein Freisian x Red Bororo, HFSG = Holstein Friesian x Sokoto Gulai, GZWF = Guzera x White Fulani, GZRB = Guzera Red Bororo, GZSG = Guzera x Sokoto Gudali

The effect of age, parity and body condition of dam on calving ease is shown in Table 3. The ages, parity and dam body condition had significant effect ($P< 0.01$) on calving ease of the dams .Calving ease increased with age, with the 9years old dams having the highest (80%) normal calving. All calves from the assisted calving of dams that were more than 4 years of age survived, while those of 4 years had 20% mortality.

Equally, calving ease increased with parity and body condition of dam with highest parity and body condition producing the best calving ease of 89 and 67%, respectively. Dams of first parity had the highest percentage (79%) of assisted calving with 20% mortality, beyond the first parity all the calves of assisted calving survived. Also dams with BCS of 3 had the highest percentage (48%) of assisted calving with 20% mortality, while dams with BCS of 5 had 33% assisted calving with zero mortality.

Table 4.3: Effect of age, parity and body condition of dam on calving ease

Factor		**Nature of Calving (%)**		**Assisted calving (%)**	
	N	Normal	Assisted	Survived	Died
Dam Age (years)	61	$\chi^2$8df = 11.232; P<0.01			
4	25	38	62	80	20
6	9	67	33	100	0
7	6	67	33	100	0
8	11	45	55	100	0
9	10	80	20	100	0
Parity of Dam	61	$\chi^2$6df = 20.246; P<0.01			
Parity 1	19	21	79	80	20
Parity 2	15	73	27	100	0
Parity 3	18	56	44	100	0
Parity 4	9	89	11	100	0
Dam Body Condition Score	61	$\chi^2$4df = 2.013; P<0.01			
BCS 3	21	22	48	80	20
BCS 4	34	53	47	94	6
BCS 5	06	67	33	100	0

The effects of sex of calf, season and year of calving on calving ease was significant (P<0.01) as shown in Table 4. The female bearing dams had higher calving ease (73%) than the male bearing ones (37%).The male bearing dams recorded the

highest percentage (63%) of assisted calving with 46% mortality, while their females counterpart recorded none. Calving ease was highest during the late wet (72%) followed by the late dry(62%) and early wet(57%).Early dry season has the highest assisted calving (77%) and mortality of calves (20%). The year 2007 had the highest (67%) calving ease, while 2004 had the highest assisted calving 64%) and calf mortality (22%).

Table 4. 4: Effect of sex of calf, season and year of calving on calving ease

Factor		Nature of Calving(%)		Assisted Calving(%)	
	N	Normal	Assisted	Survived	Died
Sex	61	$\chi^2$2df = 11.426; P<0.01			
Male	35	37	63	54	46
Female	26	77	23	100	0
Season of calving	61	$\chi^2$6df = 9.595; P<0.01			
Early dry	13	23	77	80	20
Late dry	27	63	37	90	10
Early wet	14	57	43	100	0
Late wet	7	72	28	100	0
Year of calving	61	$\chi^2$6df = 4.277; P<0.01			
2004	15	36	64	78	22
2005	31	58	42	92	8
2006	9	56	44	100	0
2007	6	67	33	100	0

The correlation amongst the measured dam characteristics is presented in Table 4.5. Age of dam was significantly (p<0.01-0.05) and positively correlated(r=0.30-0.95) with parity, gestation length, birth weight and calving ease. Parity was significantly (p<0-01) and positively correlated (r=0.44-0.56) with gestation length and calving ease; and so was gestation length with birth weight of calves (p<0.01: r =0.52). Birth weight of calves on the other hand was significantly (p< 0,01) and negatively correlated(r=0.39) with

calving ease; Body condition of dam had no significant (p>0.05) correlation with age, parity, gestation length, birth weight of calves and calving ease. However, the relationships were negative for all the traits (r= -0.01to-0.15) except for parity(r=0.12) and calving ease(r=0.11).

Table4.5: Correlations amongst age, parity, body condition score,gestation length, birth weight and calving status in indigenous cows

Characteristics	Parity	BCS	GL	BW	Calving status
Age	0.95**	-0.15	0.57**	0.30*	0.33**
Parity		0.12	0.56**	0.22	0.44**
Body Condition score (BCS)			-0.07	-0.01	0.11
Gestation length (GL)				0.52**	0.04
Birth Weight (BW)					-0.39**

* = P<0.05; ** = P<0.01

4.3 Effect of Sire and Dam Breed on Number of Inseminations

Effect of sire and dam breed on number of inseminations per conception and gestation length is shown in Table 6. The sire breed had no significant (P>0.05) effect on the number of insemination per conception but significantly influenced gestation length. Gestation length was longest for dams sired by Holstein-Friesian (288.05 days) and least for those sired by Brown Swiss (284.67 days). The effect of sire breed on the number of inseminations was not significant (P>0.05).

Dam breed significantly (P<0.05) influenced number of insemination and gestation length. The lowest number of inseminations per conception was observed in Sokoto gudali dams (1.1) and the highest (1.6) for Red bororo dams. Both white Fulani and Red bororo dams had lower gestation lengths compared to Sokoto gudali dams.

Table 4.6: Effects of Sire and Dam breed on Number of Inseminations Per Conception and Gestation Length.

Factors	N	No. of insemination	Gestation length
Sire breed	61	Ns	*
Brown swiss	27	1.4	284.67[c]
Holstein Friesian	19	1.3	288.05[a]
Guzera	15	1.3	286.27[b]
Mean		**1.3**	**286.33**
SEM		**0.06**	**0.98**
Dam breed	61	*	*
White Fulani	20	1.3[b]	283.69[b]
Red Bororo	18	1.6[a]	282.30[b]
Sokoto Gudali	23	1.1[c]	288.50[a]
Mean		**1.3**	**284.83**
SEM		**0.06**	**1.87**

4.4 Growth characteristics and factors affecting them

The mean body weight characteristics of the crossbred calves are shown in Table 7. The Coefficient of Variability (CV) of body weight characteristics was low and ranged from 7 to 16%. The crossbred calves had mean birth weight, weaning age, weaning weight, 3, 6, 12, 18, and 24 months weight of 29.5kg 189.6days,181kg, 68.1,170.0, 292.3 and 345.7kg, respectively. The crossbred calves were weaned at a minimum live weight of 179.1kg or maximum of 182.9kg at the point when the growth rate was 0.799kg per day. The growth of calves was at increasing rate from birth to 6 months or weaning age and there after decreased with increase in age.

Table 4.7: Mean body weight characteristics of crossbreed indigenous cattle

Characteristics	N	Mean(±Se)	CV%
Birth weight (kg)	61	29.5±0.42	11
Weaning age (days)	58	189.6±1.63	7
Weaning weight (kg)	58	181.0±1.89	8
3mon. weight (kg)	58	68.1±0.81	9
6mon. weight (kg)	58	170.0±2.10	9
12mon. weight (kg)	58	238.4±2.44	8
18mon. weight (kg)	51	292.3±3.34	8
24mon. weight (kg)	50	345.7±4.25	9
Weight gain at 3 months (kg)	58	38.7±0.61	12
Weight gain at 6 months(kg)	58	138.3±2,98	16
Weight gain at 12 months(kg)	58	209.8±2.43	9
Weight gain at 18 months(kg)	51	263.1±3.15	9
Weight gain at 24 months(kg)	50	315.4±4.37	10

The effect of sex of calf on the body weight characteristics was significant ($P<0.01$) except on weaning age (Table 8). The male calves had higher body weight characteristics than their female counterparts.

Table 4.8: Effect of Sex of Calf on bodyweight characteristics of crossbred calves.

Trait	Sex			
	N	**Male**	**Female**	**Difference**	**LOS**
Birth weight (Kg)	61	31.3±0.46[a]	27.1±0.43 [b]	4.2±0.65	**
Weaning age (days)	58	189.8±1.94	189.4±2.80	0.40±3.32	ns
Weaning weight (Kg)	58	190.2±2.18[a]	169.7±1.27[b]	20.4±2.68	**
Weight at 3 months (Kg)	58	72.0±1.20[a]	63.50±1.4[b]	8.5±0.20	**
Weight at 6 months (Kg)	58	177.4±2.57[a]	160.9±2.50[b]	16.5±3.64	**
Weight at 12 months (Kg)	58	251.2±2.45[a]	222.7±1.82[b]	28.4±3.18	**
Weight at 18 montsh (Kg)	51	306.8±3.89[a]	274.6±2.76[b]	32.2±4.97	**
Weight at 24 months (Kg)	50	364.3±5.14[a]	323.8±3.26[b]	40.6±6.33	**
Weight gain at 3 months (Kg)	58	40.7±0.74[a]	36.4±0.81[b]	4.3±1.10	**
Weight gain at 6 months (Kg)	58	144.1±3.88[a]	131.2±4.31[b]	12.9±5.80	*
Weight gain at 12 months (Kg)	58	221.4±2.79[a]	195.7±1.91[b]	25.7±3.55	**
Weight gain at 18 months (Kg)	51	276.0±3.84[a]	247.5±2.79[b]	28.5±4.94	**
Weight gain at 24 months (Kg)	50	333.2±4.99[a]	294.5±4.62[b]	38.7±6.89	**

* = P<0.05; ** = P<0.01; NS= not significant; a, b means in the same rows with different Superscripts differ significantly (p<0.05).

Table 4.9 shows the effect of season of calving on bodyweight characteristics of calves. Season of calving had significant (P<0.05) influence on birth weight, 3 and 24 months weight characteristics but not on weaning weight 6, 12 and 18 months weight characteristics. Birth weight was higher (32.2Kg) for early dry compared to other seasons which were similar. Body weight was higher for early dry (71.7Kg) compared to late dry

season (66.1Kg). The 3months body weight at early-wet and late-wet seasons were similar and intermediate to both early-dry and late-dry seasons. The 3months weight gain was better for early-wet than late-wet and late-dry; those were also together similar to 3months weight gain at the early dry seasons. The 24 months body weight and body weight gain was better for early-dry seasons compare with late-wet seasons. However, the body weight characteristics at 24 months of age for late-dry and early-wet were similar to those of early-dry and late-wet seasons.

Table 4.9: **Effect of Season of Calving on bodyweight characteristics of crossbred calves**

Trait	Seasons						
	N	**1**	**2**	**3**	**4**	**SEM**	**LOS**
Birth weight (Kg)	61	32.2[a]	29.1[b]	28.0[b]	29.4[b]	0.38	*
Weaning age (days)	58	186.1	191.8	191.1	183.9	1.63	ns
Weaning weight (Kg)	58	182.9	182.4	180.6	173.7	1.90	ns
Weight at 3 mon (Kg)	58	71.7[a]	66.1[b]	69.3[ab]	67.4[ab]	0.78	*
Weight at 6 mon (Kg)	58	175.6	167.6	169.4	171.6	2.12	ns
Weight at 12 mon (Kg)	58	245.6	238.0	236.1	233.0	2.45	ns
Weight gain, 3 mon (Kg)	58	39.6 [ab]	37.3[b]	41.3[a]	37.9[b]	0.59	*
Weight gain, 6 mon (Kg)	58	130.9	138.7	141.3	142..2	3.02	ns
Weight gain, 12 mon (Kg)	58	213.6	209.2	211.3	203.6	2.47	ns
Weight at 18 mon (Kg)	51	301.5	291.5	291.0	283.7	3.36	ns
Weight gain, 18 mon (Kg)	51	280.7	262.6	262.9	254.3	3.18	ns
Weight at 24 mon (Kg)	50	360.2[a]	347.8[ab]	338.6[ab]	331.0[b]	4.18	*
Weight gain, 24 mon (Kg)	50	328.3[a]	318.9[ab]	310.5[ab]	293.4[b]	4.26	*

* = P<0.05; [a, b] means within the same row with different superscripts differ significantly (p<0.05), ns= not significant, 1:early dry, 2: late dry, 3:early wet, 4: late wet

The effect of parity on the body weight characteristics of crossbred calves was not significant (P>0.05) as shown in Table 10. However there were observable trends in some of the measured traits of the calves as parity of dam increased, Birth weight, weaning age,12 months weight,18months weight gain increased with parity up to parity 3 and then declined. Generally, the performance of all measured characteristics declined after parity3.

Table 4.10: Effect of parity on bodyweight characteristics of crossbred calves

Trait	Parity						
	N	**1**	**2**	**3**	**4**	**SEM**	**LOS**
Birth weight (Kg)	61	28.7	28.9	30.8	29.9	0.41	ns
Weaning age (days)	58	187.7	190.9	191.1	187.9	1.66	ns
Weaning weight (Kg)	58	181.8	178.1	183 .6	179.4	1.92	ns
Weight at 3 mon (Kg)	58	68.5	66.4	69.7	66.8	0.81	ns
Weight at 6 mon (Kg)	58	170.0	166.8	171.5	172.5	2.14	ns
Weight at 12 mon (Kg)	58	239.7	235.2	241.2	235.9	2.49	ns
Weight gain, 3 mon (Kg)	58	40.6	37.6	39.0	36.9	0.60	ns
Weight gain, 6 mon (Kg)	58	137.6	133.3	140.8	142..2	3.02	ns
Weight gain, 12 mon (Kg)	58	214.6	206.4	210.5	206.0	2.46	ns
Weight at 18 mon (Kg)	51	296.6	292.1	292.4	284.5	3.40	ns
Weight gain, 18 mon (Kg)	51	268.6	263.0	262.6	254.6	3.18	ns
Weight at 24 mon (Kg)	50	352.0	343.6	346.6	336.0	4.32	ns
Weight gain, 24 mon (Kg)	50	324.0	314.7	313.0	306.1	4.42	ns

ns = not significant

The effect of year of calving on the body weight characteristics of crossbred calves was not significant (P>0.05) except on weaning age (p<0.05) (Table11). Year 2006 had higher weaning age compared to Year 2003. Year 2004, 2005 and 2007 were intermediates between 2003 and 2006 weaning ages for the crossbred calves.

Table 4.11: Effect of Year of Calving on bodyweight characteristics of crossbred calves.

Trait		Years						
	N	**2003**	**2004**	**2005**	**2006**	**2007**	**SEM**	**LOS**
Birth weight (Kg)	61	30.8	31.2	28.9	29.4	29.1	0.41	Ns
Weaning age (days)	58	175.0	189.8^{ab}	188.2^{ab}	196.6^{a}	188.2^{ab}	1.62	*
Weaning weight (Kg)	58	178.5	179.9	180.3	187.8	177.3	1.91	ns
Weight at 3 months (Kg)	58	69.5	68.3	68.9	66.8	65.0	0.82	ns
Weight at 6 months (Kg)	58	178.6	172.6	171.0	165.9	164.7	2.14	ns
Weight at 12 months (Kg)	58	240.0	236.9	236.7	245.4	239.2	2.50	ns
Weight gain 3 months (kg)	58	38.7	37.6	40.2	37.4	36.0	0.60	ns
Weight gain at 6 months (kg)	58	147.8	130.3	142.2	136.5	135.6	3.02	ns
Weight at 18 months (Kg)	51	296.0	294.4	288.9	301.2	-	3.38	ns
Weight at 24 months (Kg)	50	351.9	348.9	341.0	359.5	-	4.28	ns
Weight gain at12 months (Kg)	58	289.2	206.2	209.4	216.0	210.1	2.49	ns
Weight gain18 month (Kg)	51	265.2	263.5	260.5	272.4	-	3.19	ns
Weightgain,24months (Kg)	50	321.1	318.0	310.5	331.1	-	4.39	ns

* = P < 0.05; ns = not significant; $^{a, b}$ means within the same row with different superscripts differ significantly (p<0.05), - =data not available

The effect of age of dam on the body weight characteristics of crossbred calves is presented in Table 12. Age of dam had no significant ($p>0.05$) effect on the weight characteristics except 3 and 24 months of age. Eight (8) years old dams produced calves that were superior in weight at 3months compared to dams aged 7years old. Calves from dams that aged 4-6and 9 years had similar performance as those coming from 7 and 8years old dams. However, weight and weight gain of crossbred calves born to 5 years old dams were superior to the performance of calves born to dams of all the other age categories which were similar.

Table 4.12: Effect of age of Dam on bodyweight characteristics of crossbred calves

Traits	Age								
	N	**4**	**5**	**6**	**7**	**8**	**9**	**SEM**	**LOS**
Birth weight (Kg)	61	28.5	30.5	29.2	28.1	31.9	30.4	0.40	Ns
Weaning age (day)	58	187.0	200.0	193.2	193.5	190.1	187.9	1.66	Ns
Weaning weight (Kg)	58	179.1	195.5	180.4	175.9	186.4	181.3	1.91	Ns
Weight at 3 mon (Kg)	58	67.5^{ab}	69.5^{ab}	67.3^{ab}	62.3^{b}	72.8a	68.1^{ab}	0.75	*
Weight at 6 mon (Kg)	58	168.8	160.5	168.5	168.4	171.0	174.8	2.17	Ns
Weight at 12 mon (Kg)	58	236.9	258.4	236.7	230.6	244.3	239.3	2.48	Ns
Weight gain, 3 mon (Kg)	58	39.5	39.0	38.1	34.6	40.9	37.7	0.59	Ns
Weight gain, 6 mon (Kg)	58	137.6	130.0	131.5	140.7	139.1	144.4	3.08	Ns
Weight gain, 12 mon (Kg)	58	211.1	227.9	207.5	202.9	212.4	208.9	2.50	ns
Weight at 18 mon (Kg)	51	293.1	325.4	293.6	286.3	292.8	289.1	3.43	ns
Weight gain, 18 mon (Kg)	51	265.1	294.9	264.0	258.1	262.5	258.7	3.23	ns
Weight at 24 mon (Kg)	50	346.9^{b}	396.0^{a}	343.9^{b}	334.0^{b}	349.0^{b}	343.2^{b}	4.31	*
Weight gain, 24 mon (Kg)	50	318.9^{b}	365.5^{a}	314.5^{b}	305.9^{b}	311.9^{b}	312.7^{b}	4.44	*

* = P<0.05; ** = P<0.01; ns = not significant; ^{a,b} means within the same row with different superscript differ significantly (p<0.05).

The effect of dam BCS on the body weight characteristics of crossbred calves is shown in Table 13.The dam body condition score had no significant effect (P>0.05) on the body weight characteristics. However, there was an observed trend showing increase in performance of calves with higher body condition score for weaning age, weaning weight and weight characteristics at 3,12 and 18 months of age.

Table 4.13: **Effect of Dam body condition score on bodyweight characteristics of crossbred calves**

Traits	**Body condition score**					
	N	**3**	**4**	**5**	**SEM**	**LOS**
Birth weight (Kg)	61	29.2	30.0	28.1	0.42	ns
Weaning age (days)	58	189.2	189.0	191.0	1.66	ns
Weaning weight (Kg)	58	179.7	181.4	183.2	1.92	ns
Weight at 3 mon (Kg)	58	67.0	68.5	69.2	0.82	ns
Weight at 6 mon (Kg)	58	170.7	169.9	169.0	2.14	ns
Weight at 12 mon (Kg)	58	237.6	238.6	239.9	2.48	ns
Weight gain, 3 mon (Kg)	58	38.3	38.6	41.1	0.61	ns
Weight gain, 6 mon (Kg)	58	138.3	137.8	140.9	3.03	ns
Weight gain, 12 mon (Kg)	58	209.0	210.0	211.8	2.47	ns
Weight at 18 mon (Kg)	51	291.7	292.5	292.5	3.41	ns
Weight gain, 18 mon (Kg)	51	263.2	262.7	264.4	3.21	ns
Weight at 24 mon (Kg)	50	340.7	350.1	340.1	4.29	ns
Weight gain, 24 mon (Kg)	50	308.8	320.3	312.0	4.39	ns

ns = not significant; ^{a,b} means within the same row with different superscript differ significantly ($p<0.05$).

4.5 Effect of Sire and Dam Breed on body weight.

The effect of sire breed origin on the body weight characteristics of crossbred calves is shown in Table 14. Sire breed origin significantly ($p<0.01$-0.05) influenced the body weight characteristics of the crossbred calves from 3 to 24 months of age. Calves sired by Brown Swiss were superior only in 3months of age body weight characteristics; while Holstein Friesian calves were superior at 6 months of age body weight characteristics. The Guzera sired calves showed superior body weight characteristics from 12-24 months of age. At 3 months of age, Brown Swiss sire breed was 4.4Kg and3.9Kg.superior to Holstein and Guzera breeds, respectively. For 6months of age, Holstein Friesian was 11.7Kg and 4.3Kg Superior to Brown Swiss and Guzera breeds respectively. For12,18, and 24 months of age, the superiority in body weight of Guzera crossbred calves to Brown Swiss and Holstein Friesian was 16.3and 10.9Kg; 34.6 and25.3kg,and 37.7and 31.7Kg, respectively.

Table 4.14: Effect of Sire-breed on bodyweight characteristics of crossbred calves.

Trait	Sire					
	N	1	2	3	SEM	LOS
Weight at 3mon(kg)	58	70.4[a]	66.0[b]	66.5[b]	0.77	*
Weight at 6mon(kg)	58	164.6[b]	176.3[a]	172.0[ab]	2.02	*
Weight at 12mon(kg)	58	232.8[b]	238.2[ab]	249.1[a]	2.33	*
Weight gain, 3mon(kg)	58	41.3[a]	36.3[b]	37.2[b]	0.54	**
Weight gain, 6mon(kg)	58	130.1[b]	146.6[a]	142.7[ab]	2.86	*
Weight gain, 12mon(kg)	58	205.4[b]	208.3[ab]	219.8[a]	2.35	*
Weight at 18mon(kg)	51	284.0[b]	293.3[b]	318.6[a]	2.98	**
Weight gain, 18mon(kg)	51	255.2[b]	264.1[b]	290.0[a]	2.76	**
Weight at 24mon(kg)	50	339.0[b]	345.0[b]	376.7[a]	3.99	**
Weight gain, 24mon(kg)	50	307.9[b]	315.1[b]	348.4[a]	4.07	**

* = P<0.05; ** = P<0.01 [a, b] means within the same row with different superscripts differ significantly (p<0.05),

The effect of dam breed on the body weight characteristics of crossbred calves is presented in Table15.Dam breed had significant (p<0.01-0.05) effect on weight characteristics at 3 and 6months of age of calves, The 3 months of age body weight for calves from Red Bororo was superior to those from white Fulani and Sokoto Gudali .The Red Bororo calves were 6.3 and 5.5kg respectively superior to their counterpart from White Fulani and Sokoto Gudali. At 6months of age the body weight of calves born to both Red Bororo and Sokoto Gudali dams were superior to those from white Fulani dams. The superiority of Red Bororo calves was 9.5 and1.0Kg over White Fulani and Sokoto gudali, respectively. The Sokoto Gudali was 8.5Kg superior to White Fulani.

Table 4.15: Effect of Dam-breed on bodyweight characteristics of crossbred calves

Trait	Dam					
	N	1	2	3	SEM	LOS
Weight at 3mon(kg)	58	65.8[b]	72.1[a]	66.6[b]	0.74	**
Weight at 6mon(kg)	58	163.7[b]	173.2[a]	172.2[a]	2.06	*
Weight at 12mon(kg)	58	234.6	244.5	236.4	2.43	Ns
Weight gain, 3mon(kg)	58	37.0[b]	41.7[a]	37.8[b]	0.56	**
Weight gain, 6mon(kg)	58	126.6[b]	142.8[a]	143.4[a]	2.86	*
Weight gain, 12mon(kg)	58	205.8	214.1	209.5	2.44	Ns
Weight at 18mon(kg)	51	291.2	297.1	288.5	3.37	Ns
Weight gain, 18mon(kg)	51	262.1	266.9	260.3	3.19	Ns
Weight at 24mon(kg)	50	348.4	348.5	340.4	4.31	Ns
Weight gain, 24mon(kg)	50	319.4	318.4	308.6	4.41	Ns

* = P<0.05; ** = P<0.01; NS= not significant; [a,b] means within the same row with different superscript differ significantly (p<0.05).

Table 16 shows the effects of sire breed and dam breed on birth weight, weaning age and weight of crossbred calves. Sire breed significantly (P<0.05) influenced weaning weight but not birth weight and weaning age of the calves. Calves sired by Guzera were superior in weaning weight by10.5Kg and 6.9Kg to Brown Swiss and Holstein Friesian sired calves respectively. The Holstein Friesian sired calves were superior by 3.6Kg than their counterparts from Brown Swiss. Dam breed significantly (P<0.01-P<0, 05) influenced weaning age and weight of crossbred calves. Age at weaning of calves was higher in White Fulani (194.5days) and Red Bororo (193.5days) dams compared with Sokoto Gudali dams (183.0). However, Red Bororo (RB) had higher weaning weight (186.9) than WF (181.5) and SG (176.1)

All the same, age of weaning was 1 day higher in white Fulani compared to Red bororo. Calves born to the Red bororo dams were superior in weaning weight by 5.4Kg and10.8kg to White Fulani and Sokoto gudali dams respectively. Equally, calves born to white Fulani dams were 5.4kg superior to calves from Sokoto gudali dams.

Table 4.16: Effect of sire breed and dam breed on birth weight, weaning age and weight of cross bred calves.

Trait	N	Sire breed BS	HF	GZ	SEM	LOS
Birth Weight (kg)	61	29.3	30.0	29.5	0.42	ns
Weaning age (days)	58	191.0	186.3	191.3	1.64	ns
Weaning weight (kg)	58	177.4^{b}	181.0^{ab}	187.9^{a}	1.84	*
		Dam breed				
		WF	**RB**	**SG**		
Birth Weight (kg)	61	29.6	30.4	28.8	0.42	ns
Weaning age (days)	58	194.5^{a}	193.5^{a}	183.0^{b}	1.50	**
Weaning weight (kg)	58	181.5^{ab}	186.9^{a}	176.1^{b}	1.82	*

* = P<0.05; ** = P<0.01; NS= not significant BS=Brown Swiss; HF=Holstein Friesian; GZ=Guzera; WF=White Fulani; RB=Red Bororo; SG=Sokoto Gudali. ^{a,b} means within the same row with different superscript differ significantly (p<0.05).

The effect of the sire-dam bred combinations on body weight characteristics of crossbred calves is presented on Table 17. Sire-Dam breed combinations significantly (p<0.01-0.05) influenced the body weight characteristics of calves from3 to24months of age. It had no significant (p>0.05) effect on birth weight.

Weaning age was longest for Brown Swiss-white Fulani (BSWF), Guzera- white Fulani (GZWF)and Brown Swiss-Red Bororo (BSRB) and least for Brown Swiss – Sokoto gudali (BSSG).The weaning age was in between for the Holstein Friesian- White Fulani (HFWF), Guzera- Red Bororo (GZRB) and Guzera- Sokoto Gudali (GZSG) cross

bred calves. The weaning age of BSSG calves was 22.2, 22.2, 21.0, 8.2, 9.5, 8.1, 9.5 and 10.4 days earlier in comparison to BSWF, GZWF, BSRB, HFWF, HFRB, HFSG, GZRB and GZSG, respectively.

With respect to calf growth performance from 3 months to 24 month of age, the BSWF sire-dam breed combination was superior only in 24 months of age body weight traits while HFWF was superior only in 6 months of age traits. The BSRB was superior for 5 traits (weight gain, 6 months weight gain,12 months, weight at 18 month and weight gain, 18months). The BSSG was superior in 5 body weight traits(weight at 6 month, weight gain, 3 months, weight gain, 6 months, weight gain, 12 months; and weight at 24 months). Also, HFSG was superior in 5 traits (weight at 6 month; weight gain, 6 months; weight at 18 months, weight at 24 months and weight gain, 24 months). The most superior sire-dam breed combination was GZRB that surpassed in all the measured traits from weaning weight to weight characteristics at 24 months of age. This was followed by HFRB combination which was superior in all body weight traits except weight gain, 18 months and weight at 24 months of age. The GZWF combination was superior in all other body weight traits except weight at 3 and 6 month and weight gain, 3 months.

Table 4.17: Effect Sire-Dam breed combinations on bodyweight characteristics of crossbred calves

Traits	N	11 BSWF 2	12 BSRB 3	13 BSSG 5	21 HFWF 2	22 HFRB 8	23 HFSG 5	31 GZWF 7	32 GZRB 10	33 GZSG 4	SEM	LOS
Birth weight (Kg)	61	28.6	30.4	28.6	29.5	31.7	29.0	30.0	29.5	29.1	0.43	ns
Weaning age (day)	58	200.0^{a}	198.8^{a}	177.8^{c}	186.0^{b}	187.3^{b}	185.9^{b}	200.0^{a}	187.3^{b}	188.2^{b}	1.70	**
Weaning weight (Kg)	58	175.2^{c}	180.6^{b}	175.4^{c}	175.9^{c}	194.2^{ab}	176.0^{c}	197.2^{a}	194.5^{a} b	177.3^{c}	1.70	**
Weight at 3 months (Kg)	58	67.3^{b}	73.1^{a}	69.5^{b}	63..8^{c}	71.6^{ab}	63.9^{c}	65.5^{bc}	69.6^{ab}	65.0^{bc}	0.72	**
Weight at 6 months (Kg)	58	149.2^{c}	162.8^{b} c	175.8^{a} b	172.4^{a} b	184.7^{a}	173.6^{a} b	171.1^{b}	183.7^{a}	164.7^{b} c	1.77	**
Weight at 12 months (Kg)	58	228.5b	233.0^{b}	235.2^{b}	231.5b	249.5^{ab}	235.9b	251.5^{a} b	261.5a	239.2b	2.30	*
Weightgain,3 months (Kg)	58	39.4^{b}	42.8^{a}	40.8^{ab}	34.7^{c}	40.2^{ab}	34.9^{c}	36.2^{bc}	40.1^{ab}	36.0^{bc}	0.51	**
Weight gain, 6 months (Kg)	58	97.9^{b}	132.4^{a}	147.2^{a}	143.3^{a}	153.3^{a}	144.7^{a}	141.8^{a}	154.2^{a}	135.6^{a}	2.36	**
Weight gain, 12 months (Kg)	58	200.6^{b}	202.7^{b}	211.0^{a} b	202.4^{b}	218.0^{ab}	206.9^{b}	222.2^{a} b	232.0^{a}	210.1^{a} b	2.31	*
Weight at 18 months (Kg)	51	282.3^{b}	285.3^{b}	283.7^{b}	286.1^{b}	301.4^{ab}	295.4^{a} b	316.4^{a}	321.7^{a}	310.4^{a}	3.09	*
Weight gain, 18 months (Kg)	51	254.4^{c}	254.9^{c}	256.1c	256.6c	270.0b	266.4^{b} c	287.1^{a} b	293.8a	281.3^{a} b	2.86	*
Weight at 24 months (Kg)	50	344.9^{a} b	335.3^{b}	339.3^{a} b	335.9b	360.1b	342.0^{a} b	379.5^{a}	371.0^{a} b	321.3^{b}	4.10	*
Weight gain, 24 months (Kg)	50	316.9^{a} b	304.9^{b}	305.5b	306.4b	328.7^{ab}	312.9^{a} b	350.2^{a}	344.8^{a} b	292.2^{b}	4.18	*

* = P<0.05; ** = P<0.01; NS= not significant, ^{a,b,c} means within the same row with different superscript differ significantly (p<0.05).

4.6 Body weight Relationship Estimations in the calves

The correlations amongst the measured body weight characteristics in crossbred calves are presented in Table 4.18. Generally, the correlation amongst the body weight characteristics were positive except between weaning age and weight at 6 and 12 month of age, respectively. The correlations between weaning age and body weight characteristics were weak except between weaning age and weaning weight (0.27) and weight at 6 month (0.41).Other correlations amongst the measures of growth rate in the crossbred calves were positive and significant($p<0.01$-0.05;$r=0.30$-0.95).

Table 4.18: Correlations amongst bodyweight characteristics of cattle

Trait	WA	WW	Wt.3	Wt.6	Wt.12	Wt.18	Wt.24
Birth weight (BW)	0.11	0.51**	0.65**	0.38**	0.56**	0.55**	0.57**
Weaning age (WA)		0.27*	0.10	-0.41**	-0.001	0.08	0.13
Weaning weight (WW)			0.50**	0.63**	0.87**	0.78**	0.75**
Weight at 3mon(Wt.3)				0.30*	0.51**	0.44**	0.46**
Weight at 12mon(Wt.6)					0.76**	0.66**	0.56**
Weight at 18mon(Wt.18)						0.93**	0.88**
Weight at 24mon(Wt.24)							0.95**

* = P<0.05; ** = P<0.01

The estimation of 3, 6, 12, 18 and 24 months body weight using birth weight and weaning weight is shown in Table 19. The regression coefficient b were all positive and highly significant (P<0.01) except the estimation of 3 month bodyweight using weaning weight. The coefficient of determination (R^2) of the estimation of the body weight using birth weight ranged from 14% to 41%, while that of the weaning weight ranged from 0%

to 58%. The 3 and 18 months body weight were better estimated by birth weight (R^2= 0.41%) and weaning weight (R^2= 0.58%), respectively, in the crossbred calves. However, considering the coefficient of determination (R^2), only 41% and 58% of the variations in body weight of the cows from 3 to 24 months of age could be attributed to birth weight and weaning weight, respectively, thus, giving an indication that weaning weight is a better estimator of body weight of these crossbred calves to 24 month of age than birth weight.

Table 4.19: Estimation of 3, 6, 12, 18 and 24 months live body weight using birth weight (BW) and weaning weight(WWT)

Characteristics	Equation	B	LOS	R^2(%)
3months body weight	32.099	1.2250BW	**	41
6months body weight	115.192	1.8669BW	**	14
12months body weight	143.645	3.2262BW	**	32
18months body weight	175.184	3,9944BW	**	30
24months body weight	193.407	5.2020BW	**	32
3months body weight	92.695	-0.014WWT	Ns	00
6months body weight	42.982	0.631WWT	**	40
12months body weight	-29.632	0.620WWT	**	39
18months body weight	61.954	0.759WWT	**	58
24months body weight	84.014	0.670WWT	**	45

** =P<0.01,b= regression coefficient; R^2 = Coefficient of determination

Table 4.20 shows the estimation of 3, 6, 12, 18 and 24 month live weight using body weight measured at different stages of the animal's growth to 18 month of age. The estimation of 6,12, 18 and 24 body weight using 3 month body weight was very low and not significant (P>0.05). However, the estimation using 6, 12, and 18 month body weight was significant (P<0.01), with coefficient of determination (R^2) ranging from 22.5 - 88.7%.

Table 4.20: Estimation of 6, 12, 18 and 24 months live body weight using body weight at different stages of growth

Characteristics	Equation	B	LOS	R^2(%)
6months body weight	169.291	0.047M3WT	ns	0.02
12months body weight	234.239	0.022M3WT	ns	0.00
18months body weight	295.952	-0.070M3WT	ns	0.05
24months body weight	354.941	-0.126M3WT	ns	1.60
12months body weight	64.223	0.474M6WT	**	22.5
18months body weight	127.091	0647M6WT	**	41.9
24months body weight	180.822	0.506M6WT	**	25.6
18months body weight	196.980	0.577M12WT	**	33.3
24months body weight	228.745	0.557M12WT	**	31.1
24months body weight	-9.798	0.942M18WT	**	88.7

** =P<0.01, b= regression coefficient; R^2 = Coefficient of determination

CHAPTER FIVE

5.0 DISCUSSION

5.1 Characteristics of Breeding Dams in Kazaure and Environs

The mean birth weight of calves (29.5±0.42kg) observed in this study is higher than that reported by Adulli (1992) and Akpa *et al,* (2007) in Friesian – Bunaji and Friesian – Mpwapwa crossbred cows, but lower than 39.2±0.20kg reported by Gwaza *et al*, (2007) in Holstein Friesian cows. The higher birth weight observed here might be related to the influence of the genotype on birth weight which is consistent even under poor management. The mean gestation length of 286.1±0.94 days in this study is higher than the 270 and 278 days reported by Osei *et al* (2004) and Gwaza *et al* (2007), respectively. Also the mean number of inseminations per conception in this study is within the range of 1.3 to 1.5 reported by McDowell and Roger (1996) and Radostits (2001), but lower than 1.74 and 1.98 reported by Stetshwaelo and Adebambo (1992). The variations in the number of insemination per conception is probably due to the quality of the semen and skill of the inseminators (Buckley *et al*.,2003b). The observed distribution of the calving ease in this study may be due to the combination of two or more of the following factors; birth weight, gestation length, sex of calf, pelvic area, body condition of the cow at calving and abnormal presentation of the calf at birth as earlier observed by Scott (2006) and Akpa *et al*. (2002a).

5.2 INSEMINATION PER CONCEPTION

5.2.1 Effect of Sire and Dam Breed on Number of Insemination per Conception and Gestation Length

The effect of sire breed on the number of inseminations per conception in this study was not significant,(P>0.05).However, the variations in the number of inseminations per preconception due to differences in dam breed were significant. Thus indicating that apart from the viability of the semen and skill of the inseminator (Rocha *et al*.,2001), the breed of the dam has a major role to play in the success of the insemination process in the indigenous cows of Nigeria. Although there was no reported case of reproductive disorder in the cows assesed in this study, Shiferaw *et al* (2005) had observed that cows with reproductive disorders required more services per conception and that they had longer intervals from calving to first service and to conception. However, proper and accurate heat detection is a key to efficient reproduction. The number of services per conception in this study were within the range (1.3 – 1.5) given by Radostits (2001) and Gosh *et al*. (2007), but lower than the estimate of 2.15 reported by Yohannes *et al.* (2001). Also, this study showed that a good proportion of conception cases (31.15%) demanded more than one service per conception. This could suggest the presence of repeat breeder in the herd, erratic heat detection skills, inefficiency of artificial insemination (A.I) and/or poor body condition (level of feeding) in the herds in consonance with the report of Gosh *et al.*(2007).

The mean gestation length of the dams in relation to both the sire breed (286.33days) and dam breed origin (284.83 days) used in this study was higher than the 270 days reported by Gwaza *et al.* (2007) and Osei *et al.* (2004) in Holstein Friesian cows. The significant effect of sire breed origin on the gestation length in this study is in

agreement with the reports of Gwaza *et al.* (2007); but contrary to the results of this study, Gwaza *et al* (2007) reported no significant effect of dam breed on gestation length. The variations in gestation length with breed observed in this study had also been reported by Goyache *et al.* (2002) who reported variations in gestation length with breeds. Catalano (1982) also reported that crossing of purebred dairy cows with beef bulls caused an increase in the gestation length of the cow. The significant effect of breed on gestation length is an indication of the high contribution of genes to this trait.

5.3 CALVING EASE

5.3.1 Distribution of calving ease according to sire and dam breed and their combinations

The distribution of the calving ease according to sire and dam breed origin and their combination revealed that both the sire breed and dam breed had significant effect on the calving ease. Although the significant effect of sire and dam breed suggests some level of genetic influence to dystocia, the heritability is low. A heritability of 5 to 15% has been reported by Cady (2004), this mean that, at most, about 85% of the variation can be attributed to environmental or management factors.Consequently, the best method of reducing dystocia is through good management practices. Therefore, proper management and before breeding, during and after calving is the key to preventing the problem. In this study, both the sire breed (42-48%) and dam breed (30-65%) exhibited high percentage of difficult calving.This is higher than the 18.7% and 7.8% reported by Barbara *et al* (2009) in Charolais and Limousine cows, respectively.

The percentages of calving difficulty in the dams vary from 17% to as high as 83% depending on the sire and dam breed combination. Anderson (1992) presented results of

calving difficulty on cross bred cows, in which all cows were crossbred with Hereford or Angus and the percentage calving difficulty varied from 4 to 14%. The differences among breed of the dam are most likely due to differences in relative pelvic area, muscling or fatness.

The Holstein-friesian x Red bororo crossbred had the highest percentage frequency (83%) of calving difficulty. This was probably due to incompatibility in size between the two breed as well as the size of pelvic canal of the dam. Houghton and Corah (1989) reported that dystocia occurs largely because of an incompatibility at birth between the size of the calf and the pelvic opening of the dam. Therefore the pelvic opening determines the maximum birth weight that can be accommodated by individual cows before calving difficulty is experienced. Likewise, Cady (2004) attributed the prevalence of calving difficulty to the mating of larger European breed bull with local breeds of cows.

Calving difficulty increased mortality to as high as 33% in Guzera-white Fulani crosses, 25% in Brown Swiss x white Fulani and 20% in Holstein-Friesian x Red Bororo. This is comparable to the 20% of calving difficulty reported by Radostis *et al* (1994). Calving difficulty has received much more attention in recent years, primarily because of the mating of large European breeds of bulls to local breeds of cows. Increased calving problems are also being encountered within pure breeds, as genetically large bulls are often mated to cows of only average size (Patterson and Herring, 2007). Research has demonstrated that significant differences exist between breed of sire and breed of dam in calving difficulty (Ritchie and Anderson, 1990). This confirms the variation in calving ease observed in this study with regard to sire and dam breed differences. Breed

difference in respect of calving ease is an important factor for genetic improvement of the efficiency of beef and dairy production. This is so because calving difficulty influences the economic of a cow/calf enterprise through increased calf death loss, increased labour and veterinary cost, reduced subsequent reproductive performance of the cow, potential loss of the cows, and reduced milk production (Patterson and Anderson, 2007). In this study, Sokoto Gudali had the lowest percentage (30%) of calving difficulty with zero mortality. This is additionally evidenced considering the fact that the Sokoto Gudali (SG) cross combinations (BSSG, HFSG and GZSG) presented the highest percentage of normal calving (67 – 71%) with no mortality recorded. This suggests that the Sokoto gudali dams are much more compatible with the Brown swiss, Holstien-friesian and Guzera sires for crossbreeding purposes than White Fulani and Red Bororo dams.

5.3.2 Effect of age, Parity and Body Condition of Dam on Calving Ease

The significant effect of age, parity and body condition of the dam on calving ease observed in this study agrees with the reports of Ritchie and Anderson (1990), Akpa *et al* (2002a),and Patterson and Herring (2008). The calving difficulty in this study agreed with the report of Cady (2004) that first calf heifers experience problems twice as often as older cows since they are usually not full grown. In the same vein, Ritchie and Anderson (1990) reported that difficulty in two-years-old dam is three to four times as high as in three years olds, and three years old have about twice as much difficulty as four-year old by the time cows reach 4 – 5 years of age, dystocia problems are minimal. Calving ease also increased with increase in parity in line with report of Akpa *et al* (2002a) that age and size of dam caused dystocia, especially among dams of first parity that were young.

However, multiparious aged dams are sometimes affected, probably due to decreasing ability of the older dams to cope with pregnancy and the associated stress. The decrease in calving difficulty with increase in body condition of the dam from 3 to 5 (on a scale 1 to 5) is probably due to the earlier observation of Vargas *et al* (2000) that absolute values for mature cows shows tendency for the birth weight of their calves to decrease with increased in body condition score of the dam. Ritchie and Anderson (1990) reported significant effect of dams' body condition on calving ease.

5.3.3 Effects of Sex of Calf, Season and Year of Calving on Calving Ease

The effect of sex of calf on calving ease in this study was significant with the female calvers having lower calving difficulty (23%) than the male calvers (63%), and with no mortality recorded. This is probably due to the fact that male fetuses grow faster during gestation and will have heavier weight at birth than female calves (Gwaza *et al.*, 2007; FAO., 2008).Birth weight is positively correlated with calving ease (Scott, 2006). In the same vein Ritchie and Anderson (1990) reported that much of the influence of sex of calf on calving difficulty is believed to be indirect through its effect on calf size. Also, Akpa *et al (*2002a) reported that the effect of sex of calf is associated with the size of the fetus at birth and that it was more prominent for dams with male offsprings which were heavier than those of their female counterparts.

The effect of season of calving on the calving ease of the dam is related to the stage in the wet and dry season cycle at which the dam became pregnant. Most farmers associated poor feeding with calving difficulty as feeding of animals become more difficult during the dry season and can affects the animals especially if it corresponded with the period of pregnancy (Akpa *et al.*, 2002a). Other authors have reported significant

effect of year and season of calving on birth weight of the calves (Ehoche *et al.*, 1992; Tawah *et al.*, 1999; Ebangi *et al.*, 2002; Akpa *et al.*, 2007) and research has shown that birth weight is a major factor that can influence calving ease (Ritchie and Anderson 1990; Scott, 2006). In the same vein, Cady (2004) Reported that cows calving in winter are more likely to experience dystocia than those calving in summer, probably because of lack of exercise. Ritchie and Anderson (1990) reported that calves born in the fall of the year are generally higher in weight and experience less dystocia than those born in the spring. This is contrary to the observation in this study in which calving difficulty was less prevalent during the wet seasons. However, the effect of the year and season of calving is an indication of the effect of management practices, housing, disease prevention and management, feeding and nutrient content of feed offered to the animal, during gestation (Gwaza *et al*, 2007).

5.4: BODY WEIGHT CHARACTERISTICS OF CALVES

5.4.1 Effect of Sex of Calf on Body weight characteristics of Calves

The significant effect of sex on the body weight characteristics observed in this study agrees with the report of FAO (2008) that sex of calf had significant effect on weight of calf from birth to 30 month of age. Many researchers (Ehoche *et al.*, 1992; Abanikanda and Olutogun 1999; Gwaza *et al.*, 2007) had reported significant effect of sex of calf on weight of calves, with the male calves being heavier than their female counterparts. This superiority of the male calves in body weight characteristics over the females may be due to the fact that male fetuses grow faster during gestation and will have heavier weight at birth than female calves (Gwaza *et al.*, 2007). However, contrary

to this report, Ikwuegbu and Campbell (1992) reported non significant effect of sex of calf on body weight at 6 and 9 month of age. Also Tawah *et al* (1999) reported non significant effect of sex of calf on birth weight, pre-weaning weight and weaning weight in which they suggested that lack of significance may be an indication that feeding was not adequate enough to elicit the expression of sexual diamorphism in these genotypes.

5.4.2 Effects of Season and Year of Calving on the Body Weight Characteristics of Cattle

The effect of season of calving on calf weight is basically due to the changes in the quality and quantity of pastures available for cows to feed on across the seasons (Alphonsus,2008) In this study, season of calving had significant effect on birth weight and weight gain at 3 and 24 month of age. The observed significant effect of season on birth weight of the calf is contrary to the report of Ikwuegbu and Campbell (1992), that season of birth had no significant effect on birth weight of the calf but significantly affected calf weight at 3, 6 and 9 month of age. Many other researchers reported significant effect of season of calving on weight of calves (Malau-Aduli *et al.*,1993; Orunmuyi *et al.*, 2001; Ebangi *et al*.,2002).

In this study, calves born during the early dry season had higher birth weight than their counterparts in the other seasons. This observation is in agreement with the report of Akpa *et al.* (2007) that calves born during late Wet and early Dry had higher birth weight than their counterpart in the other season. The effect of season of calving on later body weight is usually related to the stages in the wet and dry season cycle at which an animal reached a given age (Carew *et al*., 1986), hence the variations in weight and weight gain of the calf at 3 and 24 month of age. The effect of year of calving on pre-and post

weaning growth performance may be explained in terms of the fluctuations in the rainfall pattern, as it affect the quality and quantity of forages available for the cows and calves (Ehoche *et al*.,1992; Ebangi *et al.*,2002; Gwaza *et al*.,2007 and FAO, 2008). The quality and quantity of food available to the dam during the breeding season determines the conception rate of the dam; also the quality and quantity of the milk production in the dams is an essential component for the calf growth (Ebangi *et al*., 2002).

However, in this study, year of calving had no significant effect on the body weight characteristics of the calf except on weaning age. This is in line with the report of Tawah *et al* (1999) that year of birth had no significant effect on birth weight and weaning weight of calves. However, this report is contrary to the report of many researchers (Ehoche *et al*., 1992; Kars *et al*., 1994; Abanikada and Olotogun, 1999; Ebangi *et al*., 2002; Akpa *et al*., 2007; FAO, 2008) who observed significant effect of year of calving on body weight of calves at different ages of growth.

5.4.3 Effect of Parity and Dam Body Condition on the Body Weight Characteristics of the Calves

The observed non significant effect of parity on the body weight characteristics of the calves agrees with the report of Ikwuegbu and Campbell (1992) and Akpa *et al* (2007) that parity had no significant effect on birth weight and average weight gain of calves at 3, 6, 9 and 12 month of age of Friesain – Bunaji cows. However, FAO (2008) reported that the effect of dam parturition number was significant in all the ages of the calf from 3 to 18 month of age; other researchers (Licitra *et al.*,1990; Mbap and Ngere, 1996; Kahi *et al*., 2000) had equally reported significant effect of parity on body weight characteristics of the calf.

Information on parent mature weight and body condition score are helpful in estimating the mature size of the progeny as well (Myer *et al.,* 1993). The dams BCS in this study had no significant effect on the body weight characteristics of the calves. This is contrary to the report of Paputungan and Makerachian, (1999) that BCS of the dam was a significant source of variation in calf birth weight as well as calf growth rate at 3, 6, and 9 months of age. Vargas *et al.* (2000) also reported significant effect of dam BCS on calf weight.

5.4.4 Effect of Age of Dam on the Body Weight Characteristics of Calves

Dam's age is one of the factors that have been reported to influence the growth of calves at different ages and at various degrees. Tawah *et al.* (1999) reported that dams age at calving significantly affected birth weight, pre-weaning average daily gain and weaning weight of calves. However in this study age of dam effect was not significant on birth weight and other body weight characteristics except on weight and weight gain at 3 and 24 month of age. This is in line with the report of Ikwuegbu and Campbell (1992) that dam's age had no significant effect on birth weight and weight at 12 and 18 months of age but had significant effect on 6 and 9 month weight of the calves. Newman *et al.* (1993) and Sacco *et al.* (1991) reported increase in birth weight with increase in dam age. The significant effect of dam age on the body weight characteristics of the calves may probably indicate differences in the maternal ability of the cows.

The effect of dam age, although not significant on birth weight and average pre weaning and weaning weight was significant on later weight gains. These significant effects should therefore be taken into consideration in the estimation of genetic parameters and evaluation of the genetic merit of an individual animal during selection.

5.4.5 Effects of Sire and Dam Breed on body weight characteristics of cattle.

The significant effect of sire breed origin on the body weight characteristics has been reported by many authors. Lustra and Cundiff (2003) reported significant effect of sire breed on birth weight, weaning weight and yearly weight. Other authors like Browing *et al.* (1995), Hairing *et al.* (1996), Thrift (1997), Cundiff *et al.* (1998) and Isea *et al.* (2002) reported significant effect of sire on birth weight and weaning weight of calves. This indicates that genetic variation among breed are convenient for desired growth complementarily on selection of breed for cross breeding. Although in this study the effect of sire breed on birth weight was not significant, the breed differences in respect of growth from birth to weaning are strongly associated with the genetic potential for growth of each breed (Tawah *et al*, 1999). Similarly, Newman *et al* (1993) reported that individual additive effect between calves sired by different breeds was positive for birth weight, weaning weight and carcass weight. The significant effect of sire breed on body weight characteristic implies considerable genetic contribution to this trait. Therefore appropriate selection programme that will ensure the use of proven sire breed origin will yield good result. However, contrary to this study Snowder and Duckett (2003) reported non significant effect of sire breed on birth weight and weaning weight.

Breed differences in respect of growth is an important factor for the genetic improvement of the efficiency of dairy production (Tawah *et al.*, 1999). Many researchers like Newman *et al.* (1993); Abanikanda and Olotogun, (1999); Isea *et al.* (2002), Lustra and Cundiff, (2003), and Alphonsus (2008) reported significant effect of dam's breed on body weight characteristics of calves. Basically, effect of dam on the body weight characteristics of calves indicates that factors like dams body condition,

nutritional status and age of dam at calving and other common maternal environmental factors which are non-genetic affect the fetal development, calf weight and dams milk production (Gwaza *et al.* 2007; FAO, 2008). Also, Isea *et al*. (2002) suggested that differences in results from genetic merit when classifying breed groups of cows by their offspring performance might obey more to the different methods of evaluation used by researchers other than breed difference of dam themselves. However, in line with this study Ehoche *et al*. (1992) and Akin *et al*. (2005) reported no significant effect of dams breed on birth weight of the calves.

5.4.6 Effect of Sire – Dam Breed Combination on bodyweight characteristics of cattle

A common definition of combining ability is that it is the additive genetic effect of a line or breeds in cross combination with other line or breed (Gaines *et al.,* 1970). The knowledge of combining ability in animal breeding experiment has been based principally upon swine experiment; however, with the ever increasing interest in heterosis and crossbreeding in beef and dairy cattle, there is need to explore this area. This report is concerned with the first phase of crossbreeding experiment involving three exotic breed and three indigenous breed with the purpose of assessing the degree to which the measurable effect of combining ability are important. The traits studied were birth weight as well as weight and weight gain of calves at 3,6,9,12,18 and 24 month of age. The combining ability estimated from the combination of sire and dam effect was significant on calves' body weight characteristics except on birth weight. This is in line with the earlier report of Gaines *et al* (1970). The significant effect of sire – dam breed combination on the growth characteristics indicate that genetic variation among breed are convenient for desired growth complementarily on selection of breed for crossbreeding,

and the distinguished factor in the offspring of each crossbred is the relative amount of genetic materials contributed by each breed (Isea *et al*., 2002).

Breed differences in respect of growth are an important factor for the genetic improvement of the efficiency of beef and dairy production (Tawah *et al*.,1999). Although the Sire – Dam breed combination effect was not consistent, however, Guzera – white Fulani and Guzera – Red Bororo crosses were relatively heavier than the other crosses. These results probably suggest that breed differences in respect of growth from birth to weaning and weaning weight of progeny are strongly associated with the genetic potential for growth.

The Guzera breed therefore, showed better potential for more rapid growth within the tropical environment than the Holstein Friesian and Brown Swiss under similar production conditions. This is additionally evidenced considering the fact that crossing Guzera with Zebu cattle breeds provided the calves with growth advantage. This is probably because the Guzera crosses are much better adapted to the tropical condition than the Holstein Friesian and Brown Swiss crosses.

5.5: RELATIONSHIP ESTIMATES

5.5.1 Relationships amongst the parameters

The positive correlation between birth weight and dam age is an indication that older cows tend to give birth to heavier calves. This is in line with the report of Tawah *et al* (1999) that dam's age is one of the factors that influence growth of calves at different ages and at various degrees. Also Newman *et al*.(1993) reported increase in birth weight with increase in dam's age. Birth weight was positively correlated with gestation length.

BLCS (2008) reported that gestation length affects birth weight; shorter gestation length results in lower birth weight. The birth weight is related to pre-weaning growth (ADG) and the weaning weight (Vaccaro and Dillard, 1966). Birth weight was positively correlated with both the pre-weaning, weaning and post-weaning weight; this agreed with the report of Tawah *et al.*(1999) that pre-weaning growth is positively correlated with the post weaning growth of calf. Also Newman *et al,* (1993) reported that calves that were heavier at birth and weaning tended to be heavier at the post-weaning stage. Therefore, a reduction in birth weight may result to a decrease in growth from birth to weaning and a reduction in the weaning weight. For example estimates of the genetic correlation between direct effects on birth weight and yearling weight are approximately 0.5 (Koots *et al.*, 1994) and 0.58 in miles city line 1 Herefored (MacNeil *et al.*, 1998). This genetic relationship among direct effect resulted in a situation where selection based on phenotypes or breeding values for greater yearling weight may also significantly increase birth weight. The positive significant correlation observed between the body weight characteristics in this study agrees with the reports of Ehoche *et al* (1992), Malau-Adulli *et al*, (1993) and FAO (2008). This indicates the existence of high dependency amongst the traits, thus it may be possible to estimate or predict the later weight of the calf from the birth weight or the weaning weight of the calves

This is further confirmed by the observed positive regression between birth weight and the subsequent body weight of the calve to weaning and thereafter. This agrees with the earlier report of Newman *et al*.(1993) that the regression coefficient at weaning weight and final weight of calves were linear, indicating that older animals tended to be heavier at weaning and also to express heavier final weights.

The coefficient of determination (R^2) of the regression of body weight at 3, 6, 12, 18 and 24 months of age on birth weight ranged from 14 to 41% indicating that birth weight and weaning weight of calves could explain only 14 to 41% of the variation in body weight of the calves at 3 to 24 months of age. This implies that body weight of calves at later ages may not be adequately predicted by birth weight. However, birth weight was a fairly good estimator of 3 months body weight, explaining about 41% of the observed variations in 3 months body weight. Thus, an attempt to predict the later weight of the calves using their birth weight only may not give an adequate estimation.

It was observed that 3 months body weight of the calves was not a good estimator of body weight from 6 to 24 months of age, however, 6, 12 and 18 month body weight gave a fair estimation with the estimation of 24 months body weight using 18 months body weight being the highest (R^2 = 88.9%).

The 6 months BW explains 23-42% of variation in body weight of the animals from 12 to 24 months of age, and 12 month BW explains 31 - 35% of variation in 18 to 24 month BW while 18 months BW explained 88.9% of the variation in 24 months BW of the animals.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

The analysis of calving ease, gestation length and number of insemination in *Bos taurus* cattle and their crosses (*Bos Taurus x Bos indicus*) showed that age, parity, body condition score (BCS), sex, season and year of calving as well as sire and dam breed origin, and sire-dam bred combination of *Bos taurus* and *Bos indicus* had significant effect on calving difficulty and gestation length of the dam. Also dam breed had significant effect on number of inseminations per conception of the dam. Fifty four percent (54%) of the cows had normal calving while 24% were assisted. Amongst the assisted calving, 89% of the calves survived while 11% died. Calving ease increased with age, with the 9 years old dams having the highest (80%) normal calving. Equally, calving ease increase with parity and body condition of dam. The female bearing dams had higher calving ease (73%) than the male bearing ones (37%).The male bearing dams recorded the highest percentage (63%) of assisted calving with 46% mortality, while their female's counterpart recorded no mortality. Calving ease was highest during the late wet (72%) followed by the late dry (62%) and early wet (57%) seasons. The sire breed origin had no significant ($p>0.05$) effect on the number of insemination per conception but significantly influenced gestation length. Gestation length was longest for dams sired by Holstein-Friesian (288.05 days) and least for those sired by Brown Swiss (284.67 days).

Dam breed origin significantly (<0.05) influenced number of inseminations per conception and gestation length of dams. The lowest number of inseminations per

conception was observed in Sokoto Gudali dams (1.1) and the highest (1.6) in Red Bororo dams.

The male calves had significantly ($P<0.01$) higher body weight characteristics than their female counterparts. Season of calving had significant ($P<0.05$) influence on birth weight, 3 and 24 months weight characteristics but not on weaning weight, 6, 12 and 18 month weight characteristics. Birth weight, weaning weight,12 months weight,18months weight gain increased with parity up to parity 3 and then declined. Age of dam had no significant ($p>0.05$) effect on the weight characteristics except 3 and 24 months of age. Sire breed significantly ($p<0.01$-0.05) influenced the body weight characteristics of the crossbred calves from 3 to 24 months of age. Dam breed had significant ($p<0.01$-0.05) effect on weight characteristics at 3 and 6 months of age of calves. Sire breed significantly ($P<0.05$) influenced weaning weight but not birth weight and weaning age of the calves. Sire-Dam breed combinations significantly ($p<0.01$-0.05) influenced the body weight characteristics of calves from3 to 24 months of age. Generally, the correlation amongst the body weight characteristics was positive except between weaning age and weight at 6 and 12 months of age, respectively. The coefficient of determination (R^2) for the estimation of the body weight using birth weight ranged from 14% to 41%, while that of the weaning weight ranged from 0% to 58%.

The significant effects of these factors; age, parity, body condition score (BCS), sex, season and year of calving as well as sire and dam breed origin, and sire-dam bred combination of *Bos taurus* and *Bos indicus* on calving difficulty, number of inseminations per conception and gestation length of the dam suggest that these factors should be taken into consideration in any cattle breeding programme.

6.2 CONCLUSION

Calving Ease

- The Sokoto Gudali cross combinations (BSSG, HFSG, GZSG) presented the highest percentage normal calvings (67-71%) and had the lowest percentage (30%) of calving difficulty with zero mortality. This suggests that the Sokoto Gudali dams are much more compatible with the Brown Swiss, Holstein-Friesian and Guzera Sires for cross breeding purposes than white Fulani and Red Bororo dams.
- Birth weight and sex of calves; age, parity and body condition of dam, season and year of calving caused variations in calving ease of Sokoto Gudali, white Fulani and Red Bororo cows.

Inseminations per conception

- Sire breed does not constitute sources of variation in number of inseminations per conception while dam breed did. Therefore, the breed origin of the dam has a major role to play in the success of the insemination process in the indigenous cows of Nigeria.
- Gestation length was longest for dam sired by Holstein Friesian (288.05days) and least for those sired by Brown Swiss (284.67days).
- Number of inseminations per conception was lowest in Sokoto Gudali (1.1) and highest for Red Bororo (1.6). Both white Fulani (283.69days) and Red Bororo (282.30 days) had lower gestation lengths compared to Sokoto Gudali (288.50 days).

Body Weight Characteristics

- Sire and dam breeds significantly influenced calf growth characteristics; thus indicating that genetic variation among breeds are convenient for desired growth complementarily when selecting breed for cross breeding purposes.

- The Sire–Dam breed combination on body weight of calves showed that Guzera-White Fulani and Guzera-Red Bororo Crosses produced heavier calves than other crosses. Therefore, the use of Guzera breed as sires showed better potential for more rapid growth within the tropical environment than the Holstein-Friesian and Brown Swiss Sires under similar production conditions.

6.3 RECOMMENDATIONS

These factors; Age, Parity, Body Condition Score (BCS), Sex of calf, Season and Year of calving should be taken into consideration in any cattle breeding programme so as to reduce the risk of calving difficulty of the cows.

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