

**GENETIC AND ENVIRONMENTAL FACTORS AFFECTING CALF
BIRTH WEIGHT AND SOME CALVING TRAITS OF EXOTIC
BREEDS OF CATTLE IN A TROPICAL ENVIRONMENT**

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(SPS/12/MAS/00016)

M.Sc. DISSERTATION, 2016

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B. AGRICULTURE

**A Dissertation Submitted to the Department of Animal Science, Bayero
University, Kano in Partial Fulfillment of the Requirements for the Award
of the Degree of MASTER OF SCIENCE IN ANIMAL SCIENCE**

OCTOBER, 2016.

DECLARATION

I hereby declare that this work is the product of my research efforts, undertaken under the supervision of Professor Ibrahim Tahir and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work for this dissertation and the subsequent write-up (Mutiat Shola Abdulkareem SPS/12/MAS/00016) were carried out under my supervision.

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ABSTRACT

A study was carried out to determine the genetic and environmental factors affecting calf birth weight, calving ease and placental release ease of exotic breeds of cattle at Sebore Farms, Mayo-Belwa, Adamawa State. The data used for the study included 302 calving records and 270 calf birth weight records from five dam breeds. The dam breeds were Simmental, Brahman, Brown Swiss, Holstein-Friesian and crosses, while the sire breed was Simmental. Birth weight was significantly ($P < 0.05$) affected by calf sex. Male calves weighed heavier than female calves (37.67 kg vs. 35.17 kg). Majority (94.7%) of the cows had unassisted calving while 5.3% had to be slightly assisted. Calving ease (CE) was significantly affected by calf sex ($P < 0.05$), season of calving as well as birth weight ($P < 0.001$); however, dam breed had no significant influence on the trait. More cases of assisted calving were observed for male calves than female calves and for birth weights of between 36 and 45 kg, which was only observed during the late wet season. Most (85.7%) of the cows had normal placental expulsion while 14.3% had retained placenta (RP) and were slightly assisted. Dam breed had a significant effect on the ease of placental release ($P < 0.05$), while calf sex, season and birth weight had no significant effect on it. Dams of Simmental breed had the highest rate of RP (9.3%). There was a significant ($P < 0.001$) change in the relationship between CE and ease of placental release (PRE). 14.6% of the cows had unassisted calving but had RP and were assisted, while 4.5% had slight calving difficulty but had their placenta expelled normally. It can be concluded that sex affects birth weight which in turn influences CE. Therefore, birth weight, calf sex, season of birth are important factors to consider when breeding for calving ease as well as placental release ease. Dam breed should also be considered when avoiding RP.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND INFORMATION

In the tropics, and most developing countries, the productive and reproductive potentials of indigenous cattle are low compared to temperate breeds (Gwaza, Okwori, Abu and Fombah, 2007). Hence, several efforts to increase livestock production have been through breeding strategies and policies that encouraged the introduction and breeding of temperate breeds (Stetshwaelo and Adebambo, 1992).

Exotic livestock introduced into Africa falls into three broad groups- import from other tropical countries (e.g Sahiwal and Brahman cattle); composite or synthetic breeds developed using local and foreign breeds (e.g Dorper sheep and Bonsmara cattle); and temperate breeds e.g Hereford and Holstein cattle (Ntombizakhe, 2002). The foreign breeds have been proven to be highly productive in their countries of origin. However, in sub-saharan Africa, they have shown to perform poorly when the environment is harsh, the main problem being lack of adaptation to local production conditions (Baker and Rege, 1994). Nonetheless, they outperformed the indigenous breeds when the environment is improved substantially. For example, Holstein cows can produce more than 10 thousand kg of milk per 300-day lactation, yet indigenous breeds produce less than 2000kg per year (Moyo, 1995; Els,1997; Rege,1998).

In tropical environments, the typical climatic conditions include high ambient temperatures, high humidity and erratic rainfall. The climatic conditions influence the quality and quantity of feed and result in a wide variety of diseases (Rendel, 1981; Preston and Leng, 1987; Preston and Murgueitio, 1992; Rege, 2000). On this basis, the region can be divided into the following five ecological zones; very arid, arid to semi-arid, semi- arid to humid (without tsetsefly), temperate highland and humid tsetsefly infected (Rege, 1998; Steane,

2000). The very arid, arid and semi- arid rangelands are characterized by pronounced seasonal changes in forage supply and quality, frequent shortages of water and high ambient temperatures. The humid zones are characterized by large quantities of fodder, high temperatures and high humidity. Each of these ecological zones has endemic diseases (Terrill and Slee, 1991).

Birth weight is a characteristic of great economic importance in the cattle industry. In dairy cattle, this trait has been comprehensively studied by different researchers in several places among different breeds (Shahzad *et al.*, 2010). Differences between birth weights of calves are also used as an indication of differences between them in vigor, potential growth rate and mature size. The effect of various environmental factors such as farm, period of fodder availability, parity and calving season on birth weight of calves has been reported (Swali and Wathes, 2006).

Birth weight as an early measurable trait is of great interest because of its positive genetic correlation with further live weights (Assan and Makuza, 2005). It has become a significant predictor of later health outcomes, lower birth weights than optimum are associated with reduced energy reserves, lowered thermoregulatory capability, and increased calf deaths at or near birth (Ferrel, 1993).

Reproductive diseases are of great concern to cattle producers worldwide. The estimation of loss and effects of diseases on milk production, fertility and survival are of great importance to assess cost- benefits of diagnosis, treatments and prevention efforts (Bar and Ezra, 2005).

Calving ease is one important reproductive disease and is defined as the cow's ability to deliver a healthy calf easily and also the ability of the calf to be born easily. This functional trait has received considerable attention recently in dairy cattle breeding and improvement programs worldwide. Calving ease is an important consideration in both the economics of

cattle production and the welfare of animals. Difficult or abnormal calving requiring assistance is referred to as dystocia (Berry, Lee, Macdonald and Roche, 2007). The incidence of dystocia and perinatal calf mortality are closely correlated (Steinbock, Nasholm, Berglund, Johansson and Phillipson, 2003). According to some researchers, the frequency of difficult calving increases with an increase in the proportion of Holstein- Friesian genes (Steinbock *et al.*, 2003; Hansen, Musztal, Lund, Pederson and Christensen, 2004).

There are a variety of risk factors of dystocia such as breed, parity, weight of calf, multiple calving, year and season of calving (Zaborski *et al.*, 2009). Dystocia is much more common in primiparous than in multiparous cows (Dematawewa and Berger, 1997; Johanson and Berger, 2003; Lombard, Garry, Tomlison and Garber, 2007; Uzmay, Kaya and Ayyilmaz, 2010; Gevrekci, Akbas and Kizilkaya, 2011), but primary risk factors for dystocia are different in primiparous and multiparous cows (Lombard, Garry, Tomlison and Garber, 2007). Paulina and Zenon (2010) reported that factors affecting calving ease can be divided into direct and indirect. Direct factors are related to sire effects (weight, body conformation and sex of a calf), and the indirect i.e, maternal (cow's age and body condition, the development of hard reproductive organs, hormonal control). Complicated calvings occur more frequently in primiparous cows (Meyer, Berger and Koehler, 2000), what is reflected in a higher rate of stillbirths.

Retained Placenta (RP) is another important reproductive disease of livestock. Retained placenta is the failure to expel the fetal membrane within 12 to 24 hours after calving in bovines (Mohamed and Amer, 2009), or within 3 hours after foaling in equines (Taylor, Brazil and Hillyer, 2010). Such phenomenon is a common and poorly understood post partum disorder that has a detrimental effect on milk yield and subsequent reproductive efficiency (El-Malky, Youssef, Abdel-Aziz and Abd El-Salaam, 2010). The retention of placenta creates a number of potential problems due to the possibility of uterine infection

(Borel *et al.*, 2006). The local infection in the uterus can cause the animal to become ill (fever, weight loss, etc). Sometimes the infection is so bad and the cow can actually die. When the uterus becomes infected and inflamed, it takes much longer for the cow to clean and to be ready for the next breeding season. A retained placenta usually causes the cow to delay the next pregnancy for 2 to 6 months, late calving date in the following year and may result in an open cow next year (Borel *et al.*, 2006).

There are many factors influencing the incidence of retained placenta like abortion, dystocia, multiple birth, poor body condition score, age, nutritional deficiencies, hormonal imbalance (Grunert, 1986; Alam and Dobson, 1986). Another result of retained placenta can be tetanus. The tetanus organism is commonly found in the soil or in the faeces and when it gets into the uterus; it can set up an infection and result in tetanus (lockjaw). Tetanus can be fatal and at the minimum requires 1 to 3 months as long term therapy (Borel *et al.*, 2006).

The incidence of placental retention appears to be varying from area to area and from year to year and from breed to breed (Majeed, Aboud, Hassan and Muhammad, 2009). The incidence in cattle ranged between 5.2 to 23.5% (Youngquist and Threifall, 2007).

1.2 PROBLEM STATEMENT

The animals of temperate regions maintained in tropical conditions cannot behave similarly in both environments (Javed, Afzal and Ahmad, 2002). Vaccaro (1990) reviewed the survival rates of European breeds and their crosses with Zebu in the tropics and reported that pure-bred temperate cows were unable to replace themselves and were not a viable option, especially where there were no options for changing the environment to the level needed for animals of temperate breeds. High temperatures associated with a high relative humidity causes most heat stress for cattle in the tropics (Johnson, Shanklin and Hahan, 1987).

Birth weight is not only an easy and reliable measurement of prenatal period, but also an important factor that affects the post natal growth and development (Akubulut, Bayram and Yanar, 2001). It has been demonstrated that calves having too small live weight at birth may lack vigor and tolerance to external conditions (Johanson and Berger, 2003). Various degrees of dystocia may occur in calves that are too large at birth (Bakir, Kaygisiz and Ulker, 2004).

Calving difficulties increase the risk of calf death at or shortly after calving 2.91- folds in primiparous cows and 4.67-folds in multiparous cows (Meyer, Berger, Koehler, Thompson and Sattler, 2001). Apart from calf loss, difficult calving may result in milk yield decrease, reduced fertility and increased disease susceptibility (Mangukar *et al.*, 1984; Dematawewa and Berger, 1997). Difficult calving can also lead to problems with colostrum feeding in newborn calves, including decreased protein absorption (Skrzypek, 2000).

Dystocia is a welfare problem of cows and calves hence, of economic importance. It causes pain or pain and injury to the cow (Kaya, Uzmay and Ayyilmaz, 2015), Therefore, it directly leads to poor welfare in cows (EFSA, 2009).

Among the reproductive diseases, retained placenta is another important reproductive cyclical problem that has repercussions on the next calving (Joosten, Stetwagen and Dijkhuizen, 1988). A RP usually causes the cow to delay the next pregnancy for 2 to 6 months, late calving date in the following year and may result in an open cow next year (Borel *et al.*, 2006). The incidence of RP varies from 2 to 10% of foaling in mares (Taylor *et al.*, 2010) and 4.0 to 16.1% in cow (Mohamed and Amer, 2009). However, this incidence can be much higher in problem herds. It causes considerable economic losses in the herd due to decreased milk production, illness and treatment cost, beside a decreased market value of the animal (Ahmed, El- Khadrawy and Abel Hameed, 2006; Maldonado and Scerif, 2010).

1.3 JUSTIFICATION

Animals indigenous to sub-saharan Africa are well adapted to the various ecological zones, but have low potential for high levels of production (Steane, 2000). Animal output were increased through breeding programme efforts. These efforts involved importations of exotic breeds from both tropical and temperate countries, and promotion of these breeds and their crosses, particularly in the commercial sector, which supplies food to the urban centers. Performance of imported breeds however varied with varying environments and under certain conditions, it was either worse or not significantly different from that of indigenous breeds (Ntombizakhe, 2002).

Information on factors influencing birth weight is of interest to farmers as well as the animal breeder, because birth weight is of great economic importance (Bermejo *et al.*, 2010). Variation in birth weight within a population can be attributed to genetic, environmental and the physiological factors that impinge on individuals.

Birth weight is a measure of prenatal growth and affects partially in post natal development (Ibrahim, Ibrahim, Faysal, Abdurahman and Mohamed-Khair, 2015), they added that birth weight is an economically important production trait that is mostly influenced by additive and non-additive gene action of the calf and dam. Birth weight, due to its relative simplicity may be of interest to livestock producers and similar situations as preliminary selection criteria in animal production (Assan, 2013). Heavy individual birth weight is important not only for survival (Milligan, Fraser and Kramer, 2002) but also for lifetime performance (Rydhmer, Eliasson, Stern, Anderson and Einarsson, 1989). Therefore, understanding of factors affecting birth weight may be crucial for evaluation of lifetime performance (Assan, 2013).

Dystocia may have negative effects on levels of milk yield and reproductive performance, causing still birth, cow death, retained placenta, uterine infections or increased involuntary

culling (Dematawewa and Berger, 1997; Lombard Garry, Tomlison and Garber, 2007; Berry, Lee, Macdonald and Roche, 2007; Gaafar, Shamiah, El- Hamd, Shitta and El- Din, 2011; Ghanem *et al.*, 2013; Zobel, 2013).

Although, reducing dystocia rates by breeding is a slow process because of the low heritability, low estimates of heritability for dystocia means that most of the variation of this trait can be attributed to environmental or management factors (Eriksson, Nasholm, Johansson and Phillipson, 2004).

A retained placenta usually causes the cow to delay the next pregnancy for 2 to 6 months, late calving date in the following year and may result in an open cow next year (Borel *et al.* 2006). The incidence of retained placenta varies from 2 to 10% of foaling in mares (Taylor *et al.* 2010) and 4.0 to 16.1% in cow (Mohamed and Amer, 2009). In dairy cows, retained placenta may be the cause of serious economic losses in the herd due to decreased milk production, illness and treatment cost, beside a decreased market value of the animal (Ahmed, El- Ekhaway, Desouky, Zaabal and Ahmed, 1999; Semacan and Servinc, 2005).

Therefore, this study intends to investigate the effect of genetic and non- genetic factors on calf birth weight, calving ease as well as placenta release ease.

1.4 OBJECTIVES

The broad objective was to evaluate the effect of genetic and non- genetic factors on calf birth weight, calving ease and placenta release ease of exotic breeds of cattle in tropical environment.

The specific objectives were to:

1. Evaluate the effects of breed, season and sex on calf birth weight
2. Assess the influence of breed, season, sex and birth weight class on calving ease.
3. Determine the influence of breed, season, sex and birth weight class on placenta release ease.

4. Determine the significance of change in the relationship between calving ease and placental release ease.

CHAPTER TWO

LITERATURE REVIEW

2.1 EXOTIC BREEDS OF CATTLE IN TROPICAL ENVIRONMENT

Livestock is a crucial part in the economic and social fabric. Among the livestock that make up the farm animals in the tropics, ruminants comprising sheep, goats and cattle, constitute the farm animals largely reared by farmers in the tropical agricultural system. Cattle is an important farm animal in agricultural operations which provides valuable food of animal origin like milk, meat, milk products, industrial raw materials like skin and manures (Ntombizakhe, 2002).

There are a number of elements in the tropical environment which must be overcome if an exotic animal is to efficiently reproduce and be highly productive. The major environmental constraints to high productivity in the tropics are ambient temperature and humidity, annual and seasonal availability of feed resources, internal and external parasites and a variety of bacterial and viral infections. The effect of climate, parasites and diseases on production can be minimized either through the use of resistant genotypes or through managerial interventions to the animal's environment. In most cases, a combination of these two basic strategies is used.

Within the ecological zones, there are subdivisions based on level of intensification of agriculture. These are extensive, semi- intensive and intensive production systems under the communal and commercial sectors. Generally, the level of management and production inputs is higher in the commercial sectors than the communal one and in the intensive system than in the extensive one. Such inputs usually aim to modify the production environment and can result in higher production outputs. Modification of tropical environment includes provision of housing or shades, extra water and feed, disease control and improved management (Vilakati, 1990; Walshe, Grindle, Nell and Benchman, 1991).

Some research had found that, from the perspective of production, survival and profitability, crossbreeding can be more profitable over three generations (Carrik, Bowman and Goddard, 2003), with favourable outcomes associated with Holstein-Friesian crosses with Brown Swiss and Australian Red (a synthetic breed composed of Swedish and Danish Reds, Ilawara, Dairy Shorthorn) cows compared with Holsteins (Vilakati, 1990).

Moreover, exotic beef animals reach slaughter weights at two years of age compared with three to four years for indigenous breeds. The low production potentialities of indigenous breeds, the increasing demand for animal products as populations grow and urbanization increases, and the improvement in management and control of diseases have all encouraged the importation of high producing temperate breeds (Walshe, Grindle, Nell and Benchman, 1991).

2.2 THE BREEDS

A breed is a race or variety related by descent and similarity in certain distinguishable characteristics. More than 250 breeds of cattle are recognized throughout the world (Andrew, 2011). Livestock populations in the world occur in a wide variety of environments to which they have been well adapted through natural and artificial selection. Consequently, there are many genotypes which vary a great deal in their physical and functional characteristics as well as in their levels of productivity. In Nigeria, there are breeds that are indigenous, as well as breeds that have been imported into the country (Rege, 2000).

2.2.1 Exotic Breeds of Cattle

Exotic breeds of livestock introduced into Africa fall into three broad groups— i) imports from other tropical countries (e.g. Sahiwal and Brahman cattle); ii) composite or synthetic breeds developed using local and foreign breeds (e.g. Dorper sheep and Bonsmara cattle); and iii) temperate breeds (e.g. Hereford and Holstein cattle) (Ntombizakhe, 2002). The foreign breeds have been proven to be highly productive in their countries of origin. In

sub-Saharan Africa, however, they have been shown to perform poorly when the environment is harsh, the main problem being their lack of adaptation to local production conditions. Nonetheless, they outperform indigenous breeds when the environment is improved substantially. For example, Holstein cows can produce more than 10,000 kg of milk per 300-day lactation yet indigenous breeds produce less than 2000 kg per year (Preston and Murgueitio, 1992). Moreover, exotic beef animals reach slaughter weights at two years of age compared with three to four years for indigenous breeds. The low production potentialities of indigenous breeds, the increasing demand for animal products as populations grow and urbanisation increases, and the improvement in management and control of diseases have all encouraged the importation of high producing temperate breeds (Baker and Rege, 1994). Nevertheless, foreign breeds have been crossed with local breeds and the crosses have been found to be more tolerant to production conditions in sub-Saharan Africa than the pure breeds.

Simmental

The Simmental originated in Western Switzerland, and is the second most common cattle breed worldwide. Although pure Simmental cattle make up only 1% of the New Zealand beef herd, the bulls are popular as terminal sires, and are widely mated with Angus, Hereford and Angus- Hereford cross cows. The Simmental was initially bred for milking as well as meat, and was used as a draught animal. Specialised breeding in different countries has led to variations. In general, the Simmental is a large, well muscled horned cow, the cows weigh from 544 kg to 817 kg, and bulls can weigh from 726 kg to 1,271kg. They have white face with light straw to brownish-red in color, with white patches on the head, underside and legs, and often dark patches around the eyes. Ear is same color as the body. They have pendulous dewlap and large udder. They need more assistance during calving periods than any other breed. The cows have good maternal qualities and a good milk yield, so they produce well-grown weaners. Simmentals have excellent rates of growth and feed conversion

– they turn more of their feed into meat than some breeds. They have a potential milk yield of 10- 15 litres per day. They have average calf birth weight of 39- 43 kg (Andrew, 2011).

Brahman

This breed originated from *Bos indicus* cattle originally brought from India. They vary in color from very light grey or red to almost black, or even spotted. They have large hump over the top of the shoulder and neck. Their horns curve upwards and sometimes tilt to the rear. They have large and pendulous ears with a throat latch and dewlap which have a large amount of excess skin. They are intermediate in size among beef breeds found in the United States, with bulls weighing from 726 kg to 999 kg and cows from 454 kg to 636 kg. Calves are small at birth weighing 31- 41 kg, but grow very rapidly and wean at weights comparable to other breeds. They are intelligent, inquisitive and shy; they are unusually thrifty, hardy and adaptable to a wide range of feed and climate. Brahmans vary in color from very light grey or red to almost black (Briggs and Briggs, 1980). A majority of the breed are light to medium grey. They like affection and quickly respond to handling they receive, good or bad. Mature bulls are normally darker than cows and usually have dark areas on the neck, shoulders and lower thighs. The short, thick, glossy hair coat of the Brahman reflects much of the sun's rays, adding to its ability to graze in the glaring mid day sun without suffering (Russell, 1980).

Brown Swiss

They originated from Switzerland. They are docile and are dark brown, grey, tan or even almost white. They have white or black muzzles and floppy ears. Cows typically weigh up to 681kg while bulls weigh more than 1,135 kg. They develop dark blue eyes due to the pigment's ability to block out solar radiation. They have the ability to produce milk till 15 years of age (Russel, 1980).

Holstein-Friesian

This breed originated from Holland. Holstein-friesians are black and white or red and white. This color pattern is patchy, with big black, rounded patches over the animal's body. Some may be more white than black than others. Holsteins show more bone and less fat and muscle because they have been specifically selected to produce milk, not beef. They are the largest dairy breed, a little bigger than Brown Swiss and more so than Jersey. They have huge udder between their legs. They have long head, long nose bridge that gives this shape. Potential milk yield of 40 – 50 litres per day with low butter fat content of about 3.2% although, milk production depends on level of feeding and other management. They are suitable for zero grazing and high level of management. Needs less replacement and provide valuable male calves. Holsteins can weigh around and over 550kg, heifers are mated at 15-21 months old and lactation period lasts for approximately 305 days and calves can weigh up to 43kg (Briggs and Briggs, 1980).

2.2.2 Indigenous Breeds of Cattle

The breeds indigenous to Nigeria and Africa at large are many and are mainly owned and used by smallholder farmers and they represent over 90% of the livestock breeds. Studies to characterize indigenous breeds have been carried out in many African countries (Ntombizakhe, 2002). These studies have shown that, generally, existing indigenous livestock are well adapted to local production conditions. Survival rates for the indigenous breeds are higher than survival rates for the foreign breeds; this is primarily because many indigenous animals can tolerate local diseases. Examples of disease resistance include tolerance to trypanosomiasis by the N'Dama cattle and Djallonke sheep of West Africa (Swali and Wathes, 2006; Baker and Rege, 1994).

Examples of some indigenous breeds of cattle in Nigeria are White Fulani, N'dama, Keteku, Muturu to mention but few. Furthermore, due to their anatomical and physiological

attributes, local cattle are less sensitive to heat stress when compared with foreign breeds. They are better able to utilize low quality feeds and can walk longer distances searching for water and food than their temperate counterparts, and can tolerate dehydration for extended periods. They are also fertile and have good mothering ability. Indigenous breeds are usually late maturing, have poor growth rates and low milk yields, and produce small carcasses (Rendel, 1981). It has also been shown that few indigenous breeds respond well to good feeding management, such as that for intensive feedlot beef production systems or intensive dairy production systems. Low production or small size by itself is an adaptive attribute as it is an advantage in hot climates. However, the effect of their low genetic potential is, at times, confounded by the low standard of management under which indigenous livestock are usually kept (Osman, 1981).

2.2.3 Crosses of Indigenous Breeds

Keteku crosses

This has a white coat colour, often with black points (ear and nose), in addition, some are white with black spots or black and white (Gwaza and Momoh, 2016). The hump is usually inconspicuous while the horns are quite short. This breed is larger and taller in the North than they are in the South (Adeniji, 1985). The keteku is a crossbreed between the muturu and the zebu.

Friesian-Bunaji

To improve the reproductive efficiency of the indigenous cow, the best option is to combine the hardiness of *Bos indicus* with the genetically high reproductive and milk yield potentials of the *Bos taurus* through cross breeding (Cunningham and Syrstad, 1987). The resulting heterosis in the crossbreeds is exhibited through superior reproductive performance and high milk yield (Ngodigha and Etokeren, 2009). To utilize this genetical advantage, Nigeria imported several Holstein-Friesian bulls for crossbreeding with the local dairy

breeds, especially Bunaji heifers. This resulted in considerable reproductive improvement in milk yield and reproductive potentials (Mbap and Ngere, 1989).

2.3 BIRTH WEIGHT

Birth weight is a measure of prenatal growth and affects partially post natal development. Birth weight determines future performance of individuals engaged in prevailing environment (Assan and Makuza, 2005). The authors also reported that birth weight is an economically important production trait that is mostly influenced by additive gene action of the calf and the dam. The body substance deposited daily is proportional to weight of the growth mass; as a consequence the small birth weight, the lower absolute daily gain of given age up to weaning. Weight at birth is influenced by both hereditary and environmental factors. These include; breed, sex of calf, weight of dam, season and year of calving and others (Ferrel, 1993).

Birth weight as an early measureable trait is of great interest because of its positive genetic correlation with future live weights (Assan and Makuza, 2005). It has become a significant predictor of later health outcomes, lower birth weights than optimum are associated with reduced energy reserves, lowered thermoregulatory capability, and increased calf deaths at or near birth (Ferrel, 1993). Information on factors influencing birth weight is of interest to farmers as well as the animal breeder, because birth weight is of great economic importance (Bermejo *et al.*, 2010). Variation in birth weight within a population can be attributed to genetic, environmental and the physiological factors that impinge on individuals. Heavy individual birth weight is important not only for survival (Milligan, Fraser and Kramer, 2002), but also for lifetime performance. Therefore, understanding of factors affecting birth weight may be crucial for evaluation of lifetime performance. Foetal growth, hence birth weight, is influenced by numerous factors including number of foetuses, sex, parity or age of the cow, breed of sire, breed of dam, heat or cold stress, and nutrition.

Birth weight due to its relative simplicity may be of interest to livestock producers and similar situations as preliminary selection criteria in animal production. The accurate and reliable estimates of genetic parameters, particularly heritability estimates are key factors, required to decide optimum selection and breeding strategies for genetic improvement in animal production. The influence of direct, maternal- genetic and maternal-environmental effects on birth weight in cattle have been well documented (Dezfuli and Mashayekhi, 2009; Assan, 2012).

2.3.1 Environmental Factors Affecting Birth Weight

Birth status and parity

Birth weight is significantly affected by type of birth and generally birth weight decreased with increase in litter size. It has been reported that the number of cotyledons per foetus varies between and within breed, litter size, sex and environmental conditions. Therefore, the survival of a newborn is affected by sufficiency of placenta (Mellor and Stafford, 2004).

In general, parity had high significant effect on body weight at different age groups. The body weight increased with advancement of parity and calves born at 4th and above parities had higher body weight at different ages (Thiruvankadan, Karunanithi, Muralidharan and Babu, 2011). Birth weight of second parity is higher than first and third parity in goats (Bharathidhasan *et al.*, 2009). Tomar, Singh and Sharma (1995) observed that the parity of gestation had significant effect on birth weight.

Age of dam and maternal nutrition

It has been previously demonstrated that inappropriate maternal nutrition at key stages of pregnancy is one of the measureable factors leading to decreased live weight (Wallace, Bouke and Aitken, 1999). In cattle, a calf weighs 7-8% the weight of the dam, as weight depends on age, there is a positive relation between the age of the cow and weight of calf at

birth. Dam's age was significant on birth weight (Dixit, Dhillon and Singh, 2001) but some contradictions with others (Elfadili, Michaux, Detilleux and Leroy, 2000; Abegaz, Van and Oliver, 2005). After 10-11 years of dam age, calf birth weight tends to decline, but this varies among breeds. Differences between ages 2 and 3 was significant but ages between 2 and other ages (4, 5, 6) was very significant (Caro Petrovic *et al.*, 2012). Van der Westhuizen, Wentzel and Grobler (2004) stated that kids born to young does (2 years-old- does) had lower body weights up to 16 months of age of dam than kids born to 4 to 8 year old does. Authors concluded that age of dam is one of the internal factors that has a marked influence on overall efficiency of the flock. Birth weight determines how much milk the calf can consume, the bigger the calf the bigger suck and the more milk the cow will produce.

The effect of nutrition was relatively small and yet quite significant (Dwyer, Lawrence, Bishop and Lewis, 2003). The significant effect of year on birth weight has been shown to be due to improvements in management and feeding of dams during pregnancy (Combellas, Martinez and Gonzalez, 1980). Maternal nutrition during pregnancy plays an important role in the regulation of foetal and placental development, therefore, has the potential to influence foetal growth as indicated by birth weight. Maternal under-nutrition in pregnancy resulted in low birth weights and impaired postnatal survival in sheep (Dwyer, Lawrence, Bishop and Lewis, 2003). It was indicated that the nutrition of dam and the size of placenta are well known to determine the foetal growth rate. Konyali, Tolu, Das and Savas (2007) and Oramari, Alkass, Hermiz and Hussein (2011) showed that birth weight was strongly associated with placental traits such as placental weight. Over nourishing the adolescent dam to promote rapid maternal growth through out pregnancy resulted in a major restriction in the placental weight, and leads to a significant decrease in birth weight relative to moderately fed normally growing adolescents of equivalent gynaecological age (Wallace, Bourke and Aitken, 1999). Inappropriate maternal nutrient intake at key developmental

points during *ovine* pregnancy had a profound influence on the outcome of pregnancy and aspects of post natal productivity. However, it was noted that the responses to alterations in maternal nutrition in cows are often highly variable and inconsistent between studies. The level of nutrition of dam and calf birth weight are positively correlated, especially in the last trimester when 70% of the calf's absolute growth takes place. There is need to reduce feed to minimize difficult birth cases, or use bulls known to produce smaller calves, especially in heifers.

The differences in birth weight in cattle may be attributed to the effect of breed besides the non genetic factors (Banerjee and Jana, 2010). Ferrell (1993) studied the factors influencing foetal growth and birth weight in cattle where he reported that calf birth weight differed substantially among the nine breeds of cattle. Weights of calves from cows on the very high feed level had the highest birth weight, followed by medium and lowest feed levels gave the lowest birth weights. The nutritional effects are much less than the breed effects and are in general larger in magnitude in breeds having larger calves. It was suggested that low levels of maternal nutrition may result in reduced birth weight, but nutritional levels above adequate result in no further increase. The importance of breed in birth weight may be attributed to the way the breeds react to differences in the environment from year to year.

Sex

The average birth weight of calves is 28.9 kg, with male calves weighing about 5 to 8% more at birth than female calves, a partial effect of the testosterone that is being produced during the early stage of pregnancy (Kalyn, 2013). Heater (2014) reported that bull calves on the average, tend to be larger than heifers because bovine males are larger than females and also as a result of male calves being carried a few days longer than female calves of similar genetics. Ehoche, Malau-Aduli and Abubakar (1992) reported that male calves were heavier than female calves at birth by 1.2 kg. Assan and Makuza (2005) reported that sex had a non-

significant effect on birth weight in indigenous Sabi sheep. This was in agreement with the report of Karna, Koul and Bisht (2001), Baiden (2007) and Kamal (2008) and is attributed to anabolic effect of male sex hormones.

Genotype

Indigenous livestock are well adapted to semi arid stressful conditions. They have a high degree of heat tolerance, are partly resistant to many of the diseases and parasites, and have the ability to survive dry periods of feed scarcity and water shortage. These characteristics have become genetic for the simple reason that they have been acquired by natural selection over hundreds of generations. This suggests that there could be less influence of environmental stressors on birth weight in indigenous livestock than their counterpart imported from the temperate climates. The genotype of both the mother and the foetus play a vital role in determining the birth weight, while the consequent litter weights basically depend, beside the foetuses genotype, on the suckled milk from the dam (Abdel-Azeem, 2006).

Year and season variation

It was well established that year of birth causes variation on weight and performance of livestock due to climatic variations and management during pregnancy (Abegaz, Van Wyk and Oliver, 2005). Variation in the weather, nutrition and farm management from year to year might be responsible for increased weaning weight (Bharathidhasan *et al.*, 2009). The significant differences in body weight among calves born in different periods was attributed to differences in management, selection of dams and environmental conditions, such as the ambient temperature, humidity and rainfall (Thiruvankadan, Karunanithi, Muralidharan and Babu, 2011). The seasonal changes in the climate were reflected as differences in body weights during different periods of the year. Year of birth has been found to have a significant influence on birth weight in cattle (Magnus and Brink, 1971). The high variation in

birth weight due to year of birth can be explained by variations in amount of annual rainfall which in turn influenced pasture production and availability of feed for the dam. Seasonal influence on birth weight operates through its effect on the dam's uterine environment mostly in late gestation (Magnus and Brink, 1971).

Season of birth plays an important role in growth performance indirectly through its influence on the dam's nutrition and hence amount of milk available to the unweaned calf (Thiruvankadan, Karunanithi, Muralidharan and Babu, 2011). In the post-weaning period its influence is related to its effect on the quality and quantity of pasture available to the weaned calves. Large differences in rainfall lead to marked differences between years quality and quantity of forage available (Khombe, 1985) hence supplementation would remove the year effect. According to the same author, differences between years are natural phenomenon and are normally caused by fluctuations in environmental conditions that are difficult to control.

The month within a year in which a calf was born is very important. According to Mukandan and Rajagopalan (1971) birth weights are affected by feeding conditions. The significant effect of season of lambing on the 9th month may be due to those calves born in first season through a period with a favourable climate when grasses of good quality were available. Calves born in hot rainy season spent the first months of their life in a hot rainy season which was uncomfortable for them and in which the parasitic challenge was high (Thiruvankadan, Karunanithi, Muralidharan and Babu, 2011). Assan (2013) reported that pasture availability follows a seasonal pattern and that year of birth had a significant effect on birth weight.

The year effect encompasses factors which include feeding, management, climate, temperature, disease control and management ability of the person responsible for data collection. Magnus and Brink (1971) and Das, Sharma and Joshi (1995) reported that year of birth had a significant influence on weight gain up to 6 months of age. It is well established

that as the environmental temperature increases, the cow will direct a greater portion of her blood flow to her extremities for cooling. Therefore there is less blood flow to the core of the cow, which results in a decrease in the amount of nutrients being carried to the foetus through the maternal blood, resulting in decreased birth weights when environmental temperatures are increased during gestation. In contrast, cold temperatures will result in increased birth weights, as blood flow is directed to the core of the body (Abegaz, Van Wyk and Oliver, 2005). Birth year causes vacillations over body weight in different ages by the effect of climate condition (rate of rainfall, humidity and temperature), environmental and management conditions. Climate and environmental changes have effect on the quality and quantity of pasture forages, which also affect the provision of food and other requirements for animals (Mohammadi, Beygi, Fayazi and Roshanfekr, 2010). Differences in nutrition (especially during pregnancy) and management in various years are reasons for the effect of birth year on body weight in different ages (Shroudi, Shiri, Tawakolyan and Mesgaran, 2001; Ahmadi, Roshanfekr, Khashoei and Mohamadi, 2004). This influence on birth weight operates through its effect on the dam's uterine environment mostly in late gestation. Environmental factors including management, disease control and administrative ability of persons responsible come into play.

Fetal development

Placental weight is a primary factor determining size of birth in many animal species (Heasman, Clarke, Stephenson and Symonds, 1999). The same authors concluded that numerous factors influence placental growth and development, having investigated the role of maternal nutrition as a regulator of placental and foetal size in sheep. The major restriction in foetal growth in rapidly growing dams occurs irrespective of high concentration of essential nutrients in the maternal circulation and suggests that the small size or altered metabolic and transport capacity of placenta is the primary constraint to foetal growth hence the low birth

weight (Assan, 2012). Restricting maternal nutrition to decrease birth weights is not a sound management practice (Heasman, Clarke, Stephenson and Symonds, 1999).

Extreme reductions in feed, such as feeding less than 70% of the cow's nutrient requirements would result in decreased birth weights. However, it often times resulted in an increase in calving difficulties because the cows were weak and undernourished. Slightly restricting the nutrient requirements of the cow will result in decreases in energy reserves (body fat) of the cow before limiting the nutrient flow to the foetus. In partitioning of nutrients, the cow puts her pregnancy at the top of the list, right below keeping herself alive, therefore her body will work overtime to metabolize stored nutrients to allow the foetus to grow. This is why restricting feed, unless in an extreme case, has little impact on birth weight (Assan, 2012). In general, the right horn of the uterus in beef cows is larger, in addition, a greater percentage of the ovulations that result in pregnancy come from the right ovary. Some researches suggest that calves conceived in the right horn during gestation have great birth weights due to the larger uterine horn. While it is well understood that the dam and sire of a calf play a role in the genetically predicted birth weight of a calf, other factors do come into play. It is important to keep the other factors in mind that impact the birth weights of calves to help ensure a successful and prosperous calving season (Assan, 2013).

The relationship between birth weight and calving problems

Calving difficulties account for a tremendous amount of economic loss in the beef cattle industry. The highest correlated factor contributing to calving difficulties is the size and or body weight of the calf. Of all cases of calving difficult, 60-90% of them can be attributed to the birth weight of the calf. While it is well understood that genetic selection for birth weight is critical for a successful calving season, there are several factors, aside from genetic influence, that impact the birth weight of a calf. Birth weight has long been regarded as a major contributing factor associated with calving difficulty. Basically, the higher the Birth

Weight Expected Progeny Difference, the greater the calving difficulty is expected from the use of such sires. Also, the birth weight is an important breed characteristic in cattle. The birth weight is not only the easiest and the most reliable measure of the prenatal period, but also a substantial factor that affects post-natal growth and development (Akubulut, Bayram and Yanar, 2001). A substantial and positive relationship was determined between the birth weight and the first calving age (Bakir, Kaygisiz and Ulker, 2004). Additionally, calving difficulties and death risk are closely related to the birth weight in cattle farming. The rate of death and calving difficulty has increased in both calves that have a very low and high birth weight (Johanson and Berger, 2003).

2.3.2 Genetic Parameters Affecting Birth Weight of Calves

Literature estimates for direct heritability for birth weight in cattle are variable and range from low to high. In most cases the direct additive genetic variance is higher than maternal additive genetic variance. The corresponding direct heritability and maternal heritability of birth follow the same trend (Assan, 2012). This shows that birth weight is much more influenced by the genetics of the calf than the dam; however both effects remain very important. Findings of larger direct additive genetic variance in cattle have been reported in literature by DeMattos, Misztal and Bertrand, (2000) and Choi *et al.*, (2000).

It is generally concluded that the covariance and correlation between additive and maternal genetic effects were negative (Meyer, 1993; Arthur, Liu and Makarechian, 1994). The results in literature dealing with the genetic correlation between direct and maternal effects for birth weight vary (Meyer, 1992). A negative correlation between direct and maternal genetic effects could be an indication of genetic antagonism between genes (Ferraz, Eler and Ribeiro, 2000) and it may therefore be important to consider both direct and maternal genetic effect in selection for weaning weight.

2.4 CALVING EASE

Calving ease is defined as the cow's ability to deliver a healthy calf easily. This functional trait has received considerable attention recently in dairy cattle breeding and improvement programs world-wide (Pogorzelska and Nogalski, 2010). It is an economically important trait in dairy cattle and its importance is stressed further by current breeding programs used in beef cattle aimed to improve traits that, as daily weight gain and carcass fleshiness, exhibit antagonistic genetic relationships with ease of calving (Paolo, Riccardo, Andrea and Marco, 2010).

2.4.1 The Basics of Normal Calving

The recognition of dystocia comes first from a basic understanding of normal calving. From this understanding, guidelines for frequency of observation of cattle during calving and when to provide assistance during the delivery process can be established. Calving is a complex process. Many mechanisms affect the process, but none completely control it. As the fetus matures and the uterus enlarges, the capacity of the placenta to respond to additional demands of the fetus may be surpassed. The placenta may begin to function less efficiently due to limiting morphologic changes, which occurs during the latter part of pregnancy (Mortimer, 2015). These or other undefined stimuli cause a fetal stress reaction. In cattle, this results in an increased production of glucocorticoids such as cortisol and steroid precursors to estrogens from the fetal hypothalamo pituitary adrenal systems. These steroids in turn enable the feto-placental unit to produce estrogens and prostaglandins. Endometrium layer in the uterus may also produce prostaglandins.

Concurrently, production of progesterone is decreased, probably at least in part due to the luteolytic effect of the prostaglandins on the corpus luteum of the ovary. The estrogens and prostaglandins in turn stimulate maternal release of oxytocin, sensitize the uterus to the effects of oxytocin, and cause the cervix to dilate. The uterus is thus released from inhibition

by progesterone and made sensitive to the stimulatory effects of prostaglandins and oxytocin, and to stimulation mediated through the autonomic nervous system. Uterine muscles, which have increased contractility in late pregnancy due to stretching, begin to contract regularly as the cervix dilates. When the cervix is dilated, fetal parts are forced into the birth canal. These produce point pressure in the vagina, further stimulating release of oxytocin and initiating the abdominal press (Mortimer, 2015). The process appears to have a cascade effect and is irreversible. The fetus must be delivered or death of either the fetus and/or the dam or both are likely to occur.

Signs of Labor

From the practical view point, the time sequences involved in calving are more important than the biological process. Prediction of time of calving would be of value under certain conditions, but it is difficult to predict time precisely on the basis of clinical signs. Criteria that have been used in attempts to identify the onset of labor in cattle include changes in body temperature, respiration and heart rates, "springing" or relaxation and enlargement of the vulva, udder changes including enlargement, tenseness and filling of the teats, changes in quantity and viscosity of vaginal secretions, relaxation of the sacro-sciatic ligaments, and dilation of the cervix (Mortimer, 2015).

Two criteria, relaxation of the sacro-sciatic ligaments and cervical dilation, are more reliable, but difficult to apply on a practical basis for beef operators. Relaxation of the sacro-sciatic ligaments can be palpated best by inserting one hand into the rectum and placing the other on the caudal border of the ligament from the outside. Displacement of the ligament can be estimated when pressure is placed against it from the inside. Several days before term, the ligament can be displaced up to 2.5 cm (1 inch). This relaxation should not be confused with the progressive relaxation that occurs just before calving, allowing displacement of the

ligaments 5 cm (2 inches) or more. Successive palpation will help define this stage, which indicates that calving will usually occur within 24 hours. Dilation of the cervix begins shortly before calving. It is usually closed prior to calving; although up to four fingers can be inserted part way in some cows. Normal dilation preceding calving can be identified by a progressive, conical dilation of the cervical canal with the apex of the cone toward the internal Os. When uterine contractions begin, mechanical forces are applied to the internal Os and enlargement of the cervical canal proceeds throughout its length (Mortimer, 2015).

Once cervical dilation is initiated, calving usually occurs within 24 hours, sometimes in as little as 6 hours in mature cows. Cervical dilation is very rapid in most cows after it has opened enough to allow passage of the hand. Normal calving is a continuous process, but is often divided into three stages for the purposes of description. These stages are arbitrary but fairly well defined. They usually follow one another in the sequence given, but sometimes, when dystocia is present, fetal membranes are expelled or at least freed from their maternal attachments before a dead fetus is delivered. Dystocia occurs when any stage is slow in developing or fails to progress normally.

Stage 1

The first stage of parturition is called dilation of the cervix. Visible signs of labor may be scant or absent in mature cows, but more evident in the first-calf heifers. The pastured cow will usually seek an isolated place and vaginal discharges increase in liquefaction and expulsion of the cervical plug. The cow (particularly first-calf heifers) will show signs of uneasiness and pain (Mortimer, 2015).

The normal cervix is tightly closed right up until the cervical plug is completely dissolved. In Stage 1, cervical dilation begins some four to 24 hours before the completion of parturition. During this time the 'progesterone block' is no longer present and the uterine muscles are becoming more sensitive to all factors that increase the rate and strength of

contractions. At the beginning, the contractile forces primarily influence the relaxation of the cervix but uterine muscular activity is still rather quiet (Glenn, 2013). This stage may go unnoticed and may take days to complete. The cow's appetite might decrease and she may prefer to be off by herself. Uterine contractions begin by the end of stage one, pushing uterine contents against the cervix, causing further dilation.

What is happening inside the cow's uterus at this stage?

Each time the uterus contract, the cow feels a slight, sharp pain which produces her uneasiness. With each uterine contraction, some separation of the normal strong attachment of the placenta to the cow's uterus is being weakened. Thus, the supply of oxygen may be decreasing with each uterine contraction. Also, the cervix is also progressively dilating with each contraction. Normally, the first water sac (chorioallantoic sac) is forced into the dilating cervix and breaks during Stage 1 and the rancher may observe that the water has broken (Mortimer, 2015). Certain abnormal deliveries are characterized by a failure of the heifer or cow to progress into Stage 2 and the calf may be dead before the decision for intervention is made. Thus, if it is suspected that a cow or heifer has been in Stage 1 for long and did not progress into Stage 2, intervention is recommended (Mortimer, 2015).

Stage 2

Second stage labor begins when the cervix is fully dilated and the second water sac (amniotic sac), plus fetal parts enter the birth canal further stimulating stronger uterine contractions. The unbroken water sac is often forced through the vulva after the cow has been in labor a short time. For the producer, the observation of the water sac is probably the most practical indication that the animal is in Stage 2 labor (Mortimer, 2015). When point pressure is applied to the birth canal by fetal parts, the abdominal press accompanies its uterine contractions. The pains of uterine contraction at this point usually force most cows to lie

down. The abdominal press is exerted more frequently as labor progresses until it occurs up to 1-3 times per minute.

At this point it is appropriate to introduce the terms of **presentation**, **position**, and **posture** of the fetus during a delivery.

- **Presentation** refers to whether the calf is coming forward, backward, or transverse.
- **Position** refers to whether the calf is right side up or upside-down with only right side up being considered normal.
- **Posture** refers to the relationship of the calf's legs and head to its own body. The most frequent calf delivery is a frontward presentation, right side up position, and a normal posture of both front legs and head extended into the birth canal. Sometimes a backward presentation may occur and may be deliverable if we have right side up position and the posturing being with both hind limbs in the birth canal. Nevertheless, a backward presentation should be considered a high-risk delivery a ground for intervention. All other presentations are considered abnormal (Mortimer, 2015).

During delivery, a series of frequent abdominal presses followed by a short period of rest may occur. The greatest frequency and force is achieved when the fetal head is being forced through the birth canal and vulva. Following delivery of the head, a short period of rest may occur. Strong expulsive efforts are required again to force the shoulders and chest of the calf through the birth canal. Sometimes the cow will stop straining for a short time following delivery of the chest, allowing the rear legs to rest in the birth canal.

At this point, usually the umbilical cord may be compressed shutting off the oxygen supply to the calf from the dam. It is not unusual to observe the calf establishing its own breathing at this point. Occasionally at this point, the sac is still over the head of the calf, and the calf could suffocate if the sac is not broken. Delivery of the hips and legs is usually uneventful; occurring soon after the chest passes through the vulva. Second stage labor lasts

from half an hour to 4 hours in the cow, but intervention guidelines suggest assistance at not over 2 hours, and earlier if it is not progressing normally (Mortimer, 2015).

Stage 3

The placenta or fetal membrane is usually expelled within 8 to 12 hours after delivery of the calf.

2.5 CALVING DIFFICULTY

Dystocia is referred to as prolonged labor that exceeds the normal period of parturition (6 to 8 hours in the cow). Dystocia is also commonly known as calving difficulty. It is a major problem that most dairy and beef industries 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). Calving difficulty has received much attention in recent years primarily because of mating larger European breeds' bull with local breeds of cow (Cady, 2004).

Even though dystocia, defined as a delayed and difficult parturition, is not necessarily associated to loss of the calf or of the dam, increased costs, due to additional farmer labour, veterinary fees, subsequent health and fertility problems, and negative effects on production traits, are generally expected when difficult births occur. From a biological point of view, calving performances are affected by two components (Meijering, 1986): the ability of the dam to give birth easily (maternal effect) and the ability of the calf to be born easily (direct or fetal effect).

Literature estimates of heritability for direct and maternal effects on calving ease are generally low and a number of studies reported antagonistic genetic relationships between direct and maternal effects. Thus, selection for reducing calving problems due to direct effects (size of the calf) only, is expected to exert negative effect on the maternal component. An additional problem related to calving performance is the different genetic nature of

dystocia in heifers compared to multiparous cows (Paolo, Riccardo, Andrea and Marco, 1996).

Genetic evaluation for the direct effect on calving ease of selected bulls is based on calving records of the progeny originated by matings with cows whereas use of young bulls on heifers is avoided. Hence, selection for the direct effect relies mostly on calving records from cows. Most studies on calving ease in dairy cattle have found correlations between calving performance and production traits close to zero. Conversely, in beef cattle, traits, like daily gain and muscularity, exhibit unfavorable genetic associations with calving ease (Meijering, 1986). As a consequence, a negative correlated response in calving performance is expected when selection programs aimed to improve such traits are applied (Paolo Riccardo, Andrea and Marco, 1996).

The number of calves produced each year within a cow-calf operation depends on two main factors: 1) success of cows and/or heifers to conceive and maintain the pregnancy, and 2) birth of viable and healthy calves. Within the many factors affecting calf survival, the most important is dystocia, which is the technical term for a difficult birth that needs assistance. Depending on the degree and type of dystocia, it can result in a weakened/dead calf and injury/death to the dam. Along with decreased calf crop, dystocia is also associated with increased cow mortality, veterinary and labor costs, and impaired subsequent reproductive performance.

2.5.1 Causes of Dystocia

Many factors influence the incidence of dystocia, including: age of dam, calf birth weight, dam's pelvic area, sex of calf, size of the dam, gestation length, breed and genotype of sire, breed and genotype of dam, condition of dam, nutrition of the dam, shape of the calf, position or presentation in the uterus, geographic conditions and other unknown factors (OSU, 2014). Most of these factors can be grouped into two classifications:

- i. Factors affecting size and shape of the calf
- ii. Factors affecting the ability of the dam to give birth

The interaction between these groups of factors determines the incidence of dystocia. In general, dystocia will be observed when the size of the fetus is incompatible with the size of the pelvic opening of the cow, when the fetus is abnormally presented (breech birth, head or foot back, etc.), or when the cow does not experience normal parturition due to weakness, stress or hormonal abnormalities. By far the most common cause is when the fetus is too large or the dam is too small. However, much can be done to ensure that fetus size is compatible with the opening of the dam's pelvis (Reinaldo, Aurora and Charles, 2014).

Calf birth weight

It has been shown that the incidence of dystocia increases as birth weight increases. Although weight of the animals may be distributed differently in various breeds, it is a good approximation for calf size. Therefore, special attention should be given to the factors that influence birth weight to prevent dystocia. Breed of the sire and the dam, along with genetic traits of both parents play the most important role in determining calf birth weight. Thus, selecting replacement heifers for low birth weight in addition to choosing sires according to actual birth weight, body shape, and Expected Progeny Differences (EPD) for birth weight and calving ease will likely alleviate calving problems within a herd (Reinaldo, Aurora and Charles, 2014).

Pelvic area

The pelvic diameter determines the maximum birth size that can be accommodated by an individual cow before calving difficulty is experienced. Heritability estimate (h^2) is said to be low when it is 0.1 and below, moderate when it is between 0.20 and 0.35, whereas it is high if it is above 0.4. Heritability estimates for pelvic dimensions are moderate, ranging from 0.20 to 0.35. There are conflicting reports relating pelvic area to dystocia, which puts

the usefulness of pelvic measurements in question. In general, culling the 10% of the heifers with the smallest pelvic size will only result in a reduction in dystocia of 2 to 3% in the herd. This could be explained by the fact that pelvic dimension appears to be highly correlated with dam size (Reinaldo, Aurora and Charles, 2014).

By selecting for large pelvic dimensions, producers are also indirectly selecting for large heifers, which typically have greater nutritional requirements and also produce large calves. Consequently, the use of pelvic measurement has not been shown to be a reliable and efficient selection criterion to reduce incidence of dystocia in beef herds.

Gestation length

Gestation length can have an indirect influence on calving difficulty. As gestation length increases, birth weight increases from 0.14 to 0.36 kg per day. Gestation length is a trait that can be selected for; therefore cattle can be selected for shorter gestation length and subsequently lighter birth weights. However, selecting cattle for birth weight independent of gestation length has the same effect and is a more effective approach to reduce incidence of dystocia compared to selection for shorter gestation (Spencer, 1982).

Sex of calf

Typically, bull calves outweigh heifer calves at parturition by up to 4.54 kg. This can partly be explained by the fact that bull calves generally have longer gestation length compared to females and higher androgen concentration in male fetuses (Spencer, 1982) and also to the greater rate of skeletal growth in utero of male calves compared to female calves (Tuah and Danso, 1985). Because of heavier birth weights, many reports indicate that bull calves require from 10 to 40% higher assistance rate compared to heifer calves during birth. Additionally, it has been shown that dystocia rates in mature cows carrying male calves are twice that of cows carrying female calves (Reinaldo, Aurora and Charles, 2014).

Age and parity of dam

The incidence of dystocia decreases as dam parity increases. According to calving data from University of Nebraska and Colorado State University relating calving difficulty to age of dam at calving, first- and second-calf dams experience more calving difficulty; they typically have lighter birth weight calves (by 1.14 to 2.27 kg) than mature cows. This is probably because mature cows have greater body size and pelvic area compared to heifers; therefore, adult cows are capable of developing and giving birth to heavier calves (Reinaldo, Aurora and Charles, 2014).

Size and breed of dam

Body size is highly correlated with pelvic area, and pelvic dimensions determine limitations to the size of the calf that can go through the birth canal. Typically, larger breeds of cattle have larger pelvic areas and produce calves with heavier birth weights than smaller breeds.

Therefore, dystocia rates do not differ significantly between dams of various beef breeds that also vary in size. Data from University of Nebraska show very little difference in incidence of dystocia when 15 breeds were compared. Exceptions to this theory include Jersey-crosses and two Zebu breed crosses (Brahman and Sahiwal) which experienced an average of 3.7 % incidence of dystocia compared to an average of 14.1 % for the other breeds in the study.

Sire breed

Most producers are well aware of the impact that the bull has on the incidence of calving difficulty and subsequent calf death loss. Traditionally, commercial beef cattle producers have predominantly used British breed sires on first-calf heifers due to their small calf size at birth. Unfortunately, as beef and seedstock producers emphasized sire selection according to adult body size and growth rate, many British breed bulls are now producing

large birth weight calves. However, with proper bull selection and heifer development, producers can still breed cows with British breeds and even some Continental breeds. Emphasis on multiple trait sires (bulls with acceptable birth weight, calving ease and growth and Expected Progeny Differences) can minimize the degree of calving difficulty, while still maintaining performance traits. In addition, selecting replacement heifers out of bulls with low EPDs for birth weight should help reduce birth weight and calving difficulty. Selecting heifers out of low birth weight sires tends to result in females with a lower mature size, which may or may not be desirable. Therefore, producers should evaluate important sire EPDs (birth weight, calving ease and daughter's first-calf calving ease) when selecting replacement heifers (Reinaldo, Aurora and Charles, 2014).

Nutritional program

Supplemental energy fed for 90 to 100 days prior to calving has been shown to increase birth weight, but does not have an adverse effect on calving ease. Further, the incidence of calving difficulty is actually reduced when cows consume moderate and high amounts of energy compared to low energy intake. Inadequate protein intake during gestation also results in decreased calf vigor, delayed uterine involution, increased interval to estrus, and decreased conception rates following calving. These problems appear to be increased when energy is also deficient, illustrating the need for a properly balanced diet of cows during pregnancy.

Body condition of the dam has also been implicated as a factor that contributes to calving difficulty and is closely related to nutritional status during gestation. Underfeeding cows to the point where they are emaciated will result in calving difficulty probably due to lack of strength during the delivery process, and these cows typically have weak, non-vigorous calves. However, overfeeding cows to the point of obesity will also result in dystocia, probably due to a fat-filled birth canal and increased abnormal presentations.

Therefore, it becomes extremely important that cows are not over- or under-fed during pregnancy, but are provided adequate feed to meet their nutritional requirements and those of the fetus (Reinaldo, Aurora and Charles, 2014).

Geographical location

Calf birth weight is greater in colder environments compared with warmer, southern climates. Because of that, northern states tend to experience a higher rate of calving difficulty than their southern neighbors. The exact reason for this phenomenon is unknown (Reinaldo, Aurora and Charles, 2014).

Exercise

Increased muscle tone in heifers and cows can lead to easier calving. Forced exercise consisting of walking 1 mile per day for 4 weeks prior to calving has been shown to improve the calving ease of closely confined dairy heifers. These heifers showed improved calving ease score, reduced placenta retention time and less days open following calving. Many beef heifers are grown and developed in semi-confinement drylot conditions similar to dairy operations. Where this is the management system, it is possible that heifers could benefit from increased exercise prior to calving.

This could be accomplished simply by placing water and feed supplies at a distance from each other to force movement and exercise (Reinaldo, Aurora and Charles, 2014).

Season of the year

Fall-born calves usually are lighter and born with less assistance than spring-born calves. This can be partially explained by nutrition and environmental conditions. Hot summer temperatures tend to reduce birth weights, whereas cold temperatures increase birth weights.

Fetal position

About 5% of the calves at birth are in abnormal positions, such as forelegs or head turned back, breech, rear end position, sideways or rotated, etc. (Figure1). This requires the assistance of a veterinarian or an experienced herdsman to reposition the fetus correctly prior to delivery. If fetal position cannot be corrected, the veterinarian may have to perform a caesarean section or fetotomy (Reinaldo, Aurora and Charles, 2014).

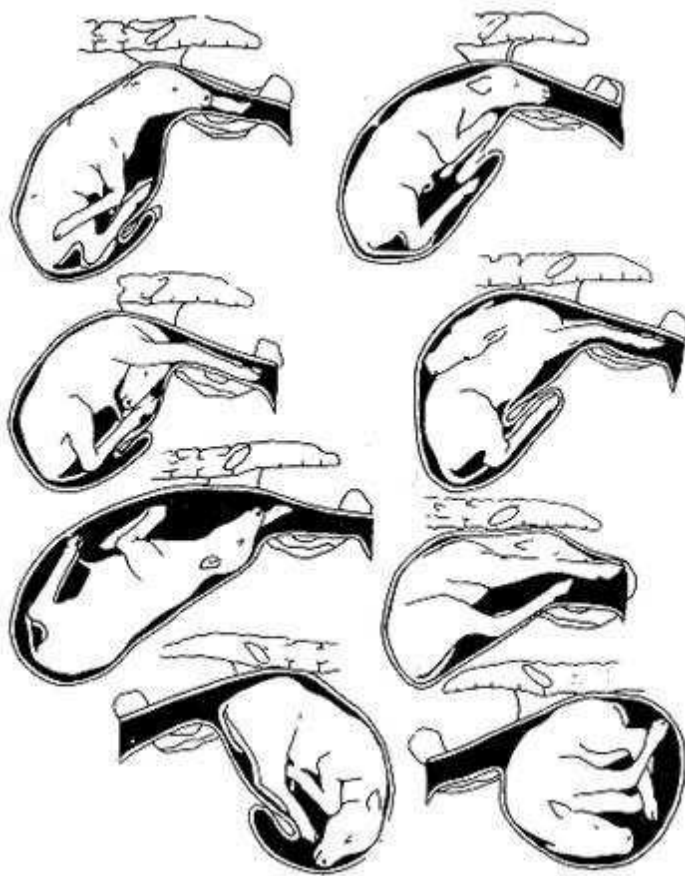


Figure 1. Some of the abnormal birth positions that may be seen in cows (Source: Reinaldo, Aurora and Charles, 2014)

2.6 PLACENTAL RELEASE EASE

Placenta

The fetal membranes or what is called “placenta” is the name given to the membranes that transfer nutrients from the dam to the fetus before birth. These membranes and blood vessels are made by the fetus and connect to the blood supply in the uterus. Across the thin

connection between the membranes of the dam and the membranes of the fetus, the essential materials pass to the developing fetus (Hanafi, Ahmed, El- Khadrawy and Zabaal, 2011). When the fetus is born, the placenta normally detaches within short time and is expelled. That is why it is referred to as the “afterbirth” (Ball and Peters, 2004). The release of fetal membranes in postpartum is a physiological process; involving loss of fetomaternal adherence, combined with contraction of uterine musculature. It is the third stage of labor and is usually accomplished within 6 hours of calving (El-Malky, Youssef, Abdel- Aziz and Ad El- Salaam, 2010); and 30 to 90 minutes of foaling (Morel, 2005) and 49 minutes in she camel (Nasr, Abdel- Ghaffar and Agag, 1996). This difference in fetal membrane separation between species may be due to different forms of placentation in different species.

2.6.1 Retained Placenta

The placenta normally drops within short time post partum (within 8 hrs of parturition), if it is retained up to 12 hrs then it is called as delayed removal and if retained for more than 24 hrs of parturition then it is called as ‘Retained placenta’ (RP). Such retention creates a number of problems by allowing microorganisms to grow inside the uterus causing its inflammation, fever, weight loss, decreased milk yield, longer calving intervals and may result in an open cow during the next year and if the infection is so bad the animal may actually die. Due to retention of placenta animal may suffer from tetanus; astetanus organism is commonly found in feaces and soil which requires at least 1 to 3 months as long term therapy. Retention of placenta causes great economic losses, mainly due to decreased milk yield and calf crop (Emtenan, Hanafi, Ahmed, El- Khadrawy and Zabaal, 2011).

2.6.2 Incidence of Retained Placenta

The incidence in cows varies from 4.0-16.1%.However, it can be much higher in problem herds and also increases during summer with increased parity, milk yield in the previous seasons and following birth of male fetus (El-Malky, Youssef, Abdel- Aziz and Ad

El- Salaam, 2010; Ahmed *et al.*, 1999) Abortions, stillbirths and twin calvings resulted in increased incidence rates of 25.9, 16.4 and 43.8%, respectively. Also El-Malky, Youssef, Abdel- Aziz and Ad El- Salaam (2010) demonstrated an incidence of RP reaching 4.6% in buffalo-cows over three years of study.

2.6.3 Mechanism of Fetal Membrane Separation

According to Youngquist and Threlfall (2007), three events are involved in cotyledon-caruncle detachment. These events are:

Morphologic events: Detachment of placenta in the cow involves separation of the finger-like cotyledon villi from the caruncle crypts without significant tearing of either fetal or maternal epithelia. For the cotyledon villi to separate from the caruncle crypt, it is critical that the mouth of the cotyledon “pouch” be opened first by proteolytic enzymes. This is achieved by formation of the “mouth” of the cotyledon toward the apex (dehiscence) or by following a concentric band pattern in which the edge of the cotyledon “pouch” is digested first (Youngquist and Threlfall, 2007).

After placental detachment is accomplished, uterine involution is completed in an average of 39 days in normal cows and 50 days in cows with RP. By day 6 post partum, caruncle septa are disorganized; by day 15, caruncles are completely sloughed as a result of necrosis. Consequently, retained membranes are detached by caruncle necrosis within 6 to 10 days and not later than 17 days post partum. The surface of the endometrium is covered by new epithelium by day 26 to 30 post partum (Youngquist and Threlfall, 2007).

Biochemical events: Postpartum uterine biochemistry is dominated by increased collagenase and other protease activities that correlate with different stages of parturition, resulting in a massive breakdown of collagen and other proteins during uterine involution. As a result, the weight of the cow’s uterus decreases from 9.0 kg at parturition to 1.0 kg at 30 days post partum (Youngquist and Threlfall, 2007).

Physiologic events: Physiologic release of placenta is accomplished in most cows between 3 and 6 hours post partum. Cotyledon proteolysis (dehiscence) and decreasing adhesiveness (viscosity) of the cotyledon caruncle interface fluids seem to be key factors in the release of placenta (Youngquist and Threlfall, 2007). Collagenases are capable of reducing the specific viscosity of collagen. Collagenase activity of cotyledon villi during delivery is increased in healthy cows and decreased in cows with RP. The cellular sources of collagenase and proteolytic enzymes for placental release in the cow are unknown. In laboratory animals and humans, myometrial cells, fibroblasts, and leukocytes have been identified as sources of collagenase in the uterus. Lack of uterine motility is not considered as a reason for primary retention, because uterine motility is normal or above normal in cows with primary RP. The direct cause of placental retention is uncertain, but is related to a deficiency of myometrial contractions and failure of the maternal immune system to successfully degrade the placentomes at the end of pregnancy (Frazer, 2005)

2.6.4 Failure of Cotyledon-Caruncle Detaching Mechanisms

The key element in the pathogenesis of retained placenta is a failure of timely breakdown of the cotyledon-caruncle attachment after delivering the fetus. The most important risk factors for placental retention are abortion, stillbirth, twinning, dystocia, induction of parturition with PGF₂ α and caesarean section, metabolic disorders, especially milk fever. Prenatal losses can be caused by infectious and non-infectious factors. Primary attention has been often directed to infectious causes, but non-infectious factors probably account for 70% or more of the cases (Frazer, 2005). The infectious causes of placental retention are behind the scope. Non-infectious causes are often multifactorial and are difficult to diagnose (Hanzen, Drion, Lourtie, Depierreux and Christians, 1999). The list of potential causes is quite long, however, there are a number of common causes (Ball and Peters, 2004).

Hereditary causes of retained placenta

Nasr, Abdel-Ghaffar and Agag (1996) reported that cows having blood group genotype BGK_OA'0' bred with sire have 'I' genotype dropped their placenta normally, while cows having BO₃Y₂ AE₃'G'P' genotype bred with sire having genotype I₂ showed high incidence of RP. On the other hand, the most frequent alleles in serum proteins of NRP (Non Retained Placenta) cows were albumin (ALA), post albumin (PalA) and amylase (AmB) gene markers, while the most frequent genetic alleles in serum proteins of RP cows were alpha globulin and transferrin D (TFD). Moreover, it was recommended to use the above mentioned genetic constituents of both dam and sire for breeding purposes. In high lactating cows, somatotropins stimulate the production of insulin-like growth factor 1 (IGF-1) in the hepatic cells. However, the plasma IGF-1 level was found to be quite low, especially in the hyperketonaemic animals (Huszenicza *et al.*, 2006) in which metabolic products (non esterified fatty acids (NEFA) and β OH-butyrate (BHB) accumulate and impairs the migration, phagocytic and killing activity and /or the oxidative burst of PMNs and other leukocytes, enhancing the susceptibility of host to invading pathogens (Reist *et al.*, 2003).

Mechanical causes of retained placenta

Difficult birth (calf too large for cow, backward presentation of calf known as breech birth, one leg or head backwards), twins, late or premature birth, prenatal loss, induction of parturition with PGF₂ α , cesarean section and fetal monsters or emphy sematous fetus (gas-filled fetus) are direct causes of dystocia and consequently to RP (Ementan *et al.*, 2011)

Nutritional causes of retained placenta

Cows (0 to 120 days postpartum) are at risk of ration formulation error and feed which leads to delivery problems. Periparturient dairy cows (0 to 20 days postpartum) undergo a transition from a relatively high fiber diet to a lactation diet that generally is higher in energy and lower in fiber. During this period, the amount of energy required for the

maintenance of body tissues and milk production usually exceeds the amount of energy in the diet (Goff and Horst, 1997). This nutrient deficit makes the cow susceptible to metabolic diseases such as ketosis and milk fever, which usually occur within 3 weeks thereby calving slowing adaptation to the postpartum diet. Also, prepartum heavy grain feeding may be associated with both higher milk production and a higher incidence of left- displaced abomasum (Lucey, Rowlands and Russel, 1986) and increased risk of reproductive disorders such as dystocia, retained placenta, cystic ovaries, metritis, prolapsed uterus (Markusfeld,1993), and acute clinical mastitis increasing the risk of non- parturient paresis (Gro, Erb, McCulloh and Saloniemi, 1989).

Cows being adapted to high- energy and high concentrate lactation rations are at risk because the rumen papillae need time to elongate and the microbial population needs time for adaptation. Also, lower dry matter intake near calving can result in depressed forage intake. It has generally been found that other feeding-related diseases increase the risk of nonfeeding-related diseases rather than vice versa. Vitamin and mineral deficiency conditions such as selenium, vitamin E and vitamin A, β -carotene and disturbed C/P (1.5/1) ratio can impair general immunity and may alter the competence of cellular self-defence mechanism and can increase the risk for placental retention and metritis. Ahmed, Abdel Hameed, El-Khadrawy and Hanafi (2009) reported that RP was associated with oxidative stress as shown by the obvious increase of blood malondialdehyde and nitric oxide and decreases of catalase, superoxide dismutase, ascorbic acid, glutathione reduced and total antioxidant capacity values with low zinc, copper, iron and selenium concentrations.

High milking cows with a greater degree of negative energy balance prepartum and higher NEFA concentrations were 80% more likely to suffer from RP (LeBlanc *et al.*, 2002). On the other side, overconditioned cows were shown to be more sensitive to retained placenta and subsequent infertility than cows with normal body condition scores. Etiological

mechanism for retained placenta was associated with dietary-conditioned liver disorders and high plasma urea and gamma-glutamyl transferase concentrations (Michal, Edward and Hanna, 2006).

Hormonal imbalances

Hormonal imbalance existing before delivery is effective in inducing retention of placenta. Placental separation occurs when foetal cortisol induces the production of the enzymes, 17 hydroxylase and aromatase in the placenta which favour oestrogen synthesis at the expense of progesterone synthesis. Maternal plasma levels of oestradiol-17 increase suddenly, while plasma levels of progesterone decline sharply immediately prior to parturition. It is supposed during the week before parturition, the level of estradiol reaches its maximum level to help the uterus to get rid of any remnant of fetal membranes. Therefore, a decreased level of oestrogen may be indicated as a factor enhancing RP (Chassagne and Barnouin, 1992). Spontaneous myometrial contractility is augmented by autocrine and paracrine release of $\text{PGF2}\alpha$ and parturition ensues. Disturbed endocrine function, high progesterone and cortisol levels and low oestradiol level was traced in the blood cows with RP (Michal, Edward and Hanna, 2006).

Increased progesterone level in RP may be due to failure of the placenta to produce specific steroidal enzymes that help in progesterone aromatization and its conversion to estrogen (Ball and Peters, 2004). Hormone imbalances existing before delivery are effective in inducing RP. Progesterone, more than estrogen, inhibits uterine collagenases and slows uterine involution. Dexamethasone increases synthesis and utilization of progesterone by cotyledon tissues in the cow. These changes may contribute to blocking postpartum expression of cotyledon collagenases. Moreover, it has been found that glucocorticoids down-regulate collagenases (Youngquist and Threlfall, 2007).

Failure of maternal immune response

Maternal immunological recognition of fetal MHC class I-proteins expressed by trophoblast cells triggers an immune/inflammatory response that contributes to placental separation (De-Mouzon and Millo, 2006). This lymphocytic activation was suppressed at the high plasma urea and gamma-glutamyl transferase concentrations. Also low plasma glucose and PGFM (the main PGF 2α metabolite) levels. Low monocyte and high red cell counts was traced in blood of cows with retained placenta, especially in the late gestation period (Chassagne and Barnouin, 1992) and could be connected with the disease by means of dietary unbalanced ratio of n-3/n-6 polyunsaturated fatty acid (PUFAs) that would involve reductions in synthesis of cyclooxygenase products, impair uterine contractions, vascular tone and platelet aggregation leading to retained placenta (Michal, Edward and Hanna, 2006) may induce the accumulation of immunosuppressive proteins in the uterine lumen which make the uterus susceptible to infection and persistence of bacteria (Azawi, Rahawy and Hadad, 2008).

In high lactating cows, somatotropins stimulate the production of insulin-like growth factor 1 (IGF-1) in the hepatic cells. However, the plasma IGF-1 level was found to be quite low, especially in the hyperketonaemic animals (Huszenicza *et al.*, 2006) in which metabolic products (non esterified fatty acids (NEFA) and β OH-butyrate (BHB) accumulate and impairs the migration, phagocytic and killing activity and /or the oxidative burst of PMNs and other leukocytes, enhancing the susceptibility of host to invading pathogens (Reist *et al.*, 2003).

Managerial causes of retained placenta

Myometrium contractility is the third component of self defence mechanisms, since uterus contractions expel the uterine content. Lack of exercise and hypocalcemia are the most frequent causes of decreased myometrium contractility (Sheldon and Dobson, 2004). However, in a study by Bajcsy *et al.* (2005) there was no correlation between blood ionized

calcium (Ca^{+2}) concentrations and any of the contractility parameters. Also, the lack of uterine motility plays little or no role in the occurrence of retained placenta. Moreover, cows with retained placenta have normal or increased uterine activity in the days after calving (Frazer, 2005). Stress (Transportation, rough handling, poor feed conditions, isolation from group, lameness), results in elevated corticosteroids and increased risk of placental retention.

Economic and reproductive consequences of retained placenta

In dairy cows, retained placenta may be the cause of serious economic losses to the farmers as cows with retained placenta may develop bacterial infection and become ill and thus reduce production, some may even die. Milk from cows with retained placenta is unfit for human consumption and therefore cannot be sold. The fertility of dairy cows is affected when most cows in the herd suffer from retained placenta. This causes a direct loss to the farmer due to delayed calving leading to a lengthy period between births (calving intervals) and hence low milk production. It is unhygienic to milk a cow with decomposing afterbirth hanging on it (LeBlanc *et al.*, 2002).

Many of these placentae have signs of substantial placentitis or premature placental separation. Adverse events that center around foaling and uterine involution are likely to contribute to acute and chronic endometritis, susceptibility to uterine infection and persistent post mating endometritis (Ball and Peters, 2004).

The financial losses due to retained placenta in dairy cattle were estimated by using a data-set containing the birth records which provided data on the reproductive performance of cows with and without retained placenta. Cows with the consequent clinical endometritis between 20 and 33 days after calving took 27% longer to become pregnant and were 1.7 times more likely to be culled for reproductive failure than cows without endometritis (Reist *et al.*, 2003).

CHAPTER THREE

MATERIALS AND METHODS

3.1 DESCRIPTION OF THE STUDY AREA

The study was conducted at Sebore Farms in Mayo-Belwa LGA, Adamawa State. The State is located in Northeastern Nigeria and lies within latitude $9^{\circ} 00'$ to $9^{\circ} 10'$ North and longitude $11^{\circ} 50'$ to $12^{\circ}06'$ East, and covers a total area of 548.8km^2 (Adebayo and Tukur, 1999). The study area is mainly accessible by foot that leads to the village in the local Government while the main town is accessible by trunk, a road that links Yola to Jalingo.

In terms of vegetation, Mayo-Belwa lies within Guinea savannah zone of the Nigerian vegetation belt which the combination of grassland coupled with a number of perennial trees has scattered over the area (Adebayo and Tukur, 1999). Mayo-Belwa Local Government is found within the region described as having a tropical Sudan-savannah climate with four seasons which are early dry season from October to December; late dry from January to march; early wet from April to June; and late wet season from July to September. The maximum temperature of the area is about 43°C , particularly between March and April and the minimum monthly temperature varies and can be as low as 26°C between December and January (Adebayo and Tukur, 1999).

The drainage system in the area includes a number of seasonal rivers that swell during rainy season and dries up in the dry season. The most significant river in the area is River Mabalwa that flow from south to north of the area and joins up to form the tributary of the River Benue. Although, other rivers are present in the area such as Jamtari River, River Mayo- lamja, River Jereng, River Mayo-Farang that form the tributaries of River Mayo-Belwa.

3.2 SEBORE FARMS

Sebore Farms located at km 12 Ngurore Road, Mayo-Belwa Local Government Area, Adamawa State, was established as a private liability company in 1985 with the cultivation of mangoes, paw-paw, citrus, cashew and rearing of indigenous cattle breeds as its main focus. Exotic breeds of cattle were later introduced in the late 1980's and a crossbreeding programme was initiated.

3.3 STUDY ANIMALS AND THEIR MANAGEMENT

Data on birth weight records were obtained from Sebore Farms, Mayo-Belwa in Adamawa State. The cows belonged to different breeds. The breeds were Simmental, Brahman, Brown Swiss, Holstein-Friesian, and crosses while the sire breed was Simmental. The animals were kept under intensive management and were regularly dewormed and vaccinated against viral diseases. Pregnant cows were dried two months to calving and kept in separate pens for "steaming up" during which they were given special concentrates. After calving, calves were weighed within 24 hours of birth and allowed to suckle their dams for the first 7 days. This is for the calves to obtain colostrums within the first 72 hours of their lives. The calves were then switched to bucket feeding.

3.4 DATA COLLECTION

Birth weight, calving ease and placenta release ease records collected over a period of 3 years, from 2012 to 2015, were used for the study. Calving ease was coded in two classes; 1 (No Assistance) and 2 (Slight Assistance), while placenta release ease was coded in two classes; 1 (Normal) and 2 (slight Assistance).

Calving ease and placenta release ease were classified according to season of calving (early dry season from October to December; late dry from January to march; early wet from April to June; and late wet season from July to September), dam breed (Brahman, Brown

Swiss, Holstein Friesian, Simmental and crosses), sex of calf (male, female) and calf birth weight class (≤ 35 kg, 36-45 kg and 46 kg and above).

3.5 STATISTICAL ANALYSIS

Data collected were entered into Micro Soft Excel sheet (2007). Birth weight records were subjected to Analysis of Variance (ANOVA) as contained in SPSS 16.0 (2007) by fitting into a fixed effect model as shown below:

$$Y_{ijkl} = \mu + D_i + S_j + X_l + DS_{ij} + DX_{il} + SX_{jl} + E_{ijkl}$$

Where Y_{ijkl} = observation

μ = General mean

D_i = fixed effect of i th dam breed (1, 2, ..., 5)

S_j = fixed effect of j th season of calving (1, 2, 3, 4)

X_l = fixed effect of l th sex of calf (1, 2)

DS_{ij} , DX_{il} , SX_{jl} , are interactions among fixed effects defined above.

E_{ijkl} = random error term.

Where significant differences existed, the means were separated using Tukey's HSD (Honest Significant Difference).

Data on calving ease and placenta release ease were analyzed using chi-square crosstabs to test for association of the traits with breed, sex, season, and birth weight class. The assumption that for an easy calving, there should be a normal placental release and vice versa, was tested using the McNemar Test for Significance of Changes, also having a chi-square distribution.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Summary Statistics of Birth Weight of Calves in Sebore Farms, Mayo-Belwa By Dam Breed, Sex and Season

Table 1 shows the summary statistics of birth weight of calves in Sebore Farms by dam breed, sex and season. The mean birth weight of calves was 36.39 kg. The mean birth weight for Simmental, Brahman, Brown Swiss, Holstein-Friesian and crosses were 36.97 kg, 33.17 kg, 36.69 kg, 35.25 kg and 36.52 kg, respectively. The birth weight for the different breeds were moderately variable ranging from 11.36% for Simmental to 18.97% for Holstein-Friesian (CV= 11.36% – 18.97%).

The mean birth weight for male and female calves were 37.67 kg and 35.17 kg, respectively and were also moderately variable, 10.74% for females and 11.95% for males.

Mean birth weight for the different seasons were 36.15 kg, 38.59 kg, 33.61 kg and 37.01 kg for early-dry, late-dry, early-wet and late-wet seasons, respectively. Seasonal effect on birth weight varied widely (CV= 11.48% - 21.74%). The variabilities were 11.48%, 12.62% and 14.35% for late-wet, early-dry and early-wet seasons, respectively, while the highest variability was 21.74% for late-dry season.

Table 1. Summary Statistics of Birth Weight of Calves in Sebore Farms, Mayo-Belwa by Dam Breed, Sex and Season

Factors	N	Mean(kg)	Std. error	CV(%)	Min.	Max.
Dam breed	270	36.39	0.34	14.58	25	52
Simmental	147	36.97	0.47	11.36	25	51
Brahman	23	33.17	0.94	16.07	28	47
Brown swiss	53	36.69	0.67	13.57	29	50
Holstein-Friesian	24	35.25	1.31	18.97	27	52
Crosses	23	36.52	1.24	18.46	30	50
Calf Sex	270					
Male	132	37.67	0.52	11.95	25	51
Female	138	35.17	0.42	10.74	27	52
Season	270					
Early Dry(Oct- Dec)	72	36.15	0.58	12.62	28	52
Late Dry(Jan- Mar)	17	38.59	1.72	21.74	30	51
Early Wet(Apr- Jun)	38	33.61	0.75	14.35	27	45
Late Wet(Jul- Sep)	143	37.01	0.48	11.48	25	50

CV= Coefficient of Variation; Min= minimum value; Max= maximum value; N= Number of observations

4.1.2 Influence of Dam Breed, Sex and Season on Calf Birth Weight of Temperate Breeds of Cows

The influence of dam breed, sex and season on calf birth weight of temperate breeds of cows is presented in Table 2. The birth weight of calves was not significantly ($P>0.05$) influenced by dam breed. Birth weight was significantly influenced ($P<0.05$) by sex of calves. Male calves weighed heavier (37.69 ± 0.517 kg) than female calves (35.17 ± 0.424 kg). Non-significant variations in birth weight of exotic breeds of calves was found with regard to the effect of season of birth.

Table 2. Influence of Dam Breed, Sex and Season on Calf Birth Weight of Temperate Breeds of Cows

Factors	N	Mean (kg) \pm SEM
Dam Breed		
		Ns
Simmental	147	36.97 \pm 0.469
Brahman	23	33.17 \pm 0.935
Brown Swiss	53	36.69 \pm 0.668
Holstein- Friesian	24	35.25 \pm 1.307
Crosses	23	36.52 \pm 1.239
Calf Sex		
		*
Male	132	37.69 \pm 0.517 ^a
Female	138	35.17 \pm 0.424 ^b
Season		
		Ns
Early-Dry(Oct- Dec)	72	36.15 \pm 0.578
Late-Dry(Jan – Mar)	17	38.59 \pm 1.715
Early-Wet(Apr- Jun)	38	33.61 \pm 0.747
Late-Wet(Jul- Sep)	143	37.01 \pm 0.482

* = P<0.05; ns = Not Significant. ^{a, b} Means within the same column with different superscripts differ significantly. \pm SEM; Standard Error of Mean; N; Number of Observations

4.1.3 Interaction Effect of Dam Breed, Calf Sex and Season on Birth Weight of Exotic Breeds of Calves

Interaction effects of dam breed, calf sex and season on birth weight of temperate breeds of calves are presented in Appendix 1. The results showed that there was significant ($P < 0.05$) effect of Breed*Season interaction while non significant interactions were recorded for Breed*Sex, Sex*Season and Breed*Sex*Season effects.

Table 3 presents the interaction effect of dam breed and season on birth weight of calves of exotic breeds. Calves born during the late-dry season was the heaviest (39.55 ± 2.43 kg) for Simmental followed by late-wet season calves (37.23 ± 0.65 kg), then, early-wet season calves (36.25 ± 1.85 kg). Those calves born in the early-dry season had the least birth weight of 35.95 ± 0.64 kg.

For Brahman, calves born in the late-wet season had the highest birth weight (44.50 ± 2.50 kg) followed by late-dry season calves (35.00 ± 0.50 kg) whereas the least birth weight was recorded for early-wet season calves (31.95 ± 0.61 kg). No record was found for calves in the early-dry season.

For Brown Swiss, the birth weight of calves were 39.50 ± 1.50 kg, 37.76 ± 3.04 kg, 37.45 ± 0.81 kg and 34.59 ± 1.28 kg for early-wet, late-dry, late-wet and early-dry seasons, respectively.

Holstein-Friesian had the heaviest calves born during early-dry season (38.13 ± 2.11 kg) followed by late-dry season (35.00 ± 0.51 kg), then early-wet season (34.00 ± 3.59 kg) and those born in the late-wet season had the least birth weight of 33.60 ± 1.93 kg.

Finally, for crosses, the highest birth weight was recorded in the early-dry season (40.50 ± 3.33 kg), followed by calves born during the late-wet season (36.19 ± 1.49 kg), whereas early-wet season had the least birth weight for calves (33.00 ± 1.15 kg). No record was obtained in the late-dry season.

Calves in the late-dry season had the highest birth weight (38.59 ± 1.715 kg), followed by late-wet season calves (37.01 ± 0.482 kg), then, early-dry season calves (36.15 ± 0.578 kg) while calves born during the early-wet season had the least birth weight (33.61 ± 0.747 kg).

Table 3. Dam Breed and Season Interaction Effect on Birth Weight of Exotic Breeds of Calves

DamBreed	Season	N	Mean (kg)± SEM
Simmental	Early-Dry	44	35.95±0.64 ^c
	Late-Dry	11	39.55±2.43 ^a
	Early-Wet	8	36.25±1.85 ^b
	Late-Wet	84	37.23±0.65 ^{ab}
Brahman	Early-Dry	–	–
	Late-Dry	1	35.00±0.50 ^b
	Early-Wet	20	31.95±0.61 ^c
	Late-Wet	2	44.50±2.50 ^a
Brown Swiss	Early-Dry	16	34.59±1.28 ^c
	Late-Dry	4	37.76±3.04 ^b
	Early-Wet	2	39.50±1.50 ^a
	Late-Wet	31	37.45±0.81 ^b
Holstein-Friesian	Early-Dry	8	38.13±2.11 ^a
	Late-Dry	1	35.00±0.51 ^{ab}
	Early-Wet	5	34.00±3.59 ^b
	Late-Wet	10	33.60±1.93 ^b
Crosses	Early-Dry	4	40.50±3.33 ^a
	Late-Dry	–	–
	Early-Wet	3	33.00±1.15 ^c
	Late-Wet	16	36.19±1.49 ^b

^{a, b, c} means within the same column with different superscripts differ significantly. ± SEM; Standard Error of Mean; N; Number of Observations

4.1.4 Effect of Dam Breed on Calving Ease of Exotic Breeds of Cows in Tropical Environment

Effect of Dam breed on calving ease is presented in Table 4. Dam breed had no significant effect on calving ease of exotic breeds of cows. However, there were varying values amongst the breeds in terms of calving ease/ difficulty. The total rate of calving ease was 94.7% with Simmental having the highest proportion of 48.5%. Brown Swiss, Brahman, crosses and Holstein–Friesian accounted for 17.9%, 11.0%, 9.6% and 7.6% respectively.

The overall incidence of slight problem/ calving difficulty was 5.3% with Simmental still having the highest percentage of 3.7%, Brown Swiss (1.3%), Holstein-Friesian (0.3%) while Brahman and crosses both had no incidence at all for calving difficulty (0%).

Table 4. Effect of Dam Breed on Calving Ease of Exotic Breeds of Cows in Tropical Environment

Calving Ease	Dam breed					Total	χ^2
	Simmental	Brahman	Brown Swiss	Holstein-Friesian	Crosses		
No Assistance	146 (48.5)	33 (11.0)	54 (17.9)	23 (7.6)	29 (9.6)	285 (94.7)	
Slight Problem	11 (3.7)	0 (0)	4 (1.3)	1 (0.3)	0 (0)	16 (5.3)	4.72 ^{ns}
Total	157 (52.2)	33 (11.0)	58 (19.3)	24 (8.0)	29 (9.6)	301 (100)	

χ^2 = Chi-square value; ns = P is not significant at 0.05. Values in parenthesis are in percentages

4.1.5 Influence of Calf Sex on Calving Ease of Exotic Breeds of Cows

Table 5 presents the effect of sex on calving ease of temperate breeds of cows. Sex had a highly significant ($P < 0.01$) influence on calving ease. Total percentage of calving ease was 94.7%. Female calves had higher rate of calving ease (49.3%) than the male calves (45.4%). Conversely, male calves had higher incidence of calving difficulty (4.3%) while female calves had only 1.0%. The overall incidence of calving difficulty was 5.3%.

4.1.6 Influence of Season of Birth on Calving Ease of Exotic Breeds of Cows

Table 6 presents the influence of season on calving ease of temperate breeds of cows. Season had a very high significant ($P < 0.001$) effect on calving ease. Calving ease was highest during the late-wet season (43.7%), followed by early-dry (25.5%), early-wet (15.6%) and late-dry season (9.9%).

On the other hand, late-wet season had the highest rate of assisted calving of 5.3%, while, early-dry, late-dry and early-wet seasons had no incidence of calving difficulty (0%), making the total incidence of assisted calvings and unassisted calvings to be 5.3% and 94.7%, respectively across the seasons.

Table 5. Influence of Calf Sex on Calving Ease of Exotic Breeds of Cows.

Calving Ease	<u>Calf Sex</u>			χ^2
	Male	Female	Total	
No Assistance	137 (45.4)	149 (49.3)	286 (94.7)	6.74**
Slight assistance	13 (4.3)	3 (1.0)	16 (5.3)	
Total	150 (49.7)	152 (50.3)	302 (100)	

χ^2 = Chi-square value; **P < 0.01. Values in parenthesis are in percentages

Table 6. Influence of Season of Birth on Calving Ease of Exotic Breeds of Cows

Calving Ease	<u>Season</u>				Total	χ^2
	Early-Dry	Late-Dry	Early-Wet	Late-Wet		
No Assistance	77 (25.5)	30 (9.9)	47 (15.6)	132 (43.7)	286 (94.7)	17.58***
Slight assistance	0 (0)	0 (0)	0 (0)	16 (5.3)	16 (5.3)	
Total	77 (25.5)	30 (9.9)	47 (15.6)	148 (49.0)	302 (100)	

χ^2 = Chi-square value; *** = P ≤ 0.001. Values in parenthesis are in percentages

4.1.7 Influence of Birth Weight Class on Calving Ease of Exotic Breeds of Cows

Influence of Birth weight class on calving ease of cows is shown in Table 7. The results showed that birth weight class had a very high significant ($P < 0.001$) influence on calving ease. Calving ease showed a decreasing trend with increase in birth weight of calves. Calves of lower birth weight class of less than 35 kg had the highest percentage of calving ease of 52.1%, followed by calves of birth weight class 36- 45kg (36.0%), then the heavy birth weight class of more than 46 kg had 6.0%, making the rate of calving ease to be 94.0%. On the other hand, calves of the middle birth weight class of between 36 to 45 kg had the highest incidence of slight problem/assisted calving of 4.5% followed by the heavy birth weight class calves of more than 46 kg (1.1%), whereas birth weight class of ≤ 35 kg had 0.4%. thus making the total incidence of calving difficulty 6.0%.

4.1.8. Effect of Dam Breed on Placental Release Ease (PRE) of Exotic Breeds of Cows.

The effect of dam breed on placental release ease (PRE) of exotic breeds of cows is shown in Table 8. The results showed that dam breed had a significant ($P < 0.05$) effect on placental release ease. The total rate of placental release ease is 85.7%, with Simmental having the highest percentage (42.9%), followed by Brown Swiss (15.9%), Brahman (11.0%), crosses (9.3%) and Holstein- Friesian (6.6%). However, Simmental had a rate of 9.3% for slight assistance, Brown Swiss (3.3%), Holstein-Friesian (1.3%) and crosses (0.3%). There was no incidence of slight assistance/ calving difficulty for Brahman (0%). This made the overall incidence of retained placenta 14.3%.

Table 7. Influence of Birth Weight Class on Calving Ease of Exotic Breeds of Cows.

Calving Ease	Birth weight class (kg)			Total	χ^2
	≤35	36-45	>46		
No Assistance	139 (52.1)	96 (36.0)	16 (6.0)	251 (94.0)	
Slight assistance	1 (0.4)	12 (4.5)	3 (1.1)	16 (6.0)	15.18***
Total	140 (52.4)	108 (40.4)	19 (7.1)	267 (100)	

χ^2 = Chi-square value; *** = P ≤ 0.001. Values in parenthesis are in percentages

Table 8. Effect of Dam Breed on Placental Release Ease (PRE) of Exotic Breeds of Cows

Placental Release Ease	Dam breed					Total	χ^2
	Simmental	Brahman	Brown Swiss	Holstein-Friesian	Crosses		
Normal	129 (42.9)	33 (11.0)	48 (15.9)	20 (6.6)	28 (9.3)	258 (85.7)	
Slight Assistance	28 (9.3)	0 (0)	10 (3.3)	4 (1.3)	1 (0.3)	43 (14.3)	10.42*
Total	157 (52.2)	33 (11.0)	58 (19.3)	24 (8.0)	29 (9.6)	301 (100)	

χ^2 = Chi-square value; * = P < 0.05. Values in parenthesis are in percentages

4.1.9 Influence of Calf Sex on Placental Release Ease (PRE) of Exotic Breeds of Cows

Table 9 gives the Influence of calf sex on Placental release ease. The results showed that calf sex had no significant effect on placental release ease. The overall cases of normally expelled placenta were 85.8% with female calves having 44.0% while male calves had 41.8%. The total incidence of PRE/Slight assistance was 14.2%, where male calves had the higher rate of 7.9% while female calves had 6.3%. This indicated that male calves had more rate of retained placenta than female calves although the difference was not statistically significant.

4.1.10. Effect of Season on Placental Release Ease (PRE) of Exotic Breeds of Cows

The effect of season on placental release ease is shown in Table 10. Season had no significant influence on placental release ease. However, the highest percentage of normally expelled placenta was recorded in the late wet season (41.7%), followed by early dry (22.2%), early wet (14.2%) and late dry season (7.6%) making placental release ease a total of 85.8%.

Total incidence of slight assistance/ retained placenta was 14.2% with late wet season having the highest incidence (7.3%), followed by early dry (3.3%), late dry (2.3%) and late wet (1.3%).

Table 9. Influence of Calf Sex on Placental Release Ease (PRE) of Exotic Breeds of Cows

Placental Release Ease	<u>Calf Sex</u>			χ^2
	Male	Female	Total	
Normal	126 (41.7)	133 (44.0)	259 (85.8)	0.76 ^{ns}
Slight Assistance	24 (7.9)	19 (6.3)	43 (14.2)	
Total	150 (49.7)	152 (50.3)	302 (100)	

χ^2 = Chi-square value; ns = P not significant at 0.05. Values in parenthesis are in percentages

Table 10. Effect of Season on Placental Release Ease (PRE) of Exotic Breeds of Cows

Placental Release Ease	<u>Season</u>				Total	χ^2
	Early-Dry	Late-Dry	Early-Wet	Late-Wet		
Normal	67 (22.2)	23 (7.6)	43 (14.2)	126 (41.7)	259 (85.8)	3.44 ^{ns}
Slight Assistance	10 (3.3)	7 (2.3)	4 (1.3)	22 (7.3)	43 (14.2)	
Total	77 (25.5)	30 (9.9)	47 (15.6)	148 (49.0)	302 (100)	

χ^2 = Chi-square value; ns = P not significant at 0.05. Values in parenthesis are in percentages.

4.1.11. Effect of Birth Weight Class on Placental Release Ease (PRE) of Exotic Breeds of Cows

The effect of birth weight class on placental release ease is presented in Table 11. Birth weight Class had no significant effect on placental release ease. The total percentage of normally expelled placenta was 83.9%. The trend decreased from 44.2% for calves having low birth weight of less than 35 kg, to 34.1% (for 36 to 45 kg birth weight class calves) and finally to 5.6% for heavy calves having birth weight of more than 46 kg.

Slight assistance had a total rate of 16.1%. Calves having ≤ 35 kg birth weight accounted for 8.2%, followed by middle class birth weight calves of 36 to 45 kg (6.4%) and finally, heavy calves of above 46 kg had 1.5%.

4.1.12. Relationship Between Calving Ease and Placental Release Ease of Exotic Breeds of Cows

Table 12 presents the relationship between calving ease and placental release ease using the McNemar Test for significance of changes. A high significant change effect ($P < 0.001$) was found in the relationship between calving ease and placental release ease. The proportion of cows that had easy calving and normal placental release was 79.4%, while only 4 (1.5%) had slight problem of calving and had to be slightly assisted for the placenta to be released.

Thirty nine cows (14.6%) had normal calving without assistance but with slight assistance during placenta release, whereas twelve (4.5%) had slight problem of calving but normal placental release. These groups accounting for (19.1%) are known as changers because they deviated from the normal assumption that for an easy calving, there should be a normal placental release and vice-versa.

Table 11. Effect of Birth Weight Class on Placental Release Ease (PRE) of Exotic Breeds of Cows

Placental Release Ease	Birth weight class (kg)			Total	χ^2
	≤ 35	36-45	>46		
Normal	118 (44.2)	91 (34.1)	15 (5.6)	224 (83.9)	0.37 ^{ns}
Slight Assistance	22 (8.2)	17 (6.4)	4 (1.5)	43 (16.1)	
Total	140 (52.4)	108 (40.4)	19 (7.1)	267 (100)	

χ^2 = Chi-square value; ns = P not significant at 0.05. Values in parenthesis are in percentages

Table 12. Relationship between Calving Ease and Placental Release Ease of Exotic Breeds of Cows

Calving ease	Placental release ease		χ^{2*}
	Normal	Slight Assistance	
No Assistance	A 212 (79.4)	B 39* (14.6)	***
Slight Problem	C 12* (4.5)	D 4 (1.5)	

χ^{2*} - McNemar test for significance of changes. * = changers, *** = $P \leq 0.001$. Values in parenthesis are in percentages

4.2. DISCUSSION

4.2.1 Summary Statistics of Birth Weight of Calves in Sebore Farms by Dam Breed, Sex and Season

The birth weight of a calf affects its growth and survivability (Rastogi and Yousef, 1979). The mean birth weight obtained in the present study was higher than that reported for Holstein- Friesian calves (31.0 kg) on the Accra Plains by Hagan (1977). This might be due to differences in maternal genotype.

The variation in birth weight amongst the different breeds could be because different genotypes are not expected to perform similarly under all environments mainly due to genotype – environmental interactions (Bourdon, 2000). This implied that growth varies with the breed and environment. The superiority of crossbred in mean birth weight over some pure breed such as Brahman and Holstein- Friesian indicated the effect of heterosis as a result of crossing since different genes pooled together.

In this study, the ratio of male to female births was 1: 1 which follows the Mendelian ratio in any given population. The male calves weighed heavier than the females and this agrees with the findings of Ibrahim *et al.* (2015).

4.2.2 Influence of Dam Breed, Sex and Season on Calf Birth Weight of Temperate Breeds of Calves

The insignificant effect of dam breed on birth weight is in agreement with the research of Ibrahim *et al.* (2015). But dissimilar results were obtained by Avila, De Rozen, Garsell and Santa Coloma (1990); Eler, Lobo and Rosa (1990); Abdel Aziz, Ali and Ahmed (1991).

The birth weight of Holstein-Friesian in this study was lower than that reported by Bakir, Kaygisiz and Ulker (2004) (38.09 kg); Gwaza, Okwori, Abu and Fombah (2007) (39.2 kg) and Bayram and Aksakal (2009) (42.76 kg).

Akubulut, Bayram and Yanar (2001) also reported a higher birth weight of 38.8 kg and 36.50 kg for Brown Swiss. Whereas, Mathai, Jacob, Abraham and Nair (1978) reported 17.22 kg for the crossbred cattle maintained at the same station which was much lower than the result of this study. This indicates that the progenies of Simmental, Holstein-Friesian and Brown Swiss were heavier at birth than Brahman and crosses.

The significant effect of calf sex on birth weight agreed with the report by Raja, Venkatachalapathy and Kennan (2010) but disagreed with the findings of Ibrahim *et al.* (2015). Male calves had significantly higher birth weight than female calves. This was in agreement with the findings of Bakir, Kaygisiz and Ulker (2004), and Shahzad *et al.* (2010). The findings of the present study also confirmed those of Akubulut, Bayram, Tuzeman and Aydin (2002) that found a significant effect of calf sex on birth weight. The difference between male and female calves was 2.52 kg (6.6%) and this was slightly higher than results of Bakir, Kaygisiz and Ulker (2004) and Raja, Venkatachalapathy and Kennan (2010), where they reported difference between male and female calves to be 1.34 kg and 0.06% respectively, but was lower than the value observed by Marquez, Correa, Ponce, Rodriguez and Fierro (2001), where the authors reported a 5.25 kg difference.

Jain, Qureshi and Khan (1996) and Suttan, Khali, El- Sobby and Abdul-Rahman (1987); Olawumi and Salako (2011), also reported similar results that sex of calf had highly significant effect on birth weight of calves. Also, Abdel Aziz, Ali and Ahmed (1991) had a similar report where they found in their study on Butana and Friesian x Kenana crosses that the calf sex had highly significant effect on birth weight. In contrast, however, Orunmuyi, Olutogun and Abanikanda (2001) reported that there was no significant effect of sex on birth weight.

The higher birth weight in male calves was attributed to the longer gestation period of male calves or higher androgen concentration in male fetuses (Spencer, 1982) and also to the

greater rate of skeletal growth in utero of male calves compared to female calves (Tuah and Danso, 1985).

The insignificant effect of season on birth weight in the present study confirmed the findings of Raja, Venkatachalapathy and Kennan (2010) and Ibrahim *et al.* (2015). Similar findings were obtained in Sudan by Khalifa (1996) who reported that summer born calves were slightly heavier than winter ones but the difference was not significant. Also, Jain, Khan, Ashog and Sing (2000); Rahman, Rejoanoul, Rahman, Hague and Das (2007) and Akdag, Serhat, Caynak and Teke (2011) reported a non- significant effect of season on birth weight. It might be that for offspring born in the late dry season, fetal growth was most rapid during the last trimester following the early dry season when dry pasture grass are optimally available, in addition, extra concentrate feed associated with a more controlled feeding program in the early dry season enhanced fetal growth.

The insignificant effect of season on birth weight agreed with the findings of Orunmuyi, Olutogun and Abanikanda (2001); Shahzad *et al.* (2010); and Olawumi and Salako (2011). Khalifa (1996) indicated non-significant effect of season on birth weight of calves where the author used data on Butana and Kenana cattle and found that summer born calves were slightly heavier than winter ones but the difference was not significant. Also, the non-significant effect of season agreed with the reports made by Akubulut, Bayram and Yanar (2001). In contrast, Ulsan (1992) and Bakir, Kaygisiz and Ulker (2004) reported a significant effect of season of calving on birth weight. Also, Jain, Qureshi and Khan (1996) reported a significant effect of season on birth weight. According to the authors, calf birth weight was generally little affected by environmental conditions unless such conditions were extremely severe. The practice of “Steaming-Up” pregnant females is believed to have evened out any fluctuation in nutrient supply that would otherwise have occurred.

Also, El- Habeeb (1991) analysed data on Butana and Kenana cattle reported that calving season significantly influenced birth weight and that the effects of season were attributed to climatic and management factors which varied between seasons.

4.2.3 Interaction Effect of Dam breed, Calf sex and Season on Birth Weight of Exotic breeds of Calves

The significant effect of breed*season interaction agreed with the findings of McClintock, Poole, Beard and Goddard (2013). However, Mekonnen and Keno (1987) reported a non significant effect of breed* season interaction on birth weight of Boran cattle and their crosses with Friesian. Hansen and Hauser (1983) reported a non- significant effect of season on genotype and environmental interactions on reproductive traits of bovine females, where the authors reported a non- significant interaction between breed and season, and also dietary level with season of calving.

4.2.4 Effect of Dam breed on Calving Ease of Exotic Breeds of Cows in Tropical Environment

The variation in the calving ease due to the effect of dam breed origin suggests some level of genetic influence on dystocia. However, Cady (2004) reported that the heritability of calving ease is low ranging from 5 to 15%, and this implies that, at most, 85% of the variation in dystocia can be attributed to environmental or management factors. Consequently, the best method of reducing dystocia is through good management practices. Therefore, proper management and breeding before, during and after calving is the key to preventing the problem (Akpa, Umar and Alphonsus, 2011).

In this study, dam breed had a non- significant effect on calving ease though there were variations amongst the breeds. The breeds exhibited moderate to high percentage of calving ease, and lower percentage of calving difficulty. The total incidence of calving difficulty is lower than 7.8% and 30- 65% presented by Barbara, Nezika and Silvester (2009) and Akpa, Umar and Alphonsus (2011), respectively.

The lower incidence of calving difficulty/ slight problem could probably be due to one or combination of the following factors; age of dam, calf birth weight, dam pelvic area, cow size, breed of sire and dam and hormonal control (Ritchie and Anderson, 1992). The differences among breeds of dam are most likely due to differences in relative pelvic area, muscling or fatness. Simmental had the highest incidence of calving difficulty; this could probably be due to the relatively large body size of the breed as well as the size of the pelvic canal which in turn gives rise to a higher birth weight calf. The pelvic opening determines the maximum birth weight that can be accommodated by individual cows before calving difficulty is experienced (Akpa, Umar and Alphonsus, 2011).

Breed differences in respect of calving ease is an important factor for genetic improvement of the efficiency of beef and dairy production. A high percentage of calving ease was observed and out of which most of the cases recorded was for Simmental and this results differ from that of Akpa, Umar and Alphonsus (2011) where the authors reported a 58% calving ease for Holstein-Friesian and 52% for Brown Swiss.

The high overall rate of calving ease could be attributed to good level of management and breeding of the cows before, during and after calving.

4.2.5 Influence of Calf Sex on Calving Ease of Exotic Breeds of Cows

According to Ritchie and Anderson (1990), much of the influence of calf sex on calving difficulty is believed to be indirect through its effect on calf size. In a study, Akpa, Ifut and Mohammed (2002) 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 offspring which were heavier than those of their female counterparts.

In this study, female calves had higher calving ease rate than the male calves. The result of this research is higher than the 37.74% and 31.56% for female and male calves respectively reported by Morek and Zarnecki (2012). Also, Akpa, Umar and Alphonsus

(2011) reported 77% and 37% female and male calves, respectively for calving ease. The calving difficulty recorded for female and male calves in the present study is far lower than the 23% and 63% reported by Akpa, Umar and Alphonsus (2011); and 59.46% and 64.28% by Morek and Zarnecki (2012) for female and male calves respectively. The lower calving difficulty of the female calves was probably due to the fact that male fetuses grew faster during gestation and will have heavier weight at birth than female calves (Gwaza, Okwori, Abu and Fombah, 2007; FAO, 2008). Differences in shape of male compared with female calves have been suggested as a contributing factor (Price and Wiltbank, 1978).

4.2.6 Influence of Season of Birth on Calving Ease of Exotic Breeds of Cows

Variation of calving difficulty with season of calving is an indication of the effect of management practices, housing, disease prevention, feeding and nutrient content of feed offered to the animal during gestation (Gwaza, Okwori, Abu and Fombah, 2007). The effect of season on calving ease of the dam is related to the stage in the wet and dry season cycle at which the dam became pregnant.

The significant effect of season on calving ease of temperate breeds of cows agreed with the reports of Tawah, Mbah, Enoh and Massine (1999); Ebangi, Erasmus, Mbah, Tawah and Massine (2002) and Akpa, Galadima, Adeyinka, Malau- Adulli and Abdu (2007). Calving ease was highest during the late-wet season, followed by early-dry, early-wet and late-dry, this result partially agreed with the findings of Akpa, Umar and Alphonsus (2011) where the authors reported highest rate of calving ease during late-wet season (72%), followed by late-dry (62%), early-wet (57%) and early-dry (23%).

The highest assisted calving in the present study was in the late-wet season, and this disagreed with the research of Akpa, Umar and Alphonsus (2011) that reported early-dry season as having the highest assisted calving rate. The authors further reported that 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 animals become more difficult during the dry season and can affect the animals especially if it corresponds with the period of pregnancy (Akpa, Ifut and Mohammed, 2002).

However, the significantly higher effect of season on calving ease and disparity with the work of Akpa, Umar and Alphonsus, (2011) could be due to the excellent management practices in the present study as opposed to the household level research conducted by these researchers.

4.2.7 Influence of Birth Weight Class on Calving Ease of Exotic Breeds of Cows

Research indicates birth weight is by far the most significant contributor to calving ease. Infact, researchers found that 60% of calving difficulty (dystocia) is due to calf birth weight. Birth weight is related to length of gestation, which would increase 0.14 – 0.454 kg/day, near the end of gestation. As the birth weight increases, the percentage of assisted births would increase 0.7- 2.0% per pound of birth weight (Anderson, 2012). The effect of birth weight on calving difficulty should be thought of as a “threshold” type of effect. In other words, while reducing birth weight will reduce the incidence of calving difficulties in some herds, beyond a certain point, continuing to reduce birth weight will not continue to reduce calving difficulties, within a given cow size. Put another way, in a herd that has little trouble calving, increasing birth weight slightly will increase dystocia, but after a while, dystocia will be at a high rate and will only increase further with large increases in birth weight.

As the birth weight of calves increased, calving ease decreased, consequently, calving difficulty increased. Research has shown that birth weight is a major factor that can influence calving ease (Ritchie and Anderson, 1990).

4.2.8 Effect of Dam Breed on Placental Release Ease (PRE) of Exotic Breeds of Cows

The significant effect of dam breed on placental release ease agreed with the research of Islam, Sarder, Rahman, Kader and Islam (2012). The breeds exhibited moderate to high percentage of PRE from Holstein-Friesian to Simmental and lower percentages of Slight Assistance from Brahman to Simmental. The total rate of PRE of 85.7% in the present study was closer to the work of Islam *et al.* (2012), where the authors reported 86.6% for normally expelled placenta.

The total incidence of Slight Assistance (retained placenta) in this study is closer to the findings of various researchers and their incidence were 12.6%, 9.2%, 13.4% and 13.4%, by Rahman, Hossain and Prodhan (1993); Majeed, Aboud, Hassan and Muhammad (2009); Islam *et al.* (2012) and Islam *et al.* (2013), respectively. But this result differ from reports of Grunert (1986) and Sarder, Moni and Aktar (2010) where the authors reported lowered values of 7.0% and 8.8%, respectively.

Dam breed had direct influence on retained placenta. Simmental had the highest incidence. The higher prevalence of retained placenta observed in some breeds could be associated with the lower degree of adaptation to the existing climate. Moreover, stress, the inability of cows to cope with its environment can predispose them to post partum problems and hence, they fail to achieve their genetic potentials (Dobson and Smith, 2000).

4.2.9 Influence of Calf Sex on Placental Release Ease (PRE) of Exotic Breeds of Cows

Female bearing cows had a higher rate of normal placenta expulsion than the male bearing cows. Also, male bearing cows had a higher rate of slight Assistance (retained) than female bearing cows. Majeed, Aboud, Hassan and Muhammad (2009) agreed to the fact that male bearing cows usually have a higher incidence of retained placenta than their female bearing counterparts. The higher incidence could be related to longer gestation period in cows

having male calves and larger size and heavy weight of male calves causing circulatory disturbances and/ or overstretching or inertia of the uterus (Roberts, 1986).

The slight increase in percentage of PRE observed with dams of female born calves than males may suggest that the fetal androgenic hormone from the fetal testes might have partially affected process of placenta retention. These results are in agreement with those obtained by Deyab (2000) and Gabr, Shamiah and Abu El- Hamd (2005). They found that the percentage of retained placenta tended to increase with dams bearing males than females.

4.2.10 Effect of Season on Placental Release Ease (PRE) of Exotic Breeds of Cows

The non-significant effect of season on PRE in this study disagreed with the findings of Majeed, Aboud, Hassan and Muhammad (2009), where the authors reported a significant effect of season on placental release ease. However, Gaafar, Shamiah, Shitta and Ganah (2010) reported a significant effect of season on placenta retention. Also, significant results were reported by Atalah (1993); Deyab (2000) and Gabr Shamiah and Abu El- Hamd (2005). Echternkamp and Gregory (1999) also reported a significant effect of season on placental release ease, the authors reported a 40% decrease in fall *vs.* spring- calving females.

Late-wet calving females were fed silage during the first trimester of pregnancy and high quality, improved pasture during most of the last two trimesters. Such seasonal differences in nutrition might have influenced placental development; ovine placental growth (i.e., mass and net cellular proliferation) is reported to be maximal in the first half of gestation (Ehrhardt and Bell, 1995) and maternal feed restriction from day 30 to 100 of gestation induces compensatory growth of the ovine placenta (Faichney and White, 1987).

4.2.11 Effect of Birth Weight Class on Placental Release Ease (PRE) of Exotic Breeds of Cows

As the birth weight of calves increased, retained placenta also increased and this agreed with the findings of Gaafar, Shamiah, Shitta and Ganah (2010) where the authors reported that retained placenta is influenced by high birth weight of calves. The increase in

percentage of incidence of retained placenta with increase in birth weight might be due to an expected pressure of the fetus on the placenta and fetal membrane, so that the attachment between the cotyledons and the fetal membrane become stronger (Gaafar Shamiah, Shitta and Ganah, 2010).

Joosten, Stetwagen and Dijkhuizen (1988), Deyab (2000) and Gabr, Shamiah and Abu El-Hamd (2005) reported increase in the incidence of retained placenta with increasing weight of born calves. However, Joosten, van Eldik, Elving and vander Mey (1987) reported that low birth weight was associated with higher rates of placental retention and also that high birth weight mainly caused higher rates when related to dystocia.

After calving, the fetal membranes will be expelled from the uterus by continued contraction waves. Beside reducing the size of the uterus and aiding in forcing the placenta to birth canal, probably, this markedly reduced the amount of blood circulating in the endometrium.

Cows having retained placenta for a first or second time are three to six times, respectively, as likely to do so again at a subsequent parturition when compared with cows which had not had retained placenta previously.

4.2.12 Relationship between Calving Ease and Placental Release Ease of Exotic Breeds of Cows

Even though several factors are implicated as predisposing to reproductive tract infection, retained placenta and dystocia result in a greater incidence of reproductive tract infections (Yoseph, Tenhagen, Merga and Tesfu, 2005; Le Blanc, 2008). Dystocia might cause over stretching and uterine inertia of the uterus which may hinder expulsion of the fetal membranes (Majeed, Taha and Qassim, 1989; Han and Kim, 2005). Increased incidence of retained placenta can be expected after difficult calving, with increasing age of the dam and after gestation periods (Joosten, van Eldik, Elving and vander Mey, 1991). Retention of placenta at previous calvings increased the risk of occurrence by up to 50%. Majeed, Aboud,

Hassan and Muhammad (2009) reported a dystocia rate of 10.52% as affecting the incidence of retained fetal membrane in Holstein-Friesian cattle. Retained placenta is most commonly associated with dystocia, milk fever (metabolic diseases) and twin births. In most herds with good management, these causes make up the majority of known risk factors for retained placenta. Joosten, van Eldik, Elving and vander Mey (1987) reported that high birth weights mainly caused higher rates of retained placenta when related to difficult calving. According to Joosten, van Eldik, Elving and vander Mey (1991), analysis of ten main effects and their interactions, indicated that increased incidences of retained placenta can be expected after difficult calving. Retention of the placenta at previous calvings increased the risk of recurrence by up to 50%. Although, these factors are implicated in retained placenta, most cases following normal parturitions have to be explained otherwise.

The considerable proportion of changers with respect to calving ease and retained placenta observed in this study was also observed by Kaya, Uzmay and Ayyilmaz (2015) to be 13.5%. In another study, Thompson, Pollak and Pelissier (1983), found that incidence of both milk fever and retained placenta was higher for assisted calvings than for unassisted ones and increased with parity. Moreover, they reported that incidence of retained placenta was higher when milk fever occurred and that calving difficulty, retained placenta and milk fever tended to occur as a complex. According to Aboum, Njenga, Wabacha, Tsuma and Gitau (2012), cows that develop retained placenta and dystocia were 5.2 and 3.9 times more likely to develop metritis respectively. Therefore, retained fetal membrane is an important risk factor for vulval discharge (Peeler, Otte and Esslemont, 1994) and increased risk of metritis (Konyves *et al.*, 2009), which can in turn influence the reproductive performance.

On the contrary, Hur *et al.* (2011) reported that retained placenta was not related to dystocia in Holsteins, as did Curtins, Erb, Sniffen, Smith and Kronfeld (1985) who found in a

study on multiparous Holsteins, that veterinary assisted dystocia was not associated with retained placenta.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The study was carried out to determine the effect of genetic and environmental factors on calf birth weight and some calving traits (calving ease and placental releases ease) of exotic breeds of cattle performing in a tropical environment kept at Sebore Farms, Mayo-Belwa, Adamawa State . The data used for the study included 302 calving records and 270 birth weight records of calves from five different breeds of dams. The breeds of dams included Simmental, Brahman, Brown swiss, Holstein-Friesian and crosses, while the sire breed was Simmental.

Birth weight was significantly affected by calf sex and breed*season interaction. Male calves weighed heavier than females (37.67 kg *vs.* 35.17 kg). The overall rate of calving ease was 94.7%. The influencing factors include dam breed, calf sex, season of birth and birth weight class. Calving ease was significantly affected by calf sex ($P<0.05$), season of calving ($P<0.001$) and birth weight class ($P<0.001$) and an overall prevalence rate of 5.3%. More cases of assisted calving were observed for male calves than females and for birth weights of between 36 and 45 kg, while it was only observed during the late wet season.

The overall rate of normally expelled placenta was 85.7%, and incidence of retained placenta was 14.3%. Dam breed had a significant effect on placental release ease ($P<0.05$) while calf sex, season and birth weight class did not. The highest prevalence rate of 9.3% was observed among Simmental cows.

There was a significant ($P<0.001$) change in the relationship between calving ease and placental release ease as subjected to McNemar test for significance of changes. A combined proportion of 19.1% (14.6% and 4.5%) deviated from the normal assumption that for an easy calving, there should be a normal placental release and *vice versa*.

5.2 CONCLUSION

It can be concluded from the result of this study that sex of calf affects birth weight which in turn influences CE. Therefore, birth weight, calf sex, season of birth are important factors to consider when breeding for calving ease. Dam breed had an effect on placental release ease, indicating that this should be taken into account when breeding against retained placenta in the herd. Finally, a considerable proportion of calvings deviated from the normal assumption that for an easy calving, there should be a normal placental release and *vice versa*.

5.3 RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

- a) Birth weight, calf sex, and season of birth should be taken into consideration when breeding against calving difficulty;
- b) Dam breed should also be considered when avoiding retained placenta in a herd.
- c) Further investigations on the relationship between calving ease and placenta retention should be carried out.

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APPENDIX 1

Interaction Effects of Dam breed, Calf Sex and Season on Birth Weight of Temperate breeds of calves

Source of Variation	Df	SS	MS	F-Value
Dam Breed	4	66.63	16.66	0.59 ^{ns}
Calf Sex	1	127.07	127.07	4.51*
Season	3	147.78	49.26	1.75 ^{ns}
Breed*Sex	4	111.24	27.81	0.99 ^{ns}
Breed *Season	10	559.58	55.96	1.99*
Sex * Season	3	30.39	10.13	0.36 ^{ns}
Breed* Sex* Season	6	154.21	25.70	0.91 ^{ns}
Error	238	6706.23	28.18	
Total	269	8446.95		

Df = degree of freedom; SS = Sum of squares; MS = Mean square; * = P<0.05; ns = P is not significant

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