PERIPARTURIENT CONDITIONS IN SMALLHOLDER DAIRY CATTLE HERDS IN KIKUYU DIVISION OF KIAMBU DISTRICT, KENYA.

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A THESIS SUBMITTED IN PARTIAL FULFILMENT

OF REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE IN CLINICAL STUDIES

UNIVERSITY OF NAIROBI

FACULTY OF VETERINARY MEDICINE

DEPARTMENT OF CLINICAL STUDIES

2006.

DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university.

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DEDICATION

To

My parents Mr. and Mrs. Okumu, sister Carolyne, brothers Melvin and Kelly

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the University of Nairobi for the award of a scholarship to pursue a Master of Science degree in Clinical Studies and the Department of Clinical Studies for facilitating the laboratory work and transport during the period of this study.

My appreciation also goes to my supervisors Professor Njenga M.J., Dr.Wabacha J.K. and Dr. Tsuma V.T. for their constant encouragement and advice during the development of the proposal, the research period and in the writing of this thesis.

My gratitude also goes to Dr. Karanja T. N. and Mr. Matere C. for their assistance in the statistical analysis. I am also indebted to Mr Gachoka J. of Kikuyu for his help in data collection and all the smallholder farmers in Kikuyu Division of Kiambu District who were willing to have their animals included in the study.

I am also indebted to my family and all the members of staff and postgraduate students of the Department of Clinical Studies for their constant words of encouragement throughout the study period.

ABSTRACT

The conditions affecting dairy cattle during the periparturient period have been documented in various parts of the world. Most of these reports are based on large-scale dairy herds reared under intensive production systems. However, there is limited information on the occurrence of these conditions in the smallholder dairy production system. This study was therefore conducted to determine the periparturient conditions affecting smallholder dairy cattle in Kikuyu Division of Kiambu District. The objectives of the study were:

1) To determine the incidence of diseases affecting dairy cattle during the periparturient period in Kikuyu Division; 2) To determine their pattern of occurrence across seasons and agro-ecological zones; 3) To determine the herd level risk factors of the periparturient conditions.

Smallholder farms having ≤10 dairy cattle were selected into the study. The selection was progressive and purposive based on the presence of at least one animal 3-8 months pregnant in the herd and the farmers' willingness to participate in the study. The willing farmers were recruited. A total of 117 farms were selected for the study. Two hundred and six animals were recruited of which 150 were from the lower highland agro-ecological zone (Altitude 1820 - 2070 m above sea level) and 56 from the upper midland agro-ecological zone (Altitude 1200-1820m above sea level). One hundred and thirteen animals were followed up during the dry season while 93 were followed-up during the wet season.

Monthly visits were carried out for pregnant animals that had not entered the periparturient period (> 3 weeks prior to parturition) and weekly visits carried out as soon

as the animals entered the periparturient period (3 weeks before and 3 weeks after parturition). Data was collected during farm visits by observation, semi-structured interviews and clinical examination of animals.

Descriptive statistics were determined for breed, sex of offspring, agro-ecological zone, season and management practices. Disease incidences were also calculated.

The Chi square (χ^2) test was used to determine unconditional associations between periparturient conditions and potential predictor variables at the 5 % level of significance. Multiple logistic regression procedure was carried out to model the effects of potential risk factors on the occurrence of periparturient conditions. Factors that were found significant ($P < 0.05$) were retained in the model. The odds ratio (O.R.) as a measure of the strength of association between significant variables was calculated as the reciprocal of the antilogit of the estimate for that variable. Interaction and confounding between the variables were controlled analytically in the regression modelling.

The overall incidence of the periparturient conditions was 0.67. The incidences of the most common conditions encountered were retained placenta 0.281, dystocia 0.135, milk fever 0.111, downer cow syndrome 0.097, mastitis 0.087 and metritis 0.063.

Factors significantly associated with the development of retained afterbirth were milk fever (O.R. = 5.2, P = 0.041) and history of having developed retained afterbirth in a previous parturition (O.R. = 2.3, P = 0.045). Factors significantly associated with the development of downer cow syndrome were milk fever (O.R. = 9.32, P = 0.001) and lack of supplemental feeding (O.R. = 4.8, P = 0.007). The wet season was significantly associated with the development of mastitis (O.R. = 4.1, P = 0.015). Factors significantly associated with the development of metritis were dystocia (O.R. = 3.96, P = 0.021) and

retained afterbirth (O.R. = 5.24, P = 0.026). Dystocia was significantly associated with the development of periparturient haemorrhage (O.R. = 10.55, P = 0.012) and injuries to the birth canal (O.R. = 58.96, P <0.01).

From this study it can be concluded that retained placenta, dystocia, milk fever, downer cow syndrome, mastitis and metritis are common periparturient conditions in smallholder dairy cattle herds in Kikuyu Division of Kiambu District. Most of the conditions were interrelated with one condition predisposing the occurrence of the other.

It is recommended that more research be carried out to determine the impact of these diseases on the productivity and performance of cattle in the smallholder dairy production system and the dairy sector as a whole in this country.

CHAPTER 1 INTRODUCTION

1.1 Background

The periparturient period in cattle is the period 2-3 weeks pre- and post-partum. It is a transitional period characterized by changes in endocrine status of the animal, to provide for lactogenesis and parturition. It is also characterized by changes in tissue metabolism, nutrient utilization, and disruptions in functioning of the immune system (Goff and Horst, 1997; Dingwell *et al.*, 2003; Nikolic *et al.*, 2003). The initial stages of uterine involution, in preparation for the next reproductive cycle also take place at this time (Roberts, 1986).

Several diseases such as milk fever, ketosis, injuries to the birth canal, nerve paralyses, mastitis and metritis occur during the periparturient period in cattle. These diseases account for up to 8 percent of all the diseases in dairy cattle (Roine and Saloniemi, 1978; Roberts, 1986; Markusfeld, 1987), and cause huge losses to the dairy industry in terms of increased generation interval, loss of genetic pool, deaths, reduced productivity of the animals and costs of treatment (Erb *et al.*, 1985).

Most of these diseases are interrelated, with one condition predisposing the occurrence of the other (Curtis *et al.*, 1985; Peeler *et al.*, 1994). For example, milk fever predisposes to the occurrence of dystocia, uterine prolapse, retained foetal membranes and downer cow syndrome (Erb *et al.*, 1985; Markusfeld, 1987; Ectemkamp and Gregory, 1999; Fleischer *et al.*, 2001). Dystocia is a predisposing factor to the development of puerperal metritis (Arthur *et al.*, 1996). A drop in the dry matter intake of cows during this period often occurs and this predisposes them to developing metabolic diseases such as ketosis (Roberts, 1986; Grummer, 1993; Arthur *et al.*, 1996).

1.2 Problem Statement

The conditions affecting dairy cattle during the periparturient period have been documented in various parts of the world (Roberts, 1986; Markusfeld, 1987; Radostits *et al.*, 2000). These reports have been based on large-scale dairy herds reared under intensive production systems where feed supplementation is also practiced.

There is limited information on the occurrence of these conditions in smallholder dairy production systems. Dystocia, retained placenta and milk fever have previously been reported in smallholder dairy herds in Kiambu District (Odima, 1994). Information on the occurrence of diseases such as uterine prolapse, downer cow syndrome, metritis, ketosis and mastitis in the smallholder production systems is lacking.

Since these diseases account for up to 8 percent of all the diseases affecting dairy cattle as has been reported in intensive large-scale herds in temperate countries, they might be of economic significance in smallholder herds. Smallholder dairy farming accounts for up to 80 percent of milk production in Kenya (M.O.A.R.D., 1992). Thus, suboptimal production due to these diseases will have a significant effect on the national milk production. This study was designed to determine the periparturient conditions affecting smallholder dairy cattle in Kikuyu Division of Kiambu District. Knowledge generated from this study will be used to design appropriate interventions and extension information, in order to improve on the socioeconomic well being of the farmers and the country as a whole.

1.3 Hypothesis

Periparturient conditions are important in the smallholder dairy production system in Kikuyu Division of Kiambu District.

1.4 Broad objective

Improve the productivity and performance of dairy cattle in smallholder production systems by identifying and seeking solutions to the periparturient conditions.

1.4.1 Specific objectives

1) To estimate the incidence of diseases affecting dairy cattle during the periparturient period in Kikuyu Division.

2) To determine their pattern of occurrence across seasons and agro-ecological zones.

3) To determine the herd level risk factors of the periparturient conditions.

CHAPTER 2 LITERATURE REVIEW

2.1 Retained after birth

This results from a lack of dehiscence of foetal membranes and failure of expulsion of the afterbirth within the duration of the physiological third stage labour; either due to insufficient uterine contraction or due to a placental lesion affecting the physical union between foetal villi and maternal crypts (Arthur *et al.*, 1996).

The condition affects most domestic animals but the incidence is highest in dairy cattle with a morbidity rate of 55-65 percent (Arthur *et al.*, 1996). The condition does not cause a high mortality in cattle but its main effect is on subsequent fertility due to delayed uterine involution and chronic metritis (Roberts, 1986).

Factors associated with increased incidence of the condition include twinning, abortion, nutritional deficiencies especially of vitamin A, E and the mineral selenium and infections of the uterus by diseases such as brucellosis, moulds and non-specific organisms that may lead to placentitis (Arthur *et al.*, 1996; Peeler *et al.*, 1994; Campbell and Miller, 1998; Ecternkamp and Gregory, 1999; Radostits *et al.*, 2000). Cows with retained placenta have also been reported to have neutrophils with reduced function (Kimura *et al.*, 2002).

The signs of the condition do vary depending on the severity of uterine disease. These include the placenta hanging outside the vulva opening, increased pulse and respiratory rates, fever, anorexia, diarrhoea, depression, straining and a foetid sanguino-purulent vaginal discharge (Arthur *et al.*, 1996).

Treatment is by manual removal and the use of systemic and local antibiotics. The uterus can also be flushed with saline and the exudates siphoned out. Ecbolics can also be

used but some authors do doubt their efficacy (Arthur *et al.*, 1996; Stevens and Dinsmore, 1997; Drillich *et al.*, 2003).

An incidence of retained afterbirth of 12.1, 4.2 and 7.6 percent has been reported in Kiambu district, smallholder herds in rural northern Tanzania and periurban farms in Lusaka, Zambia, respectively (Odima, 1994; Kanuya *et al.*, 2000; Ahmadu *et al.*, 2002). However, none of the studies related the occurrence of the condition to any factors nor did they determine its pattern of occurrence.

2.2 Dystocia

Dystocia means difficult birth. It is a common condition in cattle with an incidence of between 3-25 percent depending on the region. It can be divided into foetal or maternal dystocia depending on the cause (Roberts, 1986; Arthur *et al.*, 1996).

A prevalence of 8 percent has been reported in Kiambu District of Kenya (Odima, 1994) while an incidence of 1.7 percent and 3.9 percent has been reported in smallholder herds in northern Tanzania and peri-urban herds in Lusaka, Zambia, respectively (Kanuya *et al.*, 2000; Ahmadu *et al.*, 2002).

Foetal dystocia has been reported to be more common than maternal dystocia. Dystocia is also more common during the first delivery, when heavy male calves are delivered, when the dam is in close confinement, is overfed, underfed or bred too early (Arthur *et al.*, 1996).

The main causes of dystocia include maldispositions, simultaneous presentation of twins, uterine inertia, uterine torsion, incomplete dilatation of the birth canal and foetal monsters (Arthur *et al.*, 1996).

Though reports are available on the occurrence of this condition in the smallholder dairy production system in Kiambu District of Kenya, Tanzania and Lusaka, Zambia (Odima, 1994; Kanuya *et al.*, 2000; Ahmadu *et al.*, 2002), none of these reports has determined its pattern of occurrence nor the risk factors in this country.

2.3 Milk fever

Milk fever is a complex metabolic disorder that occurs at the onset of lactation. It is a common disease in adult cows with an estimated morbidity of 3.5 to 8 percent worldwide. It mainly occurs in high yielding adult cattle in their third to seventh lactation and is most common three weeks to parturition or three weeks after parturition (Radostits *et al.*, 2000).

The incidence of clinical milk fever is reported at 5-10 percent although the incidence of sub-clinical milk fever is reportedly much higher (Oetzel, 1991; Radostits *et al.*, 2000; Houe *et al.*, 2001; Whitaker *et al.*, 2004). An incidence of 0.1 percent was reported in Kiambu District and an incidence of 1.7 percent was reported in smallholder herds in rural Tanzania (Odima, 1994; Kanuya *et al.*, 2001).

The main risk factors of milk fever are nutritional especially the potassium- sodium and chloride-sulphur balance in blood and calcium levels of the feed pre-partum which affect the ionization of calcium in blood (Horst *et al.*, 1997). Management factors such as housing, pasturing, exercise, the length of the dry period, pre-partum milking, season of the year and climate have also been reported as possible risk factors (Goff and Horst, 1997[a]; Goff and Horst, 1997[b]; Horst *et al.*, 1997; Radostits *et al.*, 2000; Houe *et al.*, 2001; Goff *et al.*, 2004). The animal risk factors include increased parity/age, increased body condition score, production level and breed with the Jersey being the most susceptible

(Radostits *et* al., 1994; Horst *et al.*, 1997; Houe *et al.*, 2001). Sub-clinical hypomagnesaemia has also been reported to be a possible risk factor (Samsom *et al.*, 1983).

Milk fever occurs as a result of hypocalcaemia when the calcium homeostatic mechanisms fail to compensate the calcium lost from blood at the onset of lactation (Bhanugopan *et al.*, 2004). This leads to skeletal, cardiac and smooth muscle atony that causes a reduction in the stroke volume of the heart, blood pressure, cardiac output and reduced rumen and abomasal tone and motility. These are what lead to muscle weakness, hypothermia and depression of consciousness. If blood flow to skeletal muscle is reduced for a prolonged period, it may predispose to downer cow syndrome (Radostits *et al.*, 2000).

The clinical signs include ruminal atony and tympany, inactivity, general muscle weakness, dry muzzle, weak pulse and heart sounds, mental depression, hypothermia, dilated pupils with slow or absent pupillary light reflex and lateral recumbency often with a lateral kink of the neck (Horst *et al.*, 1997; Radostits *et al.*, 2000).

Milk fever leads to an increase in the incidence of dystocia due to uterine atony, an increase in the incidence of reproductive disorders such as uterine prolapse, metritis and repeat breeding syndrome. It also causes a reduction in milk yields and subsequently increases culling rates (Radostits *et al.*, 2000; Fleischer *et al.*, 2001; Houe *et al.*, 2001).

Parenteral administration of calcium salts is the treatment of choice. Prevention can be achieved by provision of oral calcium salt and vitamin D supplementation in addition to strict dietary regulation of the minerals calcium, phosphorus, sulphur, chlorides, potassium and sodium (Oetzel, 1991; Radostits *et al.*, 2000; Thilsing-Hansen *et al.*,

2002). Recent studies also suggest that high potassium levels in feed could be an important predisposing factor as it causes alkalosis that affects the ionization of calcium in blood resulting in hypocalcaemia despite adequate levels of parathyroid hormone (Goff and Horst, 1997[b]; Horst *et al.*, 1997).

Though there are reports on the occurrence of this condition in the smallholder dairy sector in Kenya (Odima, 1994), this study did not determine its pattern of occurrence nor the risk factors.

2.4 Downer cow syndrome

Downer cow syndrome most often occurs following milk fever in cattle (Radostits *et al.* 2000). The main risk factors are hypocalcaemia and stillbirths that have been shown to increase its incidence by five fold (Correa *et al.*, 1993). In addition, ischaemic myopathies, serum electrolyte imbalances especially of potassium ions, traumatic injuries to the pelvis and pelvic limbs and slippery floors are important risk factors (Cox, 1982; 1988; Correa *et al.*, 1993; Radostits *et al.*, 2000). Paralysis of the obturator, gluteal and peroneal nerves can predispose to the condition post calving.

Initially there is recumbency followed by secondary muscle and nerve damage due to tissue compression. This damage then leads to permanent recumbency even if the primary factors are reduced by therapeutic measures (Cox, 1982; Radostits *et al.*, 2000). Clinically, affected cows are unable to rise or make no attempts to do so. Cows that are unable to rise after 24 hours or after two treatments for milk fever can be classified as downer cows. Successful treatment is dependent on the degree of muscle damage and the incidence of the condition can be reduced by the early detection and treatment of milk fever (Radostits *et al.*, 2000).

The actual incidence of the condition may not be clear due to different diagnoses of recumbency as made by clinicians (Radostits *et al.*, 2000). No published reports are available on the incidence of this condition in Kenya.

2.5 Mastitis

Mastitis is an inflammation of the mammary gland characterized by physical and chemical changes in the milk, changes in the mammary gland and changes in the animal as a whole (Radostits *et al.*, 2000). Mastitis has been reported to be the most prevalent production disease in dairy herds world-wide and is important because it leads to losses attributable to reduced milk production, treatment costs, discarding of milk with antibiotics and culling of chronically affected animals that are refractory to treatment (Schalm *et al.*, 1971; Seegers *et al.*, 2003, Whitaker *et al.*, 2004; Wilson *et al.*, 2004). Clinical mastitis early in lactation has also been reported to have a negative effect on reproductive performance (Barker *et al.*, 1998).

Worldwide morbidity rates are estimated at 40 percent (Radostits *et al.*, 2000). An incidence rate of 5-8.4 percent has been reported in smallholder herds in rural northern Tanzania and in periurban farms in Lusaka, Zambia (Kanuya *et al.*, 2000; Ahmadu *et al.*, 2002). Another study in smallholder farms in Ungunja island of Zanzibar revealed an incidence of 68% quarter infection rate with the high incidence associated with poor hygiene (Gitau *et al.*, 2003). A high percentage of sub-clinical quarter infection was reported in Nyeri District of Kenya (Maina, 1984).

Mastitis has many causes but the main and most economically important of these are the infectious agents especially bacteria (Hillerton, 1996). These can be divided into contagious and environmental bacteria (Wright, 1983; Eberhart, 1986; Radostits *et al.*,

2000). The most common organisms in descending order in a Nyeri study were *Staphylococcus aureus*, *Streptococcus* species, *Klebsiella pneumoniae*, *Escherichia coli*, *Bacillus cereus*, *Pseudomonas aeruginosa*, yeasts and *Pasteurella multocida* (Maina, 1984). A quarter prevalence rate of 43.5 percent was reported in Kenya with multiple quarter infections present (Ngatia, 1988).

Staphylococci and gram-negative rod-shaped organisms were reported to be the most commonly isolated bacteria in clinical mastitis cases in Kiambu district and similar findings were seen in cases of subclinical mastitis in smallholder herds in Rift Valley (Omore, 1997; Ankalo and Gathoni, 2004). A high proportion of mastitis due to Gram-negative organisms has been reported to occur during the periparturient period and this has been attributed to the hyperketonaemia present during this phase of production (Harmon, in 1984; Janosi *et al.*, 2003; Huszenicza *et al.*, 2004). In addition, animals with milk fever have been reported to be eight times more likely to develop clinical Coliform mastitis relative to those with no milk fever (Curtis *et al.*, 1983).

Antibiotics are the main modes of treatment of clinical cases of mastitis. They are also used for control in the form of dry cow therapy since the incidence of new infection is higher during this period, but the use of this method among smallholder farmers is very low (Eberhart, 1986; Omore, 1997; Dingwell *et al.*, 2003). The development of resistance to antibiotics has been reported in various parts of the world. Multiple resistance to antimicrobials used in the treatment of mastitis has been reported in Nyeri District and Kabete area of Kiambu District (Maina, 1984; Mulei, 1990). This occurrence has also been reported in herds in Prince Edward Island, Canada (Chibeu, 1992). Resistance and

multiple resistance have been reported to thrive when antibiotics are misused or when there is poor hygiene (Catry *et al.* 2003).

Changing patterns of the microbial agents causing mastitis and their sensitivity patterns have been reported (Wright, 1983) justifying the need to do a study to find out the current state in Kenya. However, none of the above studies specifically dealt with mastitis occurring during the periparturient period in the smallholder dairy cattle production system.

2.6 Puerperal metritis

This condition occurs within the first 2-10 days of parturition. It normally follows an abnormal first or second stage labour. The main predisposing factors are uterine atony, inertia and retained placenta (Roberts, 1986; Arthur *et al.*, 1996).

The condition is often a sequel to foetal emphysema, foetal anasarca, foetal gigantism and twinning all of which predispose to uterine inertia (Roberts, 1986). The condition can also occur because of an extension of necrotic vaginitis or following unsanitary practices in the removal of retained placenta or relief of dystocia (Roberts, 1986). Parity, season, other reproductive disorders and treatment for dystocia have also been reported as predisposing factors (Bruun *et al.*, 2002).

Microorganisms colonize the non-involuted uterus, proliferate and start producing toxins, which are then absorbed by the host. The most commonly isolated organisms in cattle are *Fusiformis pyogenes* and *Fusobacterium necrophorum* (Roberts, 1986; Arthur *et al.*, 1996).

The main clinical signs include a fetid, reddish, serous vaginal discharge, frequent straining by the cow, pyrexia in the early stages but normal or subnormal temperatures in

the later stages, rapid weak pulse, diarrhoea and an inflamed oedematous vulva and vagina. The cow is also often very weak, staggering or prostrate. Treatment involves the use of antibiotics and uterine lavage to help rid it of the toxic uterine contents (Roberts, 1986; Arthur *et al.*, 1996; Chenault *et al.*, 2004).

This disease is important because it leads to a prolonged calving to conception interval and an increase in the rate of services per conception thus leading to reduced reproductive performance and culling may also result (Kim and Kang, 2003; Kaczmarowski *et al.*, 2004). An incidence of 8 percent was reported for metritis in dairy herds in Kiambu District (Odima, 1994) and 15.5 percent in the central highlands of Ethiopia (Shiferaw *et al.*, 2005). No published reports are available on the occurrence of puerperal metritis in Kenya.

2.7 Lacerations, contusions, uterine and vaginal ruptures and tears (injuries)

These often occur in the second stage of labour. Minor lacerations and tears are common in the vulva and cervix following treatment of dystocia by traction or fetotomy. Lacerations on the vulva lead to pain, persistent straining and wind sucking which predisposes the cow to developing metritis (Roberts, 1986). Clinically, injuries to the birth canal can be diagnosed by careful examination of the vulva. There are no reports on the occurrence of this condition in Kenya.

Uterine and vaginal ruptures and tears commonly occur secondary to prolonged dystocia with foetal emphysema, torsion of the uterus, when improper manipulations are performed and when traction is applied to relieve dystocia. Foetal malpresentations also predispose to the occurrence of the condition (Roberts, 1986).

The signs vary with the type and position of the tear. If the tear extends into the peritoneal cavity, secondary peritonitis may occur. Abdominal viscera may also herniate through the tear and can be seen or felt during vaginal examination. The prognosis is often guarded to poor for the animal. There are no published reports on the incidence of these conditions in the tropics including Kenya.

2.8 Stillbirth

Stillbirth is a calf that dies prior, during or within 24 hours of parturition (Phillipson *et al.*, 1979) Dystocia has been implicated as the main cause of this condition (Meyer *et al.*, 2000). In addition, the birth of a male calf and increased size of the foetus have also been implicated as predisposing factors (Meyer *et al.*, 2000; Hansen *et al.*, 2004). An incidence of 7 percent has been reported in dairy cattle herds in the United States of America (Meyer *et al.*, 2000). However, there are no published reports on the occurrence of stillbirths in Kenya.

2.9 Uterine and vaginal prolapse

This is a common complication of the third stage of labour. Incidences of between 0.09 to 3 percent have previously been reported in intensively managed dairy cattle herds in temperate countries (Markusfeld, 1987; Gardner *et al.*, 1990). The disease is more common in pluriparous cows and often occurs within a few hours after calving (Roberts, 1986; Gardner *et al.*, 1990; Arthur *et al.*, 1996).

The main risk factor to the occurrence of this condition is uterine inertia due to hypocalcaemia (Risco *et al.*, 1984). A low plane of nutrition and excess dietary estrogens are also thought to play a role (Roberts, 1986; Arthur *et al.*, 1996). Forced extraction of

the foetus with the uterus tightly contracted around a dry foetus can also result in uterine prolapse (Roberts, 1986).

The clinical signs are obvious since the prolapsed organ is seen hanging outside the vulva opening. Treatment is achieved by replacing the organ and maintaining it with perivulva sutures. In addition, antibiotics, oxytocin and calcium salts can be given. Amputation is done if the organ has severe detrimental changes (Roberts, 1986; Gardner *et al.*, 1990; Arthur *et al.*, 1996). Recovery and survival rates are high and better prognosis is observed with early treatment, in primiparous cows and cows that have not experienced third stage milk fever (Gardner *et al.*, 1990).

This condition is important because it leads to losses associated with the costs of treatment and infertility due to endometritis. There is also loss of genetic material if the affected animal is culled, dies or if the organ is amputated as a method of treatment. No published reports are available on the incidence of this condition in Kenya.

2.10 Post partum haemorrhage

This condition may follow trauma, lacerations or rupture of genital organs. Premature dehiscence of the placenta may also cause it (Roberts, 1986; Arthur *et al.*, 1996). The condition most often occurs as a sequel to dystocia and the bleeding may either be intrauterine, intrapelvic or intraperitoneal (Roberts, 1986).

The clinical signs do vary depending on the severity of the haemorrhage. They include blood oozing at the vulva, paleness of mucous membranes, weakness, depression, tachypnoea and tachycardia and if very severe sudden death (Roberts, 1986; Arthur *et al.*, 1996). Most fatal haemorrhages are intraperitoneal and occur as a sequel to rupture of

blood vessels following degenerative changes on the vessel wall (Roberts, 1986; Pascoe, 1979; Rooney, 1964).

Postpartum haemorrhage resulting in sudden death following rupture of blood vessels has been documented in Kenya (Njenga and Tsuma, 2004). However, the incidence of this condition has not been determined, nor are there reports on postpartum haemorrhage due to the other causes in Kenya.

2.11 Physiological oedema

This condition is common in high producing dairy cattle occurring pre- and postpartum (Roberts, 1986; Arthur *et al.*, 1996). It is caused by increased blood supply to the mammary gland than the venous system can accommodate (Roberts, 1986).

Clinical signs include swelling around the udder that occasionally can extend from the area just ventral to the vulva up to the sternum. This condition results in pain and discomfort to the animal and can also lead to skin necrosis, failure of milk letdown and long-term damage of the udder's support structure (Roberts, 1986). There is no information on the incidence of this condition in Kenya.

2.12 Ketosis

This is a multifactorial disorder of energy metabolism representing an incomplete combustion of fatty acids during their hepatic utilization (Radostits *et al.*, 2000). Previous studies revealed an incidence of between 3.3 and 7.4 percent (Radostits *et al.*, 2000).

A body condition score of 3.5 or higher at calving has been associated with increased risk of developing ketosis. In addition, primiparous cows are at reduced risk compared to pluriparous cows (Gillund *et al.*, 2001; Busato *et al.*, 2002).

The increased energy requirements in late gestation and early lactation superimposed on an animal with reduced dry matter intake in late gestation, lead to a negative energy balance. These make periparturient cows more susceptible to ketosis and hepatic lipidosis since maximum milk production peaks before maximum dry matter intake at 4 weeks (Grummer, 1993; Gerloff, 2000; Radostits *et al.*, 2000; Kim and Suh, 2003).

Clinical signs include wasting, decreased appetite and milk yield over 2-4 days, ketone odour in breath and milk, nervous signs with staggering, apparent blindness, head pushing, aimless movements and chewing movements with salivation (Radostits *et al.*, 2000). Indigestion, liver disease or combinations of these are also major causes of reduced appetite in early lactation and should be considered before making a presumptive diagnosis of ketosis (Steen, 2001).

Field tests have been developed for detecting ketosis. Urine and milk are the most common test samples used with the latter preferred because it is easier to obtain and has an overall better test characteristic (Nielen *et al.*, 1994; Geishauser *et al.*, 2000). The Rothera test was previously used but currently newer tests such as the ketolac test strip that are more sensitive are used (Nielen *et al.*, 1994, Geishauser *et al.*, 1998; Jorritsma *et al.*, 1998; Geishauser *et al.*, 2000). Guttzwiller (1998) reported that there was a correlation of results from test strips and analyzers when used to test beta hydroxybutyrate levels in milk. Although the incidence of the condition has been reported in other countries/production systems, no reports exist for the smallholder herds in Kenya.

2.13 Cystic ovarian disease

Cystic ovarian disease occurs when the ovaries contain one or more fluid filled structures greater than 2.5 cm in diameter lasting for more than 10 days (Jubb *et al.*, 1985; Roberts, 1986; Arthur *et al.*, 1996). The disease results from a failure of the hypophysis to release sufficient luteinizing hormone for ovulation and proper development of a corpus luteum. This can either lead to the formation of a follicular cyst or a luteal cyst depending on the levels of luteinizing hormone.

Sixty percent of cows have been shown to develop cysts before the first post partum ovulation but these normally regress spontaneously. Among the predisposing factors are periparturient stress, genetic predisposition, breed predisposition and level of production where the disease is more prevalent in high yielders (Roberts, 1986; Arthur *et al.*, 1996)

The clinical signs include acyclicity, nymphomania, short interestrus intervals, vulva oedema, sinking of the sacrosciatic ligaments which cause the tail head to be elevated, masculinization and anoestrus (Jubb *et al.*, 1985; Roberts, 1986; Arthur *et al.*, 1996). Follicular cysts are more common and are thin walled when palpated per rectum while luteal cysts are thick walled due to the lining of luteal tissue (Arthur *et al.*, 1996). In temperate countries, the condition is reported to occur most often during the winter months when the cows are confined indoors (Roberts, 1986). However, there are no published reports on the occurrence of this condition in the dairy production systems in Kenya.

2.14 Uterine torsion

This is a common condition in housed cattle in temperate countries with 90 percent of the cases being observed just prior to parturition as a cause of dystocia. It occurs when a gravid uterus twists along its longitudinal axis. An incidence rate of between 7.0-7.3 percent was reported at the New York State Veterinary College (Roberts, 1986). In a North American study, it was reported that there was no effect of season on the occurrence of this condition and that most torsions involved heavy calves, 67 percent of which were male (Frazer *et al.*, 1996).

The clinical signs include restlessness, colic, tail switching. Tenesmus may be absent, mild or intermittent. In advanced cases having uterine gangrene or rupture, signs of toxaemia, depression, weakness and prostration occur. On vaginal examination, one may feel the direction of the torsion at the cervix and vagina and foetal parts. In more severe cases, the dorsal commisure of the vulva may be displaced to the left or right and it may be impossible to pass the hand through the birth canal (Roberts, 1986; Arthur *et al.*, 1996). Frazer *et al.* (1996) reported that 34 percent of the torsions in a North American study were pre-cervical, 57 percent were between 180^0-270^0 turns while 22 percent were 271^0-360^0 turns. They also reported that the cow survival rate was 78 percent. Uterine rupture, peritonitis, foetal emphysema and maceration may result sequel to this condition and they worsen the prognosis (Roberts, 1986).

Treatment is achieved by correcting the torsion either by rolling the dam, rotation of the foetus and uterus through the birth canal or by caesarian section (Roberts, 1986). There is no published information on the occurrence of this condition in Kenya.

2.15 Abomasal displacement

This condition commonly occurs within one month of parturition. It is a multifactorial condition caused by hypomotility and gaseous dilatation of the abomasum. The disease is more prevalent in large sized high producing adult cattle immediately post-partum though few cases occur prepartum (Radostits *et al.*, 2000).

The main risk factors are high-level grain feeding with low crude fibre in the diet, ketosis, increased age, high milk yield potential, late pregnancy, hypocalcaemia and genetic predisposition (Radostits *et al.*, 2000; Melendez *et al.*, 2003). This disease is important because it leads to reduced milk production and can cause mortalities. Other losses are due to the costs of treatment.

The clinical signs presented depend on the type of displacement. General signs are reduced appetite, reduced milk production, reduced frequency and intensity of rumen movement and reduced faecal volume with the faeces being much softer than normal or profuse diarrhoea (Radostits *et al.*, 2000). In left displacement of the abomasum (L.D.A.), high-pitched sounds will be picked from the area bordered by the middle of the paralumbar fossa up to just behind the left elbow. The left lateral abdominal wall will also appear slab sided. In right displacement of the abomasum (R.D.A.), there will be distension of the right abdomen, absence of rumination, high pitched sounds over the 9^{th} – 13^{th} rib and on rectal examination one can palpate the distended abomasum (Radostits *et al.*, 2000).

When abomasal volvulus occurs, the clinical signs are more severe due to vascular compromise. These include tachycardia, depression, weakness, toxaemia and dehydration. If the animal is not treated, it becomes recumbent in 48-72 hours and death

results from dehydration and shock or it can be sudden if the abomasum ruptures (Radostits *et al.*, 2000).

In Ontario, Canada, an incidence rate of 2 percent has been reported in dairy herds while in Denmark the range of occurrence is between 0.2 and 1.6 percent (Radostits *et al.*, 2000). There are no published reports on the occurrence of this disease in Kenya.

CHAPTER 3 MATERIALS AND METHODS

3.1 Study area

This study was carried out in Kikuyu Division of Kiambu District. It has an area of 239.7Km^2. The division is divided into two main agroecological zones, the lower highland, i.e. altitude between 1820 to 2070 m above sea level and the upper midland, i.e. altitude between 1200-1820 m above sea level. Temperatures are mainly determined by altitude ranging from 16.4°C to 18.0°C in the lower highland and 18.0 °C to 21.9 °C in the upper midland agro-ecological zone.

The rainfall in this area is bimodal and reliable with the long rains occurring between the months of April-May while the short rains occur from October to November. Average rainfall is 800-2000mm/annum and 600-1600mm/annum in the lower highland and upper midland agro-ecological zones, respectively. The total cattle population in this area is 35,000 most of them being dairy cattle that are intensively reared (K.D.D.P., 1997).

3.2 Selection of study farms and animals

Farms were purposively selected based on the presence of at least one pregnant animal in the herd and the farmers' willingness to participate in the study. Smallholder farms were considered as those having $\leq$ 10dairy cattle. A pregnancy diagnosis test was performed on cows and heifers before being recruited into the study and those found to be 3 - 8 months pregnant were recruited. One hundred and seventeen farms were recruited into the study. Two hundred and six animals were selected from the study area. Monthly visits were carried out for pregnant animals that had not entered the periparturient period (> 3 wks prior to parturition and weekly visits as soon as the animals entered the periparturient period (3 weeks before and 3 weeks after parturition).

3.3 Data collection

Data collection began on 15.4.04 and ended on 30.12.04. The wet season was from 15th April to 8th June and 9th October to 22nd November while the dry season was from 9th June to 8th October and 23rd November to 31st December.

3.3.1 Farm and management data

Farm visits were organized in consultation with the farmers. These visits were carried out during the dry and wet seasons. Monthly visits were carried out upon recruitment and weekly visits as soon as the cows/heifers entered the periparturient period.

During the first visit to the farm, baseline data were collected by direct observation and administration of a semi-structured questionnaire via personal interviews. The data collected included the farm location, management system, herd structure, feeding system and breeding practices. The level of hygiene and maintenance of farm structures were scored as good, fair or poor (Appendix 1).

During the initial and subsequent visits, detailed data about individual cows participating in the study were collected using a clinical record form (Appendix 2). This included animal identification, its reproductive history, present medical and fertility status determined by careful clinical examination and the body condition scored as 1-5 according to the method described by Radostits *et al.* (1994). A rectal examination was performed to determine the pregnancy status, age of pregnancy and the presence or absence of uterine infection post partum. The udder was carefully examined for size, symmetry and warmth.

3.3.2 Retained placenta

Occurrence of retained placenta was based on the history of a placenta that had not dropped within 8-12 hours after calving and observation of the placenta hanging outside the vaginal opening or physical palpation per-vaginum.

3.3.3 Dystocia

Occurrence of dystocia was based on the history of occurrence from the farmer and clinical examination of the dam and foetus to determine the type and the cause of the dystocia.

3.3.4 Milk fever

Occurrence of milk fever was determined based on history of occurence and clinical signs observed. These included reduced rectal temperature, mental state, dry muzzle, weak pulse and heart sounds, generalized muscle weakness, ruminal atony and tympany, dilation of pupils with slow pupillary light reflex and recumbency.

3.3.5 Downer cow syndrome

Animals that were unable to rise after 24 hours of recumbency or unresponsive to treatment for milk fever were termed downer cows. Their demeanour, posture, reflexes and appetite were used to determine their prognosis. Nerve paralyses were determined based on the history and clinical signs of lameness and lack of sensitivity of the limbs.

3.3.6 Mastitis

Occurrence of mastitis was determined based on history of occurrence from the farmer and gross changes in the udder, milk and the animal. A California Mastitis Test (C.M.T.) was performed using a C.M.T. paddle and reagent. The milk was scored and milk from suspect quarters sent to the laboratory for culture and sensitivity testing.

Individual quarter foremilk samples from suspect quarters were collected after carefully washing the udder with a disinfectant solution (Savlon^{R} antiseptic, Pharmedica laboratories, South Africa). The udder was then dried with disposable paper towels and the tip of the teat swabbed with ethanol (70% w/v). A sterile universal bottle was used to collect 10 mls. of the milk sample. The samples were kept in a cool box for transportation to the laboratory as previously recommended (Brar *et al.*, 2000).

Immediately after delivery, the milk samples were inoculated on blood agar plates (Biotec Lab. Limited. U.K.). A flame sterilized wire loop was dipped into each milk sample and a total of 12-14 lines made in one agar plate. Samples were incubated under aerobic conditions for 24-72 h at 37°C and examined for bacterial growth. Pure cultures were further examined for morphological staining, cultural characteristics and for biochemical reactions.

Habdisks^{R} (Abtek Biologicals Limited. Liverpool) were used for sensitivity testing. They were tested for sensitivity to ampicillin, ampiclox, cefaclor, kanamycin, tetracycline, norfloxacine, cotrimoxazole, streptomycin, gentamicin, sulphamethoxazole and chloramphenicol.

3.3.7 Puerperal metritis

Occurrence of puerperal metritis was determined based on the history of occurrence, general examination for the presence of fetid vaginal discharges, straining by the cow, inflammation and oedema of the vulva and rectal examination of the uterus for its size and contents.

3.3.8 Lacerations, contusions, uterine and vaginal tears and ruptures (Injuries)

Occurrence of these was based on history from the farmer and careful examination of the vulva, vagina, uterus and perineum for tears and injuries.

3.3.9 Stillbirth

Occurrence of stillbirths was based on observation and history of birth of a dead foetus at term or within 24 hours after birth.

3.3.10 Uterine and vaginal prolapse

Occurrence of uterine and vaginal prolapse was determined based on the history of occurrence from the farmer and the clinical observation of the organ hanging outside the vulva opening.

3.3.11 Postpartum haemorrhage

Occurrence of this condition was based on history from the farmer and clinical signs of blood oozing from the vulva, pale mucous membranes, tachycardia and tachypnoea

3.3.12 Physiological oedema

Occurrence of this condition was based on history of occurrence and clinical examination of oedematous swelling around the udder.

3.3.13 Ketosis

Occurrence of ketosis was determined using clinical signs of wasting, decreased or selective appetite preferring to eat roughage and less concentrate, ketone odour in breath and milk and nervous signs. Tests were also performed on urine to confirm the occurrence of ketosis using dipsticks. Ten millilitres of urine was collected into a test

tube and the dipstick dipped into the urine sample for five seconds and the reading done immediately on a scale. They were classified as either negative, +, ++ or +++ depending on the levels of ketones (Combur[10] Test; Boehringer, Mannheim).

3.3.14 Cystic ovarian disease

Occurrence of cystic ovarian disease was based on history, palpation of ovaries and detection of a cyst that is greater than 2.5 cm. in diameter and lasts for more than 10 days. Those that were thin walled were classified as follicular cysts while those that were thick-walled were classified as luteal cysts. In addition, clinical signs and history of anoestrus, nymphomania, sinking of sacrosciatic ligaments, masculinization and short inter-estrus intervals were also considered.

3.3.15 Uterine torsion

Occurrence of uterine torsion was based on history of a cow in the second stage of labour that had been unable to deliver for a prolonged period and clinical examination of the birth canal for twists in the cervix and vagina or occlusion. A rectal palpation was performed to determine the direction of the torsion and tension on the broad ligament was used to gauge the severity.

3.3.16 Displaced abomasum

Occurrence of abomasal displacements was based on history and clinical signs of inappetance, reduction in frequency and intensity of rumen movements, high pitched tinkling sounds in the left or right side in the area around the 9^{th}-13^{th} ribs and rectal palpation for right displacement of the abomasum.

Information from subsequent visits was recorded in an individual animal follow up record (Appendix 3).

3.4 Data management

The occurrence of disease was only considered once per animal even if there was recurrence during the study period. Data was entered and stored in Microsoft Office Excel 2003 (Microsoft Corporation, 2003).

3.4.1 Data analysis

The data was imported into Genstat for Windows Discovery Edition 2 (VSN international). Descriptive statistics were computed for

- Age
- Parity
- Breed
- Sex of offspring
- Agro-ecological zone
- Season
- Feeding system
- Supplemental feeding
- Management system

Incidence of the periparturient conditions were calculated as

$$\text{Lactational incidence risk (L.I.R.)} = \frac{\text{Number experiencing disease during the time period}}{\text{Initial number at risk}}$$

(Kelton *et al.*, 1998)

The χ^2 statistic was used to determine unconditional associations between predictor variables and periparturient conditions with a cut off point of $P < 0.05$

3.4.2 Modelling for potential risk factors of periparturient conditions

Multiple logistic regression procedure was carried out in Genstat to model the effects of potential risk factors on the occurrence of periparturient conditions. A backward elimination procedure was used to model the main effects and interaction effects on the hypothesized risk factors. Interaction term was modelled as a cross-product variable between the variables for which interaction was suspected.

Factors that were found significant ($P \leq 0.05$) were retained in the final model. The odds-ratio (O.R) as a measure of the strength of the association between the significant variables ($P \leq 0.05$) and the outcome was calculated as the reciprocal of the antilogit of the estimate for that variable. Interaction and confounding between the factors/variables were controlled analytically in the logistic regression modelling.

CHAPTER 4 RESULTS

4.1 Descriptive statistics

4.1.1. Response rate

Most (88.6%; 117/132) smallholder farmers interviewed were willing to participate in the study. Sixty out of the 117 (51 %) included in the study were willing to give detailed information on their production practices.

4.1.2. Number of animals

Two hundred and six heifers/cows from 117 farms were included in the study. Fifty one (24.76%) of them were heifers while 155 (75.24 %) had a parity of ≥ 1 on inclusion into the study. Most (66.88%; 138/206) animals developed at least one of the periparturient conditions under study.

4.1.3. Agro ecological zones

Most (73%; 150/206) animals examined were in the lower highland agro-ecological zone while 27 % (56/206) were in the upper midland agro-ecological zone (Plates 2 and 3).

4.1.4. Pregnancy diagnosis

The methods of pregnancy diagnosis as used on smallholder dairy cattle farms are shown in Table 4.1. Combinations of failure to return to heat and abdominal distension were used by most (43.3 %; 26) farmers. Few (15%; (9/60) farmers exclusively relied on pregnancy diagnosis performed by veterinarians.

4.1.5. Animal variables

Of the 206 cows/heifers studied, the median age was 5.0 years with a range of 2-15 years. The parity of 192/206 (93 %) cows/heifers from the study was determined. The median

parity was 2.5 with a range of 1-9. The average body condition score of the cows and heifers in this study was 2.8.

4.1.6. Distribution of breeds

The breeds of dairy cattle kept by smallholder farmers is summarised in Table 4.2. Of the 206 cows/heifers in the study, Friesian and its crosses were the most (65%; 133/206) common breed encountered.

4.1.7. Offspring

One hundred and seventeen male offspring were born during the study period while 93 were female. Five cases of twinning out of 205 parturitions were encountered during the study.

Plate 4.1 Semi restricted grazing dairy cattle in a smallholder farm in the upper midland agro-ecological zone of Kikuyu Division, Kiambu district (2004).

Pplate 4.2 Stall fed dairy cattle in a smallholder farm in the lower highland agro-ecological zone in Kikuyu Division, Kiambu District (May 2004).

Table 4.1 Methods of pregnancy diagnosis used on smallholder dairy cattle farms in Kikuyu Division, Kiambu District (April 2004-December 2004)

Method used	Count	Percentage
Lack of heat	12	20
Lack of heat + abdominal distension	11	18.3
Veterinarian	9	15
Inseminator	6	10
Lack of heat + inseminator	5	8.3
Lack of heat +Vet.	4	6.7
Lack of heat + abdominal distension + udder development	3	5
Abdominal distension	3	5
Vet.+ inseminator	3	5
Lack of heat + Vet. + inseminator	1	1.7
Lack of heat + Inseminator + Abdominal distension	1	1.7
Unknown	2	3.3
Total	60	100.0

Table 4.2 Breeds of dairy cattle kept by smallholder farmers in Kikuyu Division, Kiambu District (April 2004-December 2004).

Breed	Count	Percentage
Friesian + crosses	133	64.56
Ayrshire + crosses	54	26.21
Jersey + crosses	12	5.83
Guernsey + crosses	5	2.43
Zebu dairy crosses	2	0.97
Total	206	100.0

4.2 Preventive practices

Deworming was the most common routine management practice and was carried out by 82% (49/60) of the interviewed smallholder farmers. Only 5% of the farmers vaccinated their animals against diseases, mainly foot and mouth disease. Vaccination was carried out by the Veterinary Department, Ministry of Livestock and Fisheries Development. Fifty eight percent of the farmers practiced routine tick control; this was mainly done using Amitraz based acaricides and applied either by hand washing or using a knapsack sprayer. Steaming-up was carried out in 38% (23/60) of the farms and dry cow therapy was practiced by 5% (3/60) of the farms. None of the farms disinfected their stalls. Few (30%) farmers kept adequate records. Twenty eight percent of the farmers kept inadequate records that included mainly the date of service and production records. Forty two percent of the farmers kept no records at all.

4.3 Breeding method

Most (93.6%, 193/206), animals were bred by artificial insemination (Plate 4) while natural service was the least popular method of breeding being used on 6.3 % (13/206) of the animals. Local semen was used to breed 74.8 % (154/206) of the animals while imported semen was used to breed 18.9 % (39/206) of the animals.

4.4 Feeding systems and feeding

Most (77 %, 158/206) of the animals were stall-fed while 20% (42/206) were reared by open grazing. Only 3 % (6/206) of the animals were reared in a mixed system where they practiced both open and stall-feeding.

Grass (*Chloris gayana*, *Pennisetum clandestinum)*, napier grass (*Pennisetum purpureum)* and maize stover (*Zea mays)* combinations were the most common

roughages fed to cattle (45%) followed by grass and napier combination (43.3%), grass and maize stover (6.68%), grass only (3.33%) and napier alone (1.66%) (Table 4.3.1). Concentrate feeding was done by most of the farmers (91.7%) in various combinations as shown in Table 4.4. However, 46 % of the farms consistently fed supplements to their cows while 54 % were erratic.

4.5 Farm structures

Twenty five percent of the farmers kept their animals in permanent structures with a well enclosed wall and concrete floors; 46.6% of the farmers had semi-permanent structures consisting of a stone floor and walls made of wood or iron sheets, and 26.7% of the farmers kept their animals in temporary housing with earthen floors and walls made out of iron sheets or timber. Only one farmer (1.7%) had no structures constructed for the animal. Forty percent of the farmers had well maintained farm structures while 58.3 percent had poorly maintained structures with cracked walls, missing wooden slats and rotten timber. The level of hygiene was worse during the wet season relative to the dry season especially in housing structures with earthen floors.

4.6 Water sources

Piped water, rain and boreholes were the main sources with very few farmers using river water (Table 4.5)

Table 4.3 Feed types and practices in 117 smallholder dairy cattle farms in Kikuyu Division, Kiambu District (April 2004-December 2004)

Table 4.3.1 Types of roughage fed to dairy cattle in small holder farms in Kikuyu Division, Kiambu District (April 2004-December 2004)

Type of roughage	Count	Percentage
Grass + napier + Maize stover	27	45.00
Grass + napier	26	43.33
Grass + maize stover	4	6.68
Grass only	2	3.33
Napier only	1	1.66
Total	60	100.0

Table 4.4 Types of concentrates fed to dairy cattle in the smallholder production system in Kikuyu Division, Kiambu District (April 2004-December 2004)

Concentrate fed	Count	Percentage
Dairy meal + maize germ + minerals	17	28.33
Dairy meal + minerals	10	16.67
Dairy meal only	6	10.00
Maize germ + minerals	5	8.33
Minerals only	5	8.33
Maize germ only	3	5.00
Dairy meal + others	3	5.00
Dairy meal + minerals + others	2	3.33
Maize germ + minerals + others	2	3.33
Dairy meal + maize germ	1	1.67
Dairy meal + maize germ + minerals + others	1	1.67
No supplementation	5	8.33
Total	60	100

Others = Horticultural waste, fishmeal, cotton seed cake, soya bean meal and poultry manure.

Table 4.5 Sources of water for cattle in the smallholder dairy production system in Kikuyu Division, Kiambu District (April 2004-December 2004)

Water source	Count	Percentage
Piped water	24	40.00
Piped water + rain	19	31.67
Bore hole	5	8.34
River only	4	6.67
Piped water + Borehole	2	3.33
Piped water + Borehole + rain	2	3.33
Piped water + River	2	3.33
Rain only	2	3.33
Total	60	100.00

Plate 4.3 Poor hygienic conditions in a smallholder dairy cattle pen during the wet season in Kikuyu Division of Kiambu District (May 2004).

Plate 4.4 Artificial insemination used as a method of service in a smallholder dairy cattle farm in Kikuyu Division, Kiambu District (2004).

4.7 Periparturient disease incidence

Most (66.99%, 138/206), animals developed at least one of the periparturient conditions under study. The most common conditions encountered were retained placenta (28.16 %, 58/206), dystocia (13.59 %, 28/206) and milk fever (11.16%, 23/206) while the least common were ketosis, cystic ovarian disease and uterine torsion all with an incidence of 0.49 % (Plates 5-16). (Table 4.6).

4.7.1 Distribution of periparturient diseases across seasons

The incidence of milk fever, uterine prolapse, periparturient haemorrhage and stillbirths were higher in the dry season compared to the wet season. The incidence of downer cow syndrome, retained afterbirth, metritis and mastitis were higher in the wet season compared to the dry season (Table 4.7).

4.7.2 Distribution of diseases across agro-ecological zones

The incidence of retained afterbirth, metritis, birth canal injuries and stillbirths were higher in agro-ecological zone 1 (Lower highland - Altitude 1820-2070 m above sea level) while the incidence of downer cow syndrome and physiological oedema were higher in agro-ecological zone 2 (Upper midland - Altitude 1200-1820 m above sea level) (Table 4.8).

4.7.3 Distribution of the diseases across breeds

The conditions under study were analyzed for distribution among the five breed groups encountered. Friesians that were the most common breeds developed all the conditions apart from ketosis and displaced abomasum. Zebu crosses, which were the least common breed developed only retained afterbirth and not the other conditions. The rest of the breeds developed the various conditions in varying proportions as presented in Table 4.9.

Table 4.6 Herd incidence of periparturient conditions in smallholder dairy cattle herds in Kikuyu Division, Kiambu District (April 2004-December 2004)

Disease/condition	Number of animals	Herd incidence (%)
Retained placenta	58	28.16
Dystocia	28	13.59
Milk fever	23	11.16
Mastitis	20	9.7
Downer cow syndrome	18	8.73
Metritis	13	6.31
Stillbirth	12	5.83
Injuries to the birth canal	9	4.37
Uterine and vaginal prolapse	8	3.88
Physiological oedema	8	3.88
Postpartum haemorrhage	5	3.22
Nerve paralysis	2	0.97
Ketosis	1	0.49
Cystic ovarian disease	1	0.49
Uterine torsion	1	0.49
Displaced abomasum	0	0.00

Table 4.7. The incidence of periparturient conditions across seasons encountered in smallholder dairy cattle herds in Kikuyu Division, Kiambu District (April 2004-December 2004).

Disease	Season	# cases	Incidence (%)
Retained afterbirth	Wet	24	25.80
	Dry	34	21.24
Dystocia	Wet	12	17.20
	Dry	16	10.62
Milk fever	Wet	8	8.60
	Dry	15	13.27
Downer cow syndrome	Wet	10	10.75
	Dry	8	7.07
Mastitis	Wet	15	16.13
	Dry	5	4.42
Metritis	Wet	8	8.60
	Dry	5	4.42
Injuries to the birth canal	Wet	4	4.30
	Dry	5	4.42
Stillbirths	Wet	4	4.30
	Dry	8	7.08
Uterine and vaginal Prolapse	Wet	3	3.22
	Dry	5	4.22
Postpartum haemorrhage	Wet	1	1.07
	Dry	4	3.54
Physiological oedema	Wet	3	3.22
	Dry	5	4.22
Nerve paralysis	Wet	1	0.88
	Dry	1	1.07
Ketosis	Wet	1	1.07
	Dry	0	0.00
Cystic ovarian disease	Wet	0	0.00
	Dry	1	0.88
Uterine torsion	Wet	1	1.07
	Dry	0	0.00
Displaced abomasum	Wet	0	0.00
	Dry	0	0.00

Table 4.8 Distribution of periparturient conditions across agro-ecological zones smallholder dairy cattle herds in Kikuyu Division, Kiambu District (April 2004-December 2004).

Disease	A.E.Z.	# cases	Incidence (%)
Retained placenta	1	46	30.66
	2	12	21.42
Dystocia	1	22	14.66
	2	6	10.71
Milk fever	1	17	11.33
	2	6	10.71
Downer cow syndrome	1	5	3.33
	2	13	23.21
Mastitis	1	15	10.00
	2	5	8.92
Metritis	1	12	8.00
	2	1	1.78
Injuries to the birth canal	1	8	5.33
	2	1	1.78
Stillbirths	1	11	7.33
	2	1	1.78
Uterine and vaginal prolapse	1	7	4.60
	2	1	1.78
Postpartum haemorrhage	1	3	2.00
	2	2	1.78
Physiological oedema	1	4	2.66
	2	4	7.14
Nerve paralysis	1	2	1.33
	2	0	0.00
Ketosis	1	1	0.66
	2	0	0.00
Cystic ovarian disease	1	1	0.66
	2	0	0.00
Uterine torsion	1	1	0.66
	2	0	0.00
Displaced abomasum	1	0	0.00
	2	0	0.00

Key

A.E.Z. – Agro ecological zone.
Agro-ecological zone 1 - Lower highland - Altitude 1820-2700m above sea level.
Agro-ecological zone 2 - Upper midland - Altitude 1200m-1820m above sea level.

Table 4.9 Distribution of periparturient conditions across breeds in smallholder dairy cattle herds in Kikuyu Division, Kiambu District (April 2004-December 2004).

Disease	Friesian + crosses.	Ayrshire + crosses	Jersey + crosses	Guernsey + crosses	Zebu crosses
Retained placenta	29	17	8	3	1
Dystocia	14	8	4	2	0
Milk fever	16	6	1	0	0
Downer cow syndrome	14	3	0	1	0
Mastitis	14	5	0	1	0
Metritis	7	4	1	1	0
Injuries to the birth canal	7	2	0	0	0
Stillbirths	5	6	1	0	0
Uterine and vaginal prolapse	7	1	0	0	0
Postpartum haemorrhage	3	2	0	0	0
Physiological oedema	8	0	0	0	0
Nerve paralysis	2	0	0	0	0
Ketosis	0	1	0	0	0
Cystic ovarian disease	1	0	0	0	0
Uterine torsion	1	0	0	0	0
Displaced abomasum	0	0	0	0	0

4.7.4 Risk factors for periparturient diseases/conditions

4.7.4.1 Unconditional risk factors

The incidence (30.66%) of retained afterbirth was significantly higher (O.R = 1.8, P<0.05) in the lower highland agroecological zone relative to the upper midland agroecological zone (21.42 %).The incidence (15.4 %) of injuries to the birth canal was higher (O.R = 16.1, P<0.05) in animals served by artificial insemination relative to those served by natural methods (9.66%). The incidence (5.16 %) of injuries to the birth canal was higher (O.R =1.62, P<0.05) when male calves were delivered relative to when female calves were delivered (3.22 %). In addition, the incidence (5.98 %) of stillbirth was higher (O.R =1.12, P<0.05) when male calves were delivered relative to when female calves were delivered (5.37 %). The incidence (29.9 %) of retained afterbirth was also higher (O.R =1.3, P<0.05) when male calves were delivered relative to when female calves were delivered (24.7 %).The incidence (16.13 %) of mastitis was higher (O.R =2.7, P<0.05) in the wet season relative to the dry season (4.42 %).

4.7.4.2 Risk factors after adjusting for confounding in regression analysis

Factors significantly associated with the development of retained afterbirth were milk fever (O.R. = 5.2, P 0.041) and history of having developed retained afterbirth in a previous parturition (O.R. = 2.3, P 0.045). Factors significantly associated with the development of downer cow syndrome were milk fever (O.R. = 9.32, P 0.001) and lack of supplemental feeding (O.R. = 4.8, P 0.007). The wet season was significantly associated with the development of mastitis (O.R. = 4.1, P 0.015). Factors significantly

associated with the development of metritis were dystocia (O.R. = 3.96, P 0.021) and retained afterbirth (O.R. = 5.24, P 0.026). Dystocia was significantly associated with the development of periparturient haemorrhage (O.R. = 10.55, P 0.012) and injuries to the birth canal (O.R. = 58.96, P <0.01) (Table 4.10).

Table 4.10 Risk factors of periparturient conditions after adjusting for confounding in regression modelling in small-holder dairy cattle herds in Kikuyu Division of Kiambu District (April 2004-December 2004)

Disease/condition	Risk factor	Incidence rate (%)	Odds ratio	P-value
Retained placenta	Medical history	12.06	2.374	0.045
	Milk fever	39.13	5.2219	0.041
Mastitis	Wet season	16.13	4.152	0.015
Downer cow Syndrome	Milk fever	44.44	9.32	<0.001
	Lack of supplemental feeding	33.33	4.803	0.007
Metritis	Dystocia	30.76	3.96	0.021
	Retained afterbirth	61.53	5.24	0.026
Injuries to birth Canal	Dystocia	88.88	58.96	<0.01
Postpartum haemorrhage	Dystocia	60.00	10.55	0.012

4.7.5 Culture and sensitivity results for mastitis

The incidence of mastitis as determined by history, general examination, physical examination and the California Mastitis Test was 9.7% (20/206). Growth was obtained from 17 samples while 3 had no growth. *Escherichia coli* (35.29%) and *Klebsiella* (35.29%) were the most common causes of clinical mastitis during the periparturient period. *Streptococcus* species comprised 23.53 % (4/17) of the isolates while *Staphylococcus aureus* was only isolated from one (5.88 %) milk sample.

Antimicrobials with the highest sensitivity were norfloxacine, chloramphenicol and cefaclor that had 100% sensitivity for the organisms that they were tested against (Table 4.11).

Table 4.11 Percentage sensitivity patterns for bacteria isolated from clinical cases of mastitis during the periparturient period in smallholder dairy cattle herds in Kikuyu Division, Kiambu District (April 2004-December 2004).

Antimicrobial	*Escherichia coli*	*Klebsiella*	*Streptococcus spp*	*Staphylococcus aureus*
Ampicillin-Cloxacillin	100 (6/6)	33.33 (2/6)	Nt	100 (1/1)
Ampicillin	50 (3/6)	16.66 (1/6)	75 (3/4)	100 (1/1)
Gentamicin	100 (6/6)	100 (6/6)	50 (2/4)	100 (1/1)
Cefaclor	100 (6/6)	100 (6/6)	Nt	nt
Cotrimoxazole	0 (0/6)	25 (1/4)	66.66 (2/3)	0 (0/1)
Chloramphenicol	100 (6/6)	100 (6/6)	100 (4/4)	Nt
Kanamycin	83.33 (5/6)	80 (4/5)	50 (2/4)	100 (1/1)
Tetracycline	60 (3/5)	83.33 (5/6)	100 (4/4)	100 (1/1)
Norfloxacine	100 (6/6)	100 (6/6)	Nt	Nt
Streptomycin	75 (3/4)	66.66 (4/6)	100 (4/4)	100 (1/1)
Sulphamethoxazole	0 (0/6)	0 (0/6)	Nt	0 (0/1)

Key.

nt = not tested.

spp= Species

( ) Actual counts

Plate 4.5 Downer cow syndrome secondary to dystocia in a five year old Friesian cow in Kikuyu Division, Kiambu District (2004).Treatment was first attempted by traction without success. A caesarian section was later performed and a deformed calf delivered.

Plate 4.6 Dystocia relieved by traction in a Zebu-Friesian cross heifer 6 hours after onset Labour in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004). A large live bull calf was delivered. Red arrow indicates the hind limbs.

Plate 4.7 Haemorrhage following relief of dystocia by traction in a cow in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District. Recumbency due to fatigue (2004).

Plate 4.8 Thirteen-year-old cow with a dystocia due to lateral head flexion posture in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004).The cow was found straining by the farmer in the morning. The dystocia was relieved by traction and the cow did not develop any other complications. Red arrow indicates the presenting forelimbs

Plate 4.9 Retained afterbirth in an Ayrshire heifer with a stone tied at the tip by the farmer(Black arrow) in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District as a method of treatment (2004).

Plate 4.10 Cow with retained afterbirth (Black arrow) and severe physiological oedema of the udder 2 days post calving in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004). The oedema had been progressing from day 15 prepartum.

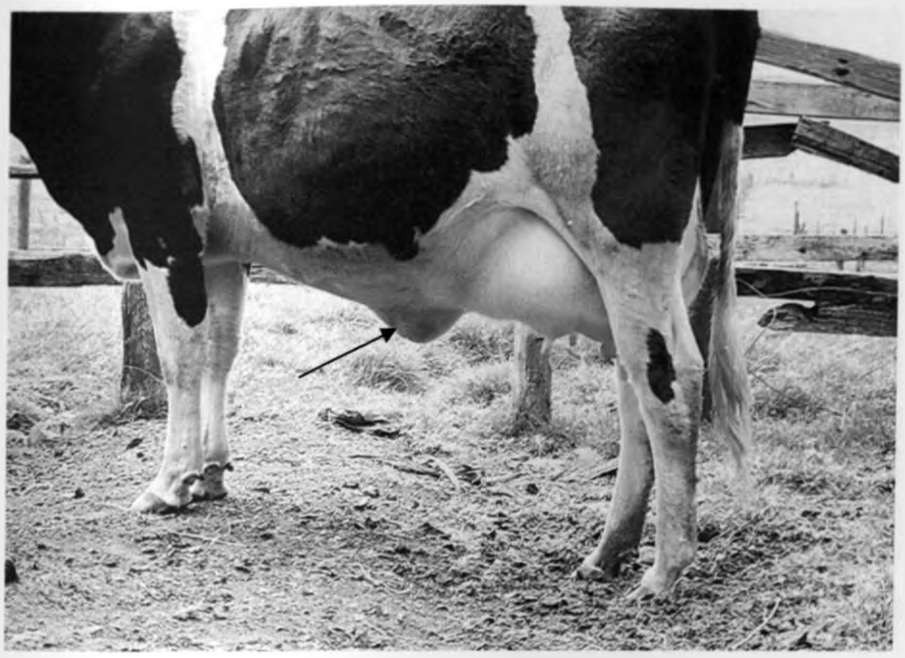

Plate 4.11 Free ranging Friesian heifer in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District with physiological oedema (Black arrow) seven days prior to parturition (2004).

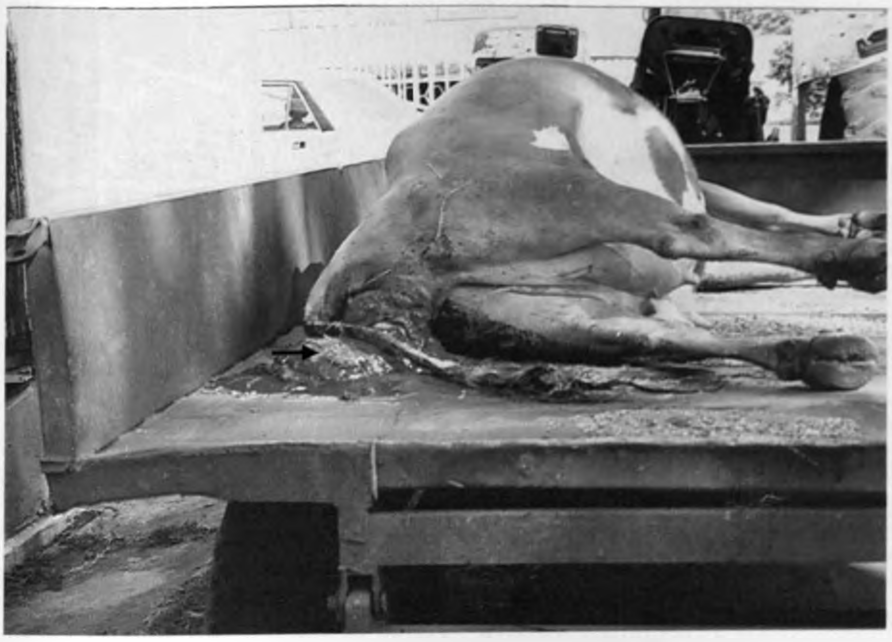

Plate 4.12 Mortality in a cow from a smallholder dairy cattle farm in Kikuyu Division of Kiambu District as result of complete prolapse of the uterus and cervix (2004). The cow died eight hours post calving due to delayed intervention

Plate 4.13. Complete uterine and cervical prolapse twenty four hours after calving in a heifer in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004).

Plate 4.14 The heifer in plate 4.13 immediately after treatment by manual reduction and retention with a perivulva suture in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004).

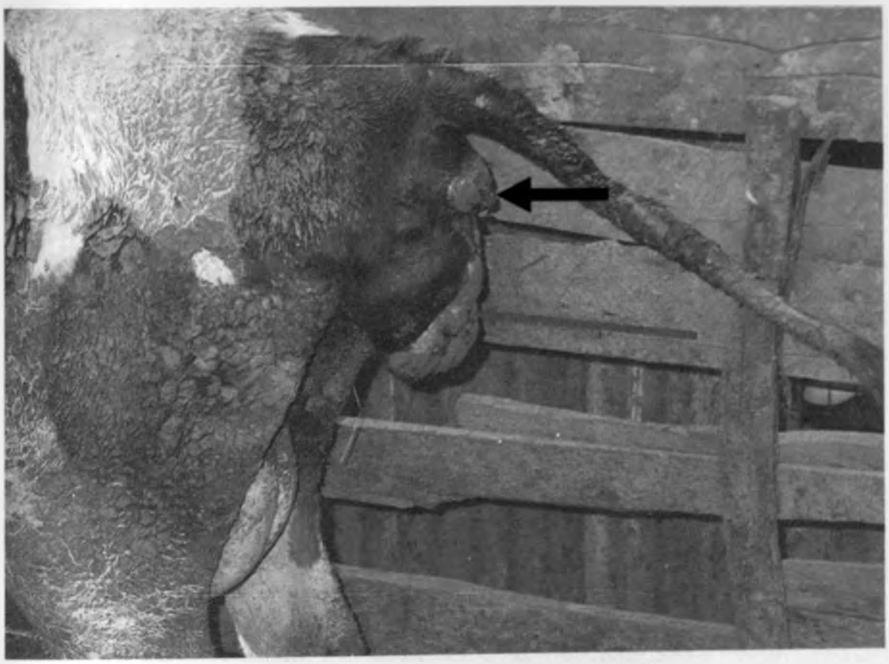

Plate 4.15 Cow with vaginal (green arrow) and rectal prolapse (black arrow) two weeks post partum in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004).

Plate 4.16. Downer cow secondary to milk fever in a six year old Friesian cow at day 275 in a smallholder dairy cattle farm in Kikuyu Division of Kiambu District (2004).The cow was culled from the herd three days after the treatment was instituted because of the prolonged recumbency.

CHAPTER 5 DISCUSSION, CONCLUSIONS AND RECOMENDATION

5.1 Discussion

The farm size, age, sex, parity, breeds of animals and management practices in the studied herds were as has been reported previously (Odima, 1994; Gitau, 1997; Omore, 1997; M.L.F.D., 2003).

The incidence of retained afterbirth in this study was high. The high incidence may have been due to stall feeding that would have led to reduced exercise by the cows and also increased the chances of uterine contamination due to accumulation of microorganisms in the animals' environment as had been reported previously (Radostits *et al*., 1994). In addition, milk fever was significantly associated with the occurrence of retained afterbirth. It has been suggested that this is due to the resultant uterine atony in cows with milk fever and failure of expulsion of the placenta after parturition (Roberts, 1986). A history of having developed retained afterbirth in the previous parturition was also significantly associated with the development of retained afterbirth; this may been due to the increased risk of developing placentitis thus leading to a firm attachment between the foetal cotyledons and maternal caruncles (Roberts, 1986). The high incidence of retained afterbirth reported in this study could have had an impact on reproductive performance of cattle in the smallholder dairy production system in terms of delayed uterine involution, uterine infections and the resultant infertility as has previously been reported (Roberts, 1986; Arthur *et al*, 1996).

Dystocia means difficult birth. Factors reported to predispose to the development of this condition include low parity, birth of heavy male calves, confinement, the use of artificial insemination and overfeeding (Arthur *et al*., 1996, Meyer *et al*., 2001). The incidence of dystocia in this study was high. Factors thought to have led to this include the increased use of artificial insemination in the study farms; this would have led to the birth of larger and heavier calves thus predisposing the cows to developing dystocia as had been reported previously (Meyer *et al*., 2001). Furthermore, confinement may also have led to the high incidence of dystocia in this study possibly due to a lack of exercise in these animals. The high incidence of dystocia could have a negative impact on the productivity of cattle in the smallholder dairy production system in terms of loss of genetic material from the death of calves and dams, veterinary costs and the resultant reproductive disorders (Roberts, 1986).

Milk fever is a complex metabolic disorder in dairy cattle that most often is seen at the beginning of lactation. The main risk factors to the development of this condition include the dry season, breed, potassium ion levels in feed prepartum, increased parity/age of the cow, increased body condition score and the increased level of production (Radostits *et* al, 1994; Goff and Horst 1997[b]; Horst *et al*. 1997; Radostits *et al*. 2000; Houe *et al*. 2001 Goff *et al*. 2004). The incidence of milk fever in this study was high. The high incidence could have been due to the prolonged drought that occurred during the study period which could have led to deficiencies due to reduced intake of calcium from the diet. In addition, improved genetics from increased use of artificial insemination resulting in higher milk producers without adequate supplementation as was evident in this study could also have led to an increase in the incidence as has been

reported in previous studies (Radostits *et al.*, 1994). Previous reports on this disease had indicated that the Jersey breed was at an increased risk of developing the disease (Horst *et al.*, 1997); however, in this study, the incidence in the Friesian was higher than in the other breeds. This could have been due to the high population of Friesians within the study area. The findings of this study indicate milk fever could be an important cause of economic loss in the smallholder dairy production system in terms of veterinary costs and the resultant complications such as downer cow syndrome.

Downer cow syndrome is a condition in cattle that most often occurs following milk fever. Factors reported to increase the incidence of this condition include milk fever, ischaemic myopathies, slippery floors, low plane of nutrition and paralysis of the obturator, gluteal and peroneal nerves following relief of dystocia by traction (Cox, 1982; 1988; Correa *et al.*, 1993; Radostits *et al.*, 2000). The findings of this study indicated milk fever was significantly associated with the development of downer cow syndrome; this could have been due to the secondary muscle and nerve damage when the cows were recumbent (Radostits *et al.*, 2000). In addition, lack of supplementation during the third trimester was also significantly associated with the development of the condition; this inanition combined with the nutrient demands of a developing foetus would have led to generalised muscle weakness thus predisposing these animals to developing downer cow syndrome as had been reported previously (Cox, 1982, 1988; Correa *et al.*, 1993). Obturator nerve paralysis as a result of traction to relieve dystocia was associated with the development of downer cow syndrome in two cows.

Mastitis refers to inflammation of the mammary glands. It has been reported to be the most prevalent production disease in dairy cattle herds worldwide (Schalm *et al.*, 1971).

Factors reported to predispose the development of this condition include increasing age at the time of parturition, wet season, poor hygiene and the stage of lactation among others (Oltenacu and Eksbol, 1994; Dublin *et al*., 1998; Radostits *et al*., 2000). In addition, milk fever and the lack of disinfection of stalls post calving in zero-grazed animals has been significantly associated with an increased incidence of *Escherichia coli* mastitis in dairy cattle (Curtis *et al*., 1983; Elbers *et al*., 1998). In this study, the incidence of clinical mastitis was similar to the findings of previous studies in this region (Kanuya *et al*., 2000; Ahmadu *et al*., 2002). The occurrence of clinical mastitis was significantly associated with parturition during the wet season; this could have been due to the deterioration in hygienic standards that occurs during the wet season thus leading to an increased risk of udder infection (Oltenacu and Eksbol, 1994; Radostits *et al*., 2000). In addition, the findings of this study revealed a high incidence of clinical Coliform mastitis; this was similar to the findings of previous studies on mastitis occurring during the periparturient period (Harmon, 1984; Janosi *et al*., 2003; Huszenicza *et al*., 2004). They attributed this to the hyperketonaemia present during this phase of production predisposing them to developing Coliform mastitis. Other authors have associated the high incidence of clinical Coliform mastitis during the periparturient period to the lack of disinfection of stalls post calving as was evident in this study (Elbers *et al*., 1998).

Puerperal metritis is a condition that occurs within the first 2-10 days after calving (Roberts, 1986; Arthur *et al*., 1996). The risk factors for this condition include increased parity, season, stall feeding, dystocia, retained afterbirth and routine genital examinations post partum among others (Roberts, 1986; Kaneene *et al*., 1994; Arthur *et al*., 1996; Bruun *et al*., 2002). In this study, retained afterbirth was significantly associated with the

occurrence of puerperal metritis. This could have been due to the unsanitary practices in the relief of retained after birth as had been reported in previous studies (Roberts, 1986). In addition, dystocia was also significantly associated with the occurrence of this condition. This could have been due to the resultant uterine atony that delayed the expulsion of uterine contents post calving and contamination of the uterus when obstetrical hygienic practices were not observed during relief of the dystocia as had been reported previously (Roberts, 1986; Bruun *et al.*, 2002). The high number of stall fed animals and lack of disinfection of the stalls post calving and between calvings in this study could also have contributed to the occurrence of this condition as has previously been reported (Kaneene and Miller, 1994).

Injuries to the birth canal are common during the second stage of labour. The risk factors to the development of this condition include dystocia, uterine torsion, foetal malpresentations and large calf sizes (Roberts, 1986). In this study, dystocia was significantly associated with the development of this condition. Most of these injuries were iatrogenic occurring during obstetrical manipulations to relieve dystocia. Furthermore, the traction applied on the foetus could have led to physical injuries to the birth canal (Roberts, 1986). Animals that were bred by artificial insemination and those that gave birth to male calves were at increased risk of developing injuries to the birth canal. This may have been due to the larger calf sizes in both instances which predisposed the dams to developing dystocia.

A stillborn calf is one that dies prior, during or within 24-48 hours of birth (Phillipson *et al.*, 1979). Dystocia has been reported to be the most common cause of stillbirth. Among the predisposing factors to the development of this condition are the birth of a

male calf and increased size of the foetus (Meyer *et al.*, 2001). Dystocia causes stress to the foetus which can lead to its death either before or within a few hours after birth. The incidence of stillbirths in this study was high. The occurrence of stillbirth in this study was associated with the birth of a male offspring. This may have been as a result of their relatively larger body size (Meyer *et al.*, 2001).

Uterine and vaginal prolapse are complications of the third stage of labour that are more commonly seen in cows and ewes (Roberts, 1986). The risk factors of this condition include uterine inertia due to hypocalcaemia, dystocia, a low plane of nutrition and excess dietary oestrogens, among others (Risco *et al.*, 1984, Roberts, 1986; Arthur *et al.*, 1996). In this study, the incidence of prolapse was positively associated with the dry season. This may have been due to the fact that the poor nutrition during the dry season would have led to loss of body condition and perivaginal fat that is important in supporting the uterus and vagina within the pelvic cavity as has been reported (Roberts, 1986). Lay interference and a prolonged period before the treatment was found to lead to death of 45 percent of animals that had uterine prolapse. Mortality in this condition has been related to shock, internal haemorrhage or incarceration of intestines (Roberts, 1986). However, in this study it was not possible to determine the exact cause of death since no proper post mortem examination was performed on any of the dead animals.

Post parturient haemorrhage is a condition that often occurs as a sequel to dystocia following trauma, laceration or rupture of genital organs. Premature dehiscence of the placenta can also lead to the condition (Roberts, 1986). In this study, the occurrence of this condition was significantly associated with dystocia. Most of the cases were iatrogenic and occurred when injuries occurred on blood vessels in the reproductive tract

during manipulation of the foetus in order to relieve the dystocia. No mortality was associated with this condition in this study unlike in a previous report (Njenga and Tsuma, 2004). This was because most of the haemorrhages were not severe and were treated conservatively using oxytocin.

Physiological oedema is a condition seen in the pre and post partum period. The condition has been reported to be associated with high milk production in dairy cattle (Roberts, 1986; Arthur *et al.*, 1996). In this study, the occurrence of this condition was associated with being of Friesian breed. This may have been due to the fact that the other breeds were encountered at very low frequencies so a fair comparison could not be done.

Previous studies have reported ketosis, cystic ovarian disease, uterine torsion and abomasal displacements to be some of the most important periparturient conditions in dairy cattle (Roine and Saloniemi, 1978; Roberts, 1986; Markusfeld, 1987). However, in this study, these conditions occurred in very low frequency; indeed no case of abomasal displacement was observed throughout the study period.

Cystic ovarian disease has been described as a condition that occurs when ovaries have one or more fluid filled structures that are greater than 2.5 cm. in diameter and last more than 10 days (Jubb *et al.*, 1985; Roberts, 1986; Arthur *et al.*, 1996). The predisposing factors to the development of this condition include periparturient stress and increased level of production, among others (Roberts, 1986; Arthur *et al.*, 1996; Fleischer, 2001). In this study, the incidence of cystic ovarian disease was low. This may have been due to the low level of production of dairy cattle in the smallholder sector relative to dairy cattle in the temperate countries that leads to less stress post partum. In addition, as per the study design, animals in this study were examined up to 3 weeks post partum while

indeed cystic ovarian disease has been reported to occur even up to 28 weeks post partum (Roberts, 1986); thus some of the animals may have developed the condition in the postpartum period beyond three weeks but was not diagnosed.

Uterine torsion is a condition commonly observed just prior to parturition as a cause of dystocia (Roberts, 1986). It is important because it poses a threat to the lives of the calf and the dam. The risk factors for this condition include seasonal factors, slippery floors in housed cattle that may lead to sudden falls and the breed among others (Rakuljik-Zelov and Zandik, 2002). The findings of this study revealed a very low incidence of uterine torsion. This may be due to the fact that most farms had non slippery floors either made of stones or earthen floors. The chances of cows falling in such circumstances were therefore reduced. In addition, Friesians which were the predominant breed in this study have been reported to be at a reduced risk of developing the condition relative to other breeds (Frazer *et al.*, 1996) which may have contributed to the low incidence.

Ketosis has been reported to be one of the most common metabolic diseases in intensively raised dairy cattle (Radostits *et al.*, 2000). The predisposing factors include having a body condition score of 3.5 and above at calving, being a multiparous animal and high milk production (Gillund *et al.*, 2001; Busato *et al.*, 2002). In this study, the incidence of ketosis was very low. This low incidence may have been due to the relatively low milk production in smallholder dairy cattle relative to intensively reared dairy cattle; this would have led to reduced chances of the cows having a negative energy balance and developing ketosis. Furthermore, the relatively low average body condition score of cows in this study could also have contributed to the low incidence. In addition, ketosis has been known to occur even up to 60 days postpartum (Radostits *et al.*, 2000)

while animals in this study were examined up to 21 days postpartum. This implies some of the animals may have developed ketosis later in the postpartum period but were not detected because they had already been eliminated from the study.

Displaced abomasum is a condition that results from hypomotility and gaseous distension of the abomasum. Predisposing factors to the development of this condition include high level grain feeding with low crude fibre in the diet. These are what lead to abomasal hypomotility and gaseous distension of the abomasum. Other predisposing factors include ketosis, increased age, high milk yield potential and hypocalcaemia (Radostits *et al.*, 2000; Melendez *et al.*, 2003). In this study, no case of abomasal displacement was encountered. This could be attributed to the low level feeding of grain concentrate and the predominantly high roughage diets fed to the animals in the small-holder dairy production system relative to intensively reared dairy cattle. Indeed as described in chapter 4, the feeding of grain concentrate was erratic.

5.2 Conclusions

There was a high incidence of periparturient conditions among smallholder dairy cattle herds in Kikuyu division of Kiambu district with retained afterbirth, dystocia, milk fever, downer cow syndrome, mastitis, metritis and injuries to the birth canal being the most common conditions encountered. The agro ecological zone, season, stall-feeding, the birth of male calves and lack of supplementation had an effect on the occurrence of periparturient conditions. In addition, conditions such as milk fever and dystocia did predispose to the occurrence of other periparturient conditions.

5.3 Recommendation

It is recommended that further research needs to be carried out so as to determine the impact of these diseases on the productivity and performance of cattle in the smallholder dairy production system and the dairy sector as a whole in Kenya. To reduce the incidence of mastitis, farmers need to educated on the need to improve on their hygienic practices especially during the rainy season. Cases of milk fever need to be treated promptly to reduce the incidence of downer cow syndrome and retained afterbirth. Farmers also need to be sensitised about the importance of supplementation especially during the last trimester of pregnancy in order to reduce the incidence of downer cow syndrome.

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APPENDIX 1; FARMERS SURVEY QUESTIONNAIRE

PART 1: BACKGROUND INFORMATION.

1) Location of farm_____ Farm size_____
2) Owners details – Name_____
   - Age_____
   - Level of education_____
   - Profession (if any)_____
   - Occupation_____
3) Do you belong to any dairy society? Yes_____ No_____
4) If yes, which one?

GENERAL MANAGEMENT PRACTICES.

1) Deworming_____
2) Vaccination_____
3) Dipping/spraying_____
4) Steaming up._____
5) Dry cow therapy. _____

BREEDING AND REPRODUCTION.

1) What type of service is used?
-Own bull
-Communal bull.
-AI Local_____ Imported_____
-Embryo transfer.

2) Choice of service when AI is used.
-Any semen available.
-Own choice.
-Inseminator's choice.
-Others(Specify)_____

3) Age at first service? _____
What characteristics are used to determine the time at first service?
Height_____
Weight_____
Heats_____

4) Confirmation of pregnancy.
Lack of heat.
Veterinarian.
Inseminator.
Abdominal distension.

Others (specify) _____

Specific conditions.

1) Have you ever had a case of milk fever? _____
What was the outcome? _____

2) Have you ever had an animal with downer cow syndrome? _____
What was it after? milk fever
Dystocia
Normal delivery

3) Have you ever had animal with retained afterbirth? _____
What was the outcome? Recovery_____
Complications (Specify)_____

4) Have you ever had an animal with vulva discharges (Metritis)? _____
what was the outcome? _____

5) Have you ever had an animal with uterine prolapse? _____
What was the outcome? _____

6) Have you ever had a case of nerve paralysis? _____
What was the diagnosis? _____
What was the outcome? _____

7) Have you ever had an animal with cystic ovarian disease? _____
What was the diagnosis? _____
What was the outcome? _____

8) Have you ever had an animal with injuries to the birth canal? _____
What was the diagnosis? _____
What was the outcome? _____

9) Have you ever had an animal with peripartum haemorrhage? _____
What was the diagnosis? _____
What was the outcome? _____

10) Have you ever had an animal with physiological edema? _____
What was the outcome? _____

11) Have you ever had an animal with uterine torsion? _____
What was the outcome? _____

12) Have you ever had an animal with abortions/stillbirth? _____
What was the diagnosis? _____
What was the outcome? _____

13) Have you ever had an animal with abomasal displacements? _____
What was the diagnosis? _____
What was the outcome? _____

14) Have you ever had an animal with uterine/vaginal tears? _____
What was the outcome? _____

15) Have you ever had an animal with dystocia? _____
What was the outcome? _____

16) Have you ever had an animal with mastitis during the pericardium period? _____
What was the outcome? _____

Observational study.

1) Farm structures.
- -Permanent (Stone walls and concrete floor).
- -Semipermanent (Well enclosed timber walls and earth/stone floor)
- -Temporary (Not well enclosed wood/timber walls and earth floor)

2) Maintenance of farm structures.
- -Well maintained.
- - Not maintained.

3) Farm records.
- -Adequate.
- -Inadequate.
- -Not kept.

4) Feeding system.
- - Complete/total stall-feeding.
- - Semi/partial stall-feeding.
- -Open grazing.
- -Others_____

5) Roughage.
Grass
Napier.
Others_____
6) Concentrate/supplements fed.
-
-
-
-
-

7) Frequency of concentrate feeding.

8) Level of hygiene.

- Good
- Fair
- Poor

8) Water source_____

9) Frequency of watering.
- Regular.
-Irregular
-Adlibitum.

APPENDIX 2; CLINICAL RECORD FORM.

1) Date _____
2) Location _____
3) Farmers name _____
4) Animal identification Name / ear tag number _____
Breed _____
Age _____

Reproductive history.

1) Last parturition date _____
2) Parity _____
3) Date of last breeding _____
4) No of services for the last conception _____
5) Number of services since the last calving _____
6) Were there any problems experienced during the peripartum period?
Yes _____ No _____
7) If yes, specify _____
8) Does the cow come on heat regularly? _____

Present medical and fertility status.

1) Body condition score _____.
2) Body temperature _____.
3) Level of milk production _____
4) Abnormal vaginal discharges
Yes _____ Mucoid
Purulent
Mucopurulent
Sanguinous
Frank blood
Others (specify)
No _____
5) Pregnant Yes _____ Age _____
No _____ Why? _____
6) Uterine palpation.
-Position _____
-Size. _____
-Tone _____
-Symmetry _____
Ovarian palpation.
Right ovary. _____
Left ovary _____
8) Tests.
i) Ketosis. (For cows in the puerperal period) Positive _____
Negative _____
ii) Milk for culture and sensitivity (For cows suspected to be suffering from mastitis)

APPENDIX 3; INDIVIDUAL ANIMAL FOLLOW UP RECORD

Farmer's name_____

Farm ID _____

Location _____

Cows ID. (Name / number)_____

age. _____

Visit date	Body condition score	Health status	Mastitis status	Ketosis status	Fertility status	Therapeutic interventions