ASSESSING ATTITUDES TOWARDS MANAGEMENT PRACTICES AND CALF PERFORMANCE ON SMALLHOLDER AND LARGE COMMERCIAL DAIRY HERDS IN NAKURU COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this or any other University for an award of any degree to the best of my knowledge.

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Recommendation

This research thesis has been submitted with our approval as the University supervisors.

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DEDICATION

This work is first and foremost dedicated to the Almighty God, secondly to my Parents Mr. and Mrs. Francis Kazara Tibendelana, my lovely wife Christina R. Shirima and my children Valentine M. A. Francis and Beatrice. A. A. Francis for their support, encouragement and understanding during the study period, thus realizing my long cherished dream.

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ABSTRACT

Performance of dairy calves, being the replacement stock, is important for sustaining dairy herds. Calf performance is known to be poorer in smallholder dairy herds than in large commercial dairy herds. In Kenya, smallholder herds predominate, implying that poor calf performance is a sustainability issue for the national dairy herd. Knowledge gap exists about the influence of producer attitudes and management practices on the observed differences in calf performance. This study answered the research question of whether producer attitudes and management practices in calf housing, feeding, health and calf performance significantly differ between smallholder and large commercial dairy herds. Data was obtained in Nakuru County using structured questionnaire and collecting blood and fecal samples from 157 calves in 20 dairy herds. Laboratory analysis of the samples for determining total viable counts (TVC), coliforms, packed cell volume (PCV), haemoglobin concentration and presence of *Escherichia coli* was analyzed. Statistical analysis of the data at producer level applied non-parametric chi square test and Mann-Whitney U test because the sample was small and measurements were categorical and ordinal scale. Analysis at animal level applied parametric two independent sample t tests and binary logistic regression in SPSS version 23. Compared to large commercial producers, smallholders expressed more ($p<0.05$) negative attitudes, they were poorer ($p<0.05$) in implementing the recommended management practices. Consequently, calf performance was poorer in smallholder herds, with lower ($p<0.05$) average daily weight gain (307.3 vs 435.4g/day/calf), packed cell volume (36.9 vs 42.0%), blood haemoglobin concentrations (5.9 vs 8 g/dL) and higher prevalence ($p<0.005$) of fecal *E. coli* (70.1 vs 52.2%). To attain improved calf performance and sustainable dairy herds, Smallholders' farmer needs to change their attitude towards positive ways, change practices of implementing recommended calf housing, feeding and health management practices. Extension services should be provided to advice, educates, guide and enforce towards implementing daily farm management practices. Feeding and health management should be practiced in connection of ensured calves' biosecurity measures. Furthermore, the government can provide the soft loans particularly to the smallholder's farmers to boost their dairy sector investments.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADG	Average Daily gain
AI	Artificial Insemination
BW	Body Weight
CESAAM	Center of Excellence in Sustainable Agriculture and Agribusiness Management
GDP	Gross Domestic Product
GLM	General Linear Model
GoK	Government of Kenya
HCl	Hydrochloric acid
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute
KDB	Kenya Dairy Board
PCA	Plate Count Agar
PCV	Packed Cell Volume
RPM	Revolution per Minute
SAS	Statistical Analysis System
TALIRI	Tanzania Livestock Research Institute
TSI	Triple Sugar Iron Agar
TVC	Total Viable Counts
USAID	United States Agency for International Development

CHAPTER ONE
INTRODUCTION

1.1 Background Information

Dairy farming is the single largest sub sector of agriculture in Kenya. The sub sector account for 6-8% of the country's Gross Domestic Product (USAID/GoK, 2009) and 14% of Agricultural GDP (Gross Domestic Product) with annually recorded higher growth rate of 4.1% compared to Agriculture with growth rate of 1.2% (IFAD, 2006). Two groups of dairy herds are prominent: smallholder with one to three cattle (Bebe *et al.,* 2003; ILRI 2008; and Mugambi *et al*., 2015) and the large scale commercial with a herd exceeding 50 cattle. The performances of the dairy calves between two groups vary considerably.

Performance of the dairy calves is important for ensuring sustainable replacement stock because their poor health and growth has lasting effects on the development and future production. As future replacement, dairy calves should be reared in an optimal way to maximize health, welfare, and future prospective as milking cow (De Vries *et al*., 2011). Important aspects in the calf rearing are proper housing facilities, health management and calves' nutrition. Poor calf rearing practices will result into lack of potential replacement heifers leading to low rate of herd growth and improvement.

Rearing a healthy calf will ensure optimum mating weight that will achieve optimum milk production in subsequent lactations. In achieving the intended goal, is important to establish the effect of alternative aspects of both on calf and cow performance (Gleeson and O'Brien, 2012). The management practices influencing calf performance includes feeding, housing and health (Uetake, 2013; Bernal-Rigoli *et al.,* 2015; Pempek *et al.,* 2017). Poor management practices impair calf health. Calf health is therefore important in realizing survival of calves before weaning age (Barrier *et al.,* 2013). Survival can be improved with good health practices because common causes of calf mortality are related to disease infections, unhygienic housing and poor feeding practices (Phiri *et al*., 2010). Calf mortality is an important indicator for evaluating calf's health; mortality can be evaluated routinely by monitored collected data (Santman-Berends *et al.,* 2018; Santman-Berends *et al.,* 2019).

The ability of a calf to resist disease infections needs active passive immunity, which often will be depressed under extreme weather condition and poor feed quality. In the tropics, calf mortality can be as high as 35% before weaning age (Jelly *et al*., 2010) compared to less than 5% in temperate countries (Menjo *et al.,* 2009). High calf mortality limits not only herd

expansion but selection for genetic improvement as well. Mortality could be due to feeding, housing and improper management practices (Jelly *et al*., 2010).

Feeding calves *ad-libitum* promotes weight gain. The amount of milk as well as colostrum fed to calves influence gut development. Calves should be fed with quality and quantity liquid as well as solid feed. According to Hill *et al*. (2015) dairy calf average daily gain is associated with frequencies of feeding. Improved growth rate, improved production and health in adult life are associated with increased milk feeding (Soberon and Van Amburgh, 2013). Properly fed dairy calves serves calves from diarrhea during the first three weeks of life, and pneumonia, associated with viral and bacterial agents, generally occurring in calves over four weeks old (Lorenz *et al.,* 2011). Diarrhea and pneumonia are recognized as the key disease challenges facing the preweaned dairy calf and have major economic impacts, both in terms of mortality and reduced performance in later life (Curtis *et al.,* 2016).

Extension service makes recommendations to dairy farmers (smallholders and large commercial) on the best management practices in housing, feeding and calf health issues, but adoption varies from farm to farm leading into variations in their calf performance (Pempek *et al.*, 2017). This variations in adoption of management practices could be linked to attitudes, which considerably varies between producers (Pempek *et al.,* 2017) and therefore likely to influence calf performance. This could be the underlying reasons for the differences observed in calf performance between the smallholder and large commercial herds. Calf performance is poorer in smallholder herds than in large commercial herds, but a knowledge gap exists about the influence of producer attitudes and management practices on the observed performance differences. In addition to attitudes, understanding a person's beliefs about who may influence their decision-making and how much control they have in making decisions are key factors in understanding a person's motivation (Sumner *et al*., 2018). This should necessitate further research on the associations that producer attitudes and management practices have with observed performance of the dairy calves. The knowledge would inform targeted interventions to improve calf performance in smallholder herds, as they account for over 75% of the herd and so are important for sustainability of the dairy sub sector in Kenya.

1.2 Statement of the Problem

Poor housing, feeding and health management practices expose dairy calves to high risk of disease infections, slow growth, poor health status and high mortality. Loss of genetic material

for herd improvement and reduced number of dairy heifers available for herd replacement and/or expansion is mainly due to calf health problems. Generally, it is an observation that calf performance is poorer in smallholder herds compared to large commercial herds yet both access extension recommending best management practices. Poor calf performance is a cause of sustainability concern in smallholder dairy herds because of associated production losses, high cost of sourcing replacement stock and loss in revenues that impact on farm profits. This is a sustainability issue in Kenya where smallholders own about 75% of the national herd. The difference in calf performance between smallholder and large commercial herds could be related to producer attitudes and implementation of the recommended management practices. Empirical evidence on producer attitudes and their management practices in calf housing, feeding and health and calf performance would be relevant knowledge for designing targeted improved calf management in smallholder herds.

1.3 Objectives

1.3.1 General Objective

The overall objective is to contribute to improved performance and sustainability of the dairy herds through improved calf performance by change in producer attitudes and management practices in calf rearing.

1.3.2 The Specific Objectives

(i) To determine the producer attitudes towards calf housing, feeding and health in smallholder and large commercial dairy herds.

(ii) To determine calf housing, feeding and health management practices in smallholder and large commercial dairy herds.

(iii) To determine calf performance in smallholder and large commercial dairy herds.

1.4 Research Questions

(i) Are the producer attitudes towards calf housing, feeding and health significantly different between smallholder and large commercial dairy herds?

(ii) Are calf housing, feeding and health management practices significantly different between smallholder and large commercial dairy herds?

(iii) Is calf performance significantly different between smallholder and large commercial dairy herds?

1.5 Justification of the Study

The small and large producers likely hold divergent attitudes towards calf rearing. This could influence the management practices they are implementing in their herds. The attitude, management practices of the dairy farmers' producers can be accessed on the basis of the dairy calf performances. In this study, smallholder producers being all members of cooperative societies so are expected to receive from the extension officers, the extension services and technical recommendations for best calf management practices. In essence, they should not deviate much in management practices from the large scale commercial producers. Large commercial dairy herds are expected to be models being better than smallholder herds in implementing good management practices and so attain better performance of the diary calves. Identifying and understanding areas where there are departure between the large commercial and the smallholder dairy herds can inform targeted intervention to smallholder farmers necessary to improve calf performance.

CHAPTER TWO
LITERATURE REVIEW

2.1 Dairy Industry in Kenya

One of the major livestock enterprises in Kenya which serves as source of income and food security is dairy production; the enterprise contribution is mainly through selling of milk (Muthui *et al*., 2014). The enterprise is largely divided into two major categories: large scale and small-scale dairy production. Smallholder dairying is typically conducted on a few acres (1.2 -2.2) with 75% of farmers keeping a small herd (1-5 cattle) of pure and crossbred cows. Production is based on the close integration of dairy cattle into the mainly maize-based farming (Bebe *et al.,* 2003; ILRI, 2008 and Mugambi *et al.,* 2015). It is sometimes accompanied by cash crops such as coffee, tea, or pyrethrum. On the other hand, large scale farms have herd averaging 50 and above (Bebe *et al.,* 2003). The small scale dairy sector developed rapidly after Kenyan independence when the white settlers converted Africans into smallholder farms and later the subdivision of the large farms for African settlement.

The success of dairy production particularly smallholders in Kenya is due to a number of factors such as condusive climatic conditions for dairy cattle, favorable agro-climatic conditions, availability of dairy genetics and accessibility of Artificial Insemination (AI) services, policy and institutional environment together with the importance of milk in the diets for many communities and reduced production cost through subsides of the inputs (Kasirye, 2003). In Kenya, the dairy value chain is robust and supported by strong institutions (Policy framework) governing the dairy sector. The cooperative movement (New Kenya Cooperative Creameries) is not only reliable but also has the ability of addressing the challenges and exploiting the available opportunities contributing to the growth of the dairy sector. This has led to the sustainability and adaptability of Kenyan dairy sector (Corné *et al.*, 2016).

2.1.1 Dairy Calves

Producer attitudes and characterization of the current dairy calf management practices is important in understanding the opportunities, direction of future research and challenges facing pre weaned dairy calves. Pre weaning is the most expensive period of dairy calf life as feed costs are high, and calves are highly susceptible to poor management practices. Ensuring good animal health is paramount (Glauber and Carla, 2015). Early detection of abnormality calf health, improper feeding plans and practices (quality and quantity) as well as house type

and conditions has the significant impact on dairy calves performance and survivability consequently affecting herd size (Curtis *et al*., 2016).

2.2 Attitudes and Management Practices of Dairy Farmers

An attitude is a positive or negative response towards an idea or concept and is a predictor of future behavior. In the dairy sector it is important to understand producers' attitudes which are considerably varying hence influencing calf performance (Pempek *et al.*, 2017). In Kenya most of the dairy producers tend to overlook the calf losses and ignore calf welfare that compromises dairy calves' performance (Menjo *et al.,* 2009) instead they focus mostly on milk production as the enterprise profitability. The best ways to keep calves healthy and comfortable is by maintaining adequate nutrition, proper pen facilities, and health care. However, management practices have been reported to differ between small and large scale dairy operations (Pempek *et al.,* 2017).

Decision in both the choice of housing, feeding and management systems and how the system is managed depends on farmer's attitudes and empathy toward animals. There is direct relationship between farmers' attitudes and behavior and between farmers' behavior and their management decisions. Their behavior affects dairy cattle management and the consequences of management decisions can be measured by defined variables related to production and health (Kielland *et al.,* 2010). Dairy calf performance is greatly affected due to the farmer's attitude. To find a solution or an improved approach to improve calf performance it is important to include the attitude of the dairy farmer as attitude influences behavior (Ellis-Iversen *et al*., 2010; Jansen *et al*., 2010 and Bruijnis *et al.,* 2013).

Dairy farmers attitude influences calves welfare, this has placed pressure on farmers to adopt practices that promote improved welfare (Ventura *et al.,* 2016). Farmers and veterinarians are responsible for ensuring welfare of dairy calves. Dairy calves housing, feeding and disease management should be well managed by both stakeholders in ensuring dairy calf performance (de Rooij *et al*., 2010; Ritter *et al*., 2015; Wolf *et al*., 2016). Surprisingly, large farmers place greater emphasis on employees and labor management for their success whereas smaller farms with growth intentions largely lacked management (Lai *et al.,* 2018).

2.2.1 Dairy Calf Housing

Improved housing may reduce calf mortalities. Individual calf pen helps in prevention of spreading of diseases, early detection of diseases as well as treatment of diseases. Clean, dry bedding separates calves and floor from enteric pathogens. Biosecurity and disruption of the disease cycles can be achieved through calf pen cleaning and disinfections cycles, change of bedding is also paramount (Jorgensen *et al*., 2017). Housing the calf protects them from extreme weather conditions; reduce competition for feed, water and space as well as easy monitoring for their health. Proper pen reduces calf mortality hence promotes calf performance. Calves in group housing are at high risk of respiratory diseases hence increased mortality (Knauer *et al.,* 2017). Calf pen should be well ventilated, clean, dry, warm, providing easy access to feed and water together with providing handling and treatment. Of the all calf pen, individual calf pen has gained popularity due to its advantages of easier detection of sick animals, minimizing transfer of diseases from one animal to the other (Table 1).

Table 1: Type of Housing Used for Pre-weaned Heifers

Housing type	Pre-weaned heifers (%)
Individual pen/hutch	74.9
Multiple animal, inside area	23.6
Tie stall/stanchion	12.1
Pasture	6.3
Free stall	5.6
Dry lot/multiple animal, outside area	5.2
Others	1.5

Source: USDA (2010)

Incidences of calf respiratory diseases are due to improper ventilation of the calf houses. Air borne pathogen load can be minimized by providing proper ventilation. The houses provide environmental protection, prevent spread of diseases and facilitate the detection and treatment of sick calves. Together with shelter, addition of suitable bedding can reduce the direct stress of coldness to calves. Cleaning and disinfecting of pens helps in maintaining biosecurity and disrupting of the disease cycle. Regular addition of clean, dry bedding is effective in controlling enteric pathogens on the pen floor. Effectiveness for thermoregulation can be achieved by avoiding wetness in the beddings (Jorgensen *et al*., 2017).

2.2.2 Feeding of the Dairy Calf

Feeding of the dairy calves are an important and expensive aspect of dairy farming and starting these heifers on a balanced diet is critical to their future efficiency, productivity, and longevity (Soberon *et al.,* 2012; Akins *et al*., 2015;). In smallholders, producer calves are not cared for adequately because the amount of milk fed to calves is determined by the quantity of milk remaining after milking where calves are allowed to suckle. Colostrum feeding is the key to calf health, survival and welfare (Kienitz *et al.,* 2017). It is recommended that the calf should be fed 3-4 litres of good quality colostrum within 12 hours after birth. Inadequate intake leads to increased mortality and risk of diseases such as diarrhea and respiratory illnesses (Vasseur *et al.,* 2010). Regardless of its economic benefits, if is handled in the poor hygienic conditions colostrum feeding has the risk of disseminating *Escherichia coli* to the young dairy calves (Nigatu *et al.,* 2017; Safaa *et al.,* 2019). At the age of two weeks, calves will start consuming solid feeds and intake keeps on increasing when milk amount is reduced (Khan *et al.,* 2011). Before weaning calves should not be given larger amounts of milk because it may depress solid feed consumption due to physical delay and rumen development (Hill *et al.,* 2010; Sweeney *et al*., 2010).

Newly born calf need to be fed up to 12L of milk per day for proper maintenance and energy. However calves shouldn't be overfed more nutrients because during transition from liquid to solid feeds calves may be stressed. Basing on the fact that milk feeding is more cost full than solid feeding; therefore, early transitioning from liquid to solid can be used as a means of reducing feed costs (Eckert *et al.*, 2015).

Despite the benefits of achieving improved health, increased growth rates, improved utilization of feed conversion for improved performance and health, feeding calves higher planes of nutrition during pre-weaning should not be advocated (Eckert *et al.*, 2015). Farmers claim that feeding calves larger amounts of milk delays solid feed intake, which in turn compromise rumen development before and during weaning hence affecting post weaning growth. Sweeney *et al*. (2010) supported the idea by concluding that calves fed large amounts of milk displayed decreased post weaning intake and weight loss during an abrupt weaning scheme at 40 days of age.

Raising animals individually reduces the dissemination of disease and create minimal competition for feeds. On the other hand, raising animals in a group has a competitive advantage which is beneficial during post weaning phase as animals can develop exploratory

behavior. However, individualization allows for the individual control of feed intake and leads to a quicker diagnosis of diseases and other management problems (Glauber and Carla, 2015).

Increased feeding frequency has been related to increase in average daily gains (ADG) in young dairy calves. Feeding calves *ad-libitum* by nipple suckling can allow for increased milk intake and weight gain with no detrimental effects on intake of solid food after weaning, however, intake of solids increase rapidly as milk supply is reduced and then stopped (Hill *et al.*, 2015). Some of the dairy producers may be reluctant to delay separation, but improvements in milk-feeding practices for calves that are separated from the cow may allow for some improvements in early weight gains. However, feeding frequency does not necessary change efficiency of nutrient use but can affect consistency of nutrients consumed as reflected in feeding precision and methods (Greter *et al.,* 2010).

2.2.3 Dairy Calf Health

The health of dairy calves in early life (their first 8 weeks) directly impacts future milk production and longevity in the dairy herd. Protecting the future health and survivability of calves starts with timely feeding of adequate amounts of high quality colostrum. Respiratory issues more often are seen when calves are stressed particularly around weaning time. However, the first episode may be traced to the pre-weaning period. Among the respiratory diseases such as acute bovine pulmonary edema and emphysema, allergic reactions, lungworm, a typical interstitial pneumonia, and calf diphtheria, bovine respiratory disease (BRD) is commonly taken to mean pneumonia. Pneumonia is caused by an infectious agent, with inflammation, consolidation, potential abscessation and fibrosis of the lungs. It can be caused by a number of pathogens, many of which are normal residents of the bovine respiratory tract (Walter, 2014). Variations in attitudes and management practices of some dairy producers claim vaccination as harmful to the calves' health. In practice vaccination prevents infectious diseases hence reducing costs for antibiotics treatments (Pempek *et al.,* 2017).

Calf mortality is one of the important problems of calf rearing in dairy herds' worldwide. Disregarding stillbirth, disease is the most significant reason for dairy calves mortality. Septicemia is an important cause of death in very young calves, diarrhea is the most important disease in calves less than 30 days of age and pneumonia is the most important problem in replacement heifers over 30 days of age (Justyna *et al*., 2015). Dairy calves born from assisted parturitions are not only at higher risk of stillbirth, but for mortality until 30 days after birth.

Generally the second week of life, the disease incidences in calves reaches the peak (Jorgensen *et al*., 2017).

High calf mortality risks represents a major economic loss to the dairy operations, of the all causes most common cause of calf hood disease is diarrhea during early ages followed by pneumonia. The calf losses can be significantly reduced by introducing new techniques of management including timely colostrum feeding, properly designed calf pen, feeding and health practices. Calf mortality has a drastic influence on milk production by reducing replacement stock and milk let down. Mortality is a common problem for livestock producers; death of calves implies a loss of future breeding stock and replacement dairy cows and a loss of milk production in breeds milked with the calf at foot. Calf diseases that cause morbidity and mortality are the results of complex interaction of the housing, feeding, health management practices, environment, infectious agents and the calf itself (Curtis *et al.,* 2016; Tadese *et al.,* 2017).

Dairy calf diseases limits daily body weight gain by 103, 300 and 408 g/day for pneumonia alone, diarrhea alone, and both together, respectively, during 44-60 days follow up period. Calf health problems cause loss of genetic material for herd improvement and decrease the number of dairy heifers available for herd replacement. Disease management in dairy calves is investable however resistance to individual drug in *E. coli* is due to calf pen and feeding system. Most routine disease management such as vaccination and treatment are producer-driven whereas managing health problems is the veterinarian's role (Pereira *et al*., 2014).

Packed cell volume (PCV) is the percentage (%) of red blood cells in blood and is involved in transportation of oxygen and nutrients absorption. A decreased PCV generally means red blood cell loss due to many reasons such as cell destruction, blood loss and failure of bone marrow production. An increased PCV generally means dehydration or an abnormal increase in red blood cell production. Packed cell volume is significant in the diagnosis of anemia. Increase in PVC implies better transportation of oxygen and nutrients absorption. High packed cell volume (PCV) reading indicated either an increase in number of red blood cells (RBCs) or reduction in circulating plasma volume. High or low level of packed cell volume (PCV) is associated with age at onset and duration of diarrhea. Packed cell volume is affected by ingestion of colostrum (Julie *et al*., 2015).

Packed cell volume, haemoglobin concentration (g/dl) and concentration of pathogens in faeces are indicators of health and immunity levels of the dairy calves (NseAbasi *et al*., 2014). Oxidation of ingested animal feed so as to release energy is due to hemoglobin physiological function of transporting oxygen to tissues of the animal.

The calf can encounter enteric pathogen from the dam via fecal-oral spread of colostrum or the environment, so putting the calves that co-mingle with cows will increase risk of calf enteric infection. Transmission of enteric pathogens through fecal-oral to calves can occur by contaminated bedding; feeds and feeding utensils, colostrum, boots, and clothing of calf caretakers among others. For the enteric pathogens of most concern to calves, the incubation periods range from 12 hours to 5 days, (Sheila, 2008). Bedding sample leads to calf diarrhea whereby calves leaves the maternity pen to unoccupied maternity pen hutch, from which they are contaminating the clean hutch (Table 2).

Table 2: Bedding Sample Results from a Dairy with Diarrhea in 5-day-old Calves

Sample Source	Coliforms (colonies/mL)	Total colonies (colonies/mL)	Salmonella culture
Maternity pen	1000	576,000	Negative
Empty maternity hutch	35,000	36,875	Negative
Clean hutch	750	11,500	Negative
3-day occupied hutch	1500	577,500	Negative
Truck	6,900,000	6,921,750	*S muenster*
Goal for clean pen	<1000	<5000	Negative
Goal for occupied pen	< 500,000	<2,000,000	Negative

Source: Sheila (2008)

An optimal calf health during the period from birth to weaning is achieved via preventive measures. An emphasis on prevention is critical, limiting the need for subsequent intervention, particularly with the management of diseases of the gastrointestinal and respiratory systems (Lorenz *et al*., 2011).

2.3 Calf Performance

The quality of dairy calves' rearing may impact the performance of the calves, the productive outcome of the future cow and through heifers' survival indices as well as the rate of genetic improvement of the herd (Vasseur *et al.,* 2010). An important technique for optimizing dairy calves' performance in late life is the adequate nutrient supply from liquid and solid feeds. In order to maintain constant growth and weight gain after weaning, sufficient concentrates

intake in the pre-weaning period is inevitable (Schäff *et al*., 2018). Poor calf growth rate and behavioral signs of stress is typically displayed from claves fed restricted levels of milk (Eckert *et al.*, 2015).

Despite advances in dairy herd health and productivity, perinatal calf mortality rates are still very high on many dairy herds. Various studies indicates calf mortality rates variations such as in tropics 8% to 35%, (Jelly *et al*., 2010) temperate countries 0.96% to 4.3% (Menjo *et al.*, 2009), Korea 10.7% (Hur *et al.*, 2013), UK 14.5% (Brickell *et al*., 2009), France averaged 4.4 and 3.2% for three days to one month old calves and 1 to 6 months old calves respectively (Raboisson *et al*., 2013). United States 6.9 and 7.8% on calf ranches (Walker *et al*., 2012), dairy herds (USDA, 2008), respectively. Mortality can be due to genetic origins which are beyond producer control. Management practices contribute positively or negatively towards calf mortality. Calf performance in the pre weaning is affected by stress and immune systems (Lindsey and Sonia, 2016). Birthing is among the calf stress which causes some calf's mortalities due to dystocia. This birth stress can be reduced by performing calf vitality assessments (Murray and Leslie, 2013).

In order to improve calf welfare table 3 below highlight some of the important aspects either to adhere to or avoid in ensuring welfare of a new born calf.

Table 3: Do's and Don'ts of Newborn Calf Management

Period	Do	Don'ts
Calving	1. Provide deep straw bedding in Individual maternity pens	1. Overcrowd group maternity pens
	2. Monitor cows every 3 to 6 hours after the onset of stage one of calving	2. Unnecessarily disturb cows during stage one or two of calving
	3. Intervene at least 2 hours after the onset of stage two of calving	3.Tether heifers at calving, unless of assistance
Post calving	1. Assess calf vital signs immediately after calving.	1. Cut the umbilical cord or rupture it prematurely.
	2. Acquire resuscitation aids and train staff in use of resuscitative techniques	3. Assume a weak calf will eventually suck adequately.
	4. Implement umbilical antisepsis	2. Leave the calf with the dam in herds with paratuberculosis

Source: Mee (2008**)**

2.3.1 Dairy Calf Morbidity and Mortality

Control of calf deaths is vitally important for producers, not only to improve animal welfare, but also to increase productivity. Acute neonatal diarrhea due to pathogenic agents and respiratory disorders, including pneumonia are the most common causes of calf death (Uetake, 2013). Success of raising calves for replacement ensures future of the dairy sector. The impacts of calf diseases could be direct, causing calf deaths, and indirect through increased treatment expenses and decreased lifetime productivity and survivorship. Recognizing the disease signs and effective treatment of sick calves serves to reduce calf mortalities. Calves older than three months of age are at lower risk of mortality than younger calves. Amount of fat in the feed, birth weight and ventilation house affects calf mortalities. Calf mortality varies considerably from herd to herd, generally as herd size increases, mortality increases and vice versa (Urie *et al.,* 2018).

The first six hours of life is the period in which maximum absorption of colostral immunoglobulins take place. The delayed first colostrum feeding (later than 6 hours) is associated with higher risk of mortality. Higher risk of morbidity is related to failure of passive transfer of colostral immunity. Older calves (more than three months) and those kept in dirty and unclean barns are at higher risk of morbidity. Delay in early detection and treating the calf from infectious diseases such as acute neonatal diarrhea increases the rate of mortality (Uetake, 2013).

Another problem associated with calf viability and health is preparturient management (Lorenz *et al*., 2011). For sustainability of the calf this problem has to be addressed both at farm and animal level through best choice of sire and sire breed, dam vaccination and nutrient intake in early pregnancy (Boersema *et al*., 2010).The fact that the calf is born without protective immunoglobulins (Ig) then successful passive transfer of maternal Ig from colostrum should be achieved through the quality of colostrum, the calf's ability to absorb Ig and the volume ingested. However, this can be affected through quickness, after birth, with which the first colostrum feeding is provided, failure of passive transfer increases morbidity and mortality in dairy calves. Successfulness passive transfer of immunity, cab ne achieved when the calf is fed high quality colostrum soon after birth (IgG >50 mg/mL). This will reduce mortalities meanwhile increasing weight and average dairy body weight gains (Priestley *et al.,* 2013; Nilusha *et al.,* 2015).

Table 4 below shows the disease syndrome of which diarrhea is the most killing disease rating 39% of risks where by the crude mortality was 22% and that of morbidity were 66%.

Table 4: Disease Conditions, Crude Morbidity and Mortality Rates in Calves

Disease syndrome	Number of cases	Calf days at risk	Incidence rate True rate/ 6 calf month at risks	Risk rate (%)[a]
Diarrhea	58	20661	0.50	39
Pneumonia	5	21191	0.04	4
Joint ill (arthritis)	7	21171	0.06	6
Navel ill (Omphalitis)_	5	21191	0.04	4
Septicemic condition	6	21181	0.05	5
Congenital problems	12	185 [b]	6.5 [c]	-
Miscellaneous cases	23	21241	0.19	17
Crude morbidity	116	21241	0.98	62
Crude mortality	029	12241	0.25	22

Source: Wudu (2008)

a = derived from the formula: Risk rate=1-e-$^{\text{true rate}}$ (Meek, 1987)

b = number of calves, c = prevalence.

2.3.2 Weight for Age

Gradual weaning from milk can increase calf starter consumption and reduce the growth check. However, there is little knowledge about the effect of different durations of gradual weaning on starter intake and weight gains of calves fed large amounts of milk. When calves are weaned gradually there is relationship between mode of weaning and weight gain of calves (Sweeney *et al*., 2010). The following Table (5) shows improved starter intake due to reduced available milk and therefore there will be reduced total digestible energy intake before weaning. Weight gain is reduced when there is low intake of starter because abrupt weaning of calves involves large reduction in amounts of milk. Due to reduced performance, producers are taking too long before weaning hence increase age for weight (Roland *et al*., 2016).

Table 5: Gradual Weaning of Calves Fed Large Amounts of Milk

Treatment	Age when weaning began (d)	Duration of weaning period (d)	Average daily reduction in milk allowed (kg/d)
22-d weaning	19	22	0.55
10-d weaning	31	10	1.20
4-d weaning	37	4	3.00
Abrupt weaning	41	1	12.00

Note: Before weaning all calves were allowed to drink up to 12 kg/d of milk.

Source: Sweeney (2010)

Intake of starter feed during the milk feeding of calves can be reduced by feeding calves large amount of milk which in turn may lead to loss of weight when calves are weaned. Abrupt weaning can lead to increased cross sucking and signs of hunger which will compromise with the constant growth. Constant growth rate is ensured if weaning is introduced gradually by reducing liquid feeding over number days, gradual weaning from milk can increase calf starter consumption whereas gradual reduction in the available milk before weaning improves the consumption of starter feed though calves cannot fully compensate for the reduced milk (Sweeney *et al*., 2010). The sooner an adequate amount of starter is consumed, the sooner weaning can successfully occur (Kertz and Loften, 2013).

2.3.3 Calves Average Daily Gain (ADG)

Dairy calves are often separated from the cow soon after birth and prevented from suckling. By letting the calf to free suckling, there is an increased weight of about 1kg/day (Julie *et al*., 2015). Partial suckling leads to high calf weight gains (Johnsen *et al.,* 2015). Calves get distress from the dam (Froberg *et al*. 2011) hence gaining less weight (Veissier *et al*., 2013). Improved average daily gain has been observed in dairy calves that are offered solid feeds early compared to those not eating the feeds. Calves learn early to feed when given solid feeds. Without learning *per se,* calves pay attention to other animals during approaching, manipulating and eating hence faster response initiation (Costa *et al*., 2016).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Sites

The study was conducted in Nakuru County, an area of I7, 495.1 Km^2 at geographical coordinates of 036° 04′ 00″ E00° 16′ 60″ S. The County has warm and temperate weather with average temperatures of 17.5ºC (Egerton University Meteorological Station, 2017) and a bimodal rainfall pattern, averaging 1800mm during the long rains between March, April, May and June and 500mm during the short rains that occur between October and November.

According to the County's department of Agriculture, Livestock and Fisheries, 70 per cent of the total land acreage in Nakuru is agriculturally productive, with a huge capacity for livestock production, especially for dairy cows.

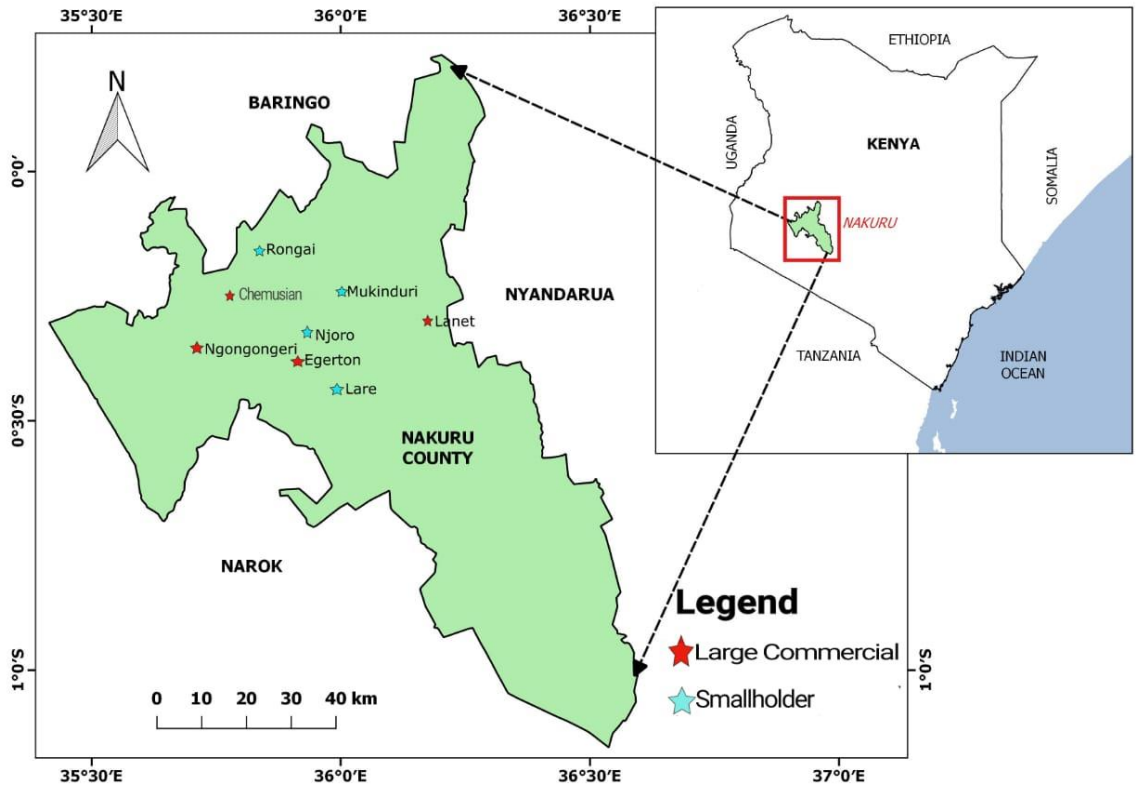

Figure 1: Map of the Study Area

Albert, N.F. (2019). Map of Nakuru County

3.2 Sample Size and Sampling Procedure

This study focused on calf shelter, calf pen beddings, pen ventilation, colostrum feeding methods, colostrum source, first colostrum, roughages, concentrate, vaccination and deworming programme, occurrences of diseases and treatment, pen disinfection as well as dairy calves management practices. A minimum sample size of 150 calves was determined from application of the formula of Kish (1965):$Y= [1.96*SD/ME]^2$ in which Y is the minimum sample size, SD is the standard deviation and ME is the margins of error at 95% confidence interval (1.96). Inputs in the formula were standard deviation of 375 g/d (mean 443g/day) average daily weight gain and margins of error at 60 g/day that were observed by Makau *et al* (2018) in a study of 321 calves in the Kenya highlands. The formula inputs were for sample size that allows 80% chance at 5% level of significance of detecting a minimum difference in mean average daily weight gain of 60 g/day which falls at the lower deviation from the mean (443±375 g/day).

In order to avoid human bias in the selection of cases (farms and dairy calves) to be included in the sample, Simple random sampling method in which sample members from a group of farmers (Cooperative members and the large commercial group) and preweaned dairy calves were selected. Randomization starting with a fixed, periodic interval was applied. This interval, called the sampling interval, was calculated by dividing the population size by the desired sample size per group (Lyman, 2010).

Actual sampling captured 157 calves in 16 smallholder and 4 large scale herds, which corresponds to the composition of the national dairy herd: about 75% are smallholder herds. The four large dairy herds were approached (Lanet ADC, Ngongongeri, Chemusian and Tatton Agriculture Park) while 16 smallholders (belonged to the cooperatives, they were receiving extension services) herds were randomly selected among four dairy cooperatives: Njoro cooperative farmers Society, Kerma dairy group-Rongai, Lare dairy farmers group and Mukinduri dairy cooperatives. The members of these dairy cooperatives have received several training on recommended calf management practices. So the differences in calf performance between their herds and those of large commercial herds were hypothesized to be related to attitudes and management practices.

3.3 Data Collection

3.3.1 Data on Producer Attitudes and Management Practices

Data was collected on producer attitudes and calf management practices on housing, feeding and health using structured questionnaire administered to farm owners. The set of questions describing attitudes were on a five (1 to 5) Likert scale: 1=strongly disagree, 2=disagree, 3=undecided, 4=agree and 5= strongly agree while management were assessed basing on the frequency of practices whereby questionnaires were administered to 20 dairy farms.

3.3.2 Data on Calf Growth Performance

Data on calf performance were from calves before their weaning age. During data collection, calf weights at birth and on the day of data collection together with the age of the calf were collected for calculating the average daily gain (the most studied variable reported) of the individual calves. This was necessary in absence of animal recording practice in smallholder herds. The variables defining attitudes, practices and performance are shown in Table 6.

Table 6: Variables Defining Producer Attitude, Management Practices and Dairy Calf Performance

Management area	Indicator variable	Measurable Unit
Housing	1.1 Pen disinfection frequency	*Likert scale 1 to 5
	1.2 Abrupt weaning	*Likert scale 1 to 5
	1.3 Calf bedding	Straw, wood shavings, sand, No bedding others
	1.4 Bedding changes	Frequency of changing/month
	1.5 Grouping of calves	Number of calves per pen
	1.6 Pen Ventilation type	Natural, mechanical, Tunnel, others
	1.7 Calf pen	Using group pen, Using individual pen, Pen exposed to elements, pen fully enclosed, pen disinfection at cleaning
Feeding	1.8 Concentrate intake at weaning	Kg/day/calf
	1.9 Calf feeding plans	Milk allowance at start, Peak (Litres/Calf)
	1.10 Colostrum source	Dam only, Other cows, pooled fresh, Pasteurized dam only
	1.11 Amount of colostrum delivered	Litres/calf
	1.12 Colostrum delivery method	Nurse from dam, Bottle only Nurse and bottle, others
Health	1.13 Vaccination	*Likert scale 1 to 5
	1.14 Deworming	*Likert scale 1 to 5
	1.15 Treatment	Kind of drug used in treatment
	1.16 Control of ectoparasites	*Likert scale 1 to 5
	1.17 Methods of controlling ectoparasites	Acaricides, Paddocks, Rotational grazing, Traditional treatments, Others
Performance	1.18 Weight for age	Kg
	1.19 Weaning age	Weeks
	1.20 Average Daily Gain (ADG)	g/day
	1.21 Survival rate	Number of calves alive/births
	1.22 *E.coli* load	Bacterial counts in feaces (cfu/mL)
	1.23 Packed Cell Volume	Percentage (%)
	1.24 Haemoglobin concentration in blood	HbConc;g/dL
	1.25 Colliforms	cfu/mL
	1.26 Total Viable Counts	cfu/mL

*1=strongly disagree, 2=disagree, 3 =undecided; 4= agree and 5=strongly agree (for attitudes) * For management practices the likert based on the frequency of practices

3.3.3 Data on Calf Health Performance

During farm visits, measurements were on calf weight and collection of their blood and fecal samples for examining immunity levels as indicative of health status. The calf fecal and blood samples were collected aseptically for laboratory analysis for presence of *E. coli* loads counts, Coliforms and Total viable counts, being health indicators. Packed Cell Volume (PCV), haemoglobin levels were analyzed.

i) The Total Variable Counts (TVC) and Coliform Counts

The media was prepared serially; a serial dilution is the stepwise dilution of a substance in solution. Usually the dilution factor at each step is constant, resulting in a geometric progression of the concentration in a logarithmic fashion as shown in figure 2 below Mackie and McCartney, 1989). The technique used to make a single dilution was repeated sequentially using more and more dilute solutions as the "stock" solution. At each step, 1ml of the previous dilution was added to 9ml of distilled water. Each step results in a further 10-fold change in the concentration from the previous concentration.

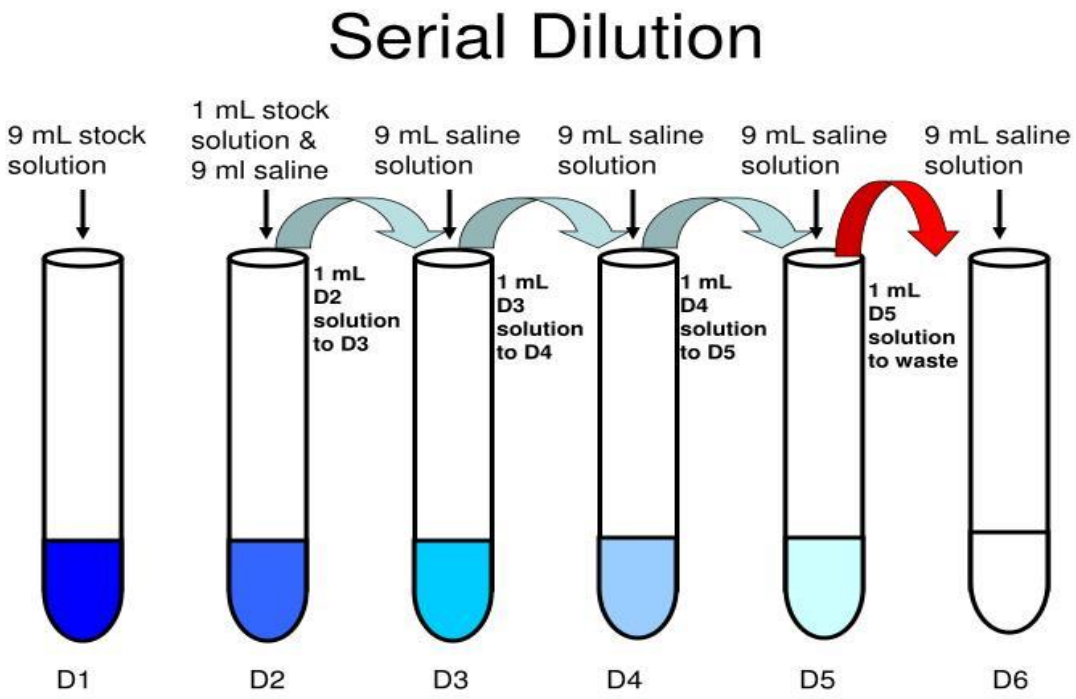

Figure 2: Serial dilution
Source: Mackie and McCartney (1989).

The spread plating method (method of isolation and enumeration of microorganisms in a mixed culture and distributing it evenly) was used whereby the media was prepared separately and poured into Petri dishes while still in liquid form (Figure 3). The technique makes it easier to quantify bacteria in a solution. The media was left to solidify. After solidifying, a 23.5 grams volume from the diluted sample was put to each Petri dish, with the help of a sterilized spreading rod; the sample was evenly spread over the media. The plates were then incubated at 32^{o}C for 48 hours the period of time which the growth is realized. The distinct colonies were counted and expressed in colony forming units per ml.

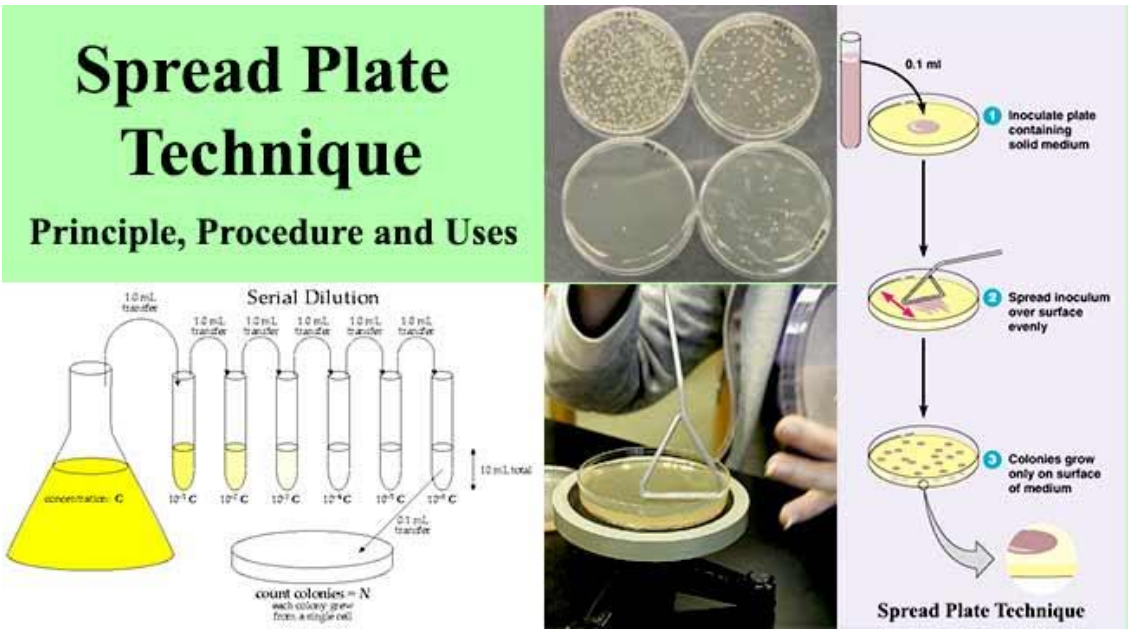

Figure 3: Spread Plate Technique
Source: Mackie and McCartney (1989).

Coliforms were determined from 157 fecal samples that were collected using sterile glass tubes, refrigerated and processed within 6 hrs. Dilutions of fecal samples (cooled mixture) were dispensed into sterile Petri Plates. There after the plates were incubated at 37^{o}C for 48 hours. Then observation, readings, results were taken/recorded for analysis.

ii) Haemoglobin Concentration (% Hb concentration)

Concentrated Hcl is 12 M, which means 12 moles/L or 0.012 moles/mL. A 0.1 M solution of Hcl has 0.1 moles/L, so for 1 litre of solution, you need 0.1 moles of Hcl. To get 0.1 moles of Hcl it requires 8.33 mL con Hcl: (0.012 moles/mL)(x mL) = 0.1 moles x = 0.1/0.012 = 8.33mL. One litre of solution needs to dilute 8.33 mL of con HcL up to a total volume of 1 litre (meaning that 8.33 mL is added to con Hcl to 991.67 mL water). For the purpose of this study 0.1M of Hcl was prepared by adding about 100ml of distilled water in a cleaned and

dried 1000ml volumetric flask, about 8.5 ml of Conc. Hydrochloric acid was added followed with continuous stirring. About 990ml of distilled of water was mixed thoroughly and allowed to cool to room temperature (William and Barbara, 2011). By using Pasteur pipette, the graduated tubes were filled up to the 0.15ml with 0.1Hcl. For proper mixture of the blood, the tube was inverted several times and 0.02ml of the blood was taken. By using tissue paper any excess blood were removed. The blood was gently added into the acid in the tube followed by thorough cleaning the pipette. The tube was allowed to stand for 5 minutes followed by adding water using a dropper until the blood-acid solution matched the standard. The blood was carefully mixed by using a glass rod each time when water was added. The volume reading was recorded when close to the matching point.

iii) Packed Cell Volume (PCV)

The blood sample was mixed by inverting the heparinised tube containing the blood several times. By inserting the capillary to the heparinised tube containing the blood, the blood was allowed to rise in the capillary tube by about two-thirds full. The unfilled end of the tube was sealed. By using the haematocrit centrifuge, the capillary tube containing blood samples were centrifuged for five minute at 11,000 rpm.

3.4 Data Analysis

3.4.1 Determining Producer Attitudes and Calf Management Practices

The measures of producer and herd characteristics were categorical data in small sample farms (n=20). Consequently, the statistical significance between smallholder and large commercial producers in attitudes and management practices were detected using non parametric chi square test. The Likert scale (1 to 5) measures of the various management practices of this same small sample was analyzed using Mann-Whitney U test to detect differences based on mean rank test statistics.

3.4.2 Determining Calf Performance

The variables defining calf performance were measured in continuous scale on 157 calves. The statistical differences between smallholder and large commercial herds in calf's average daily weight gain; Total viable counts, Coliform counts, and packed cell volume (PCV) were detected using parametric two independent sample t-test. The data on presence of *E. coli* in fecal samples, being binary variable (present, absent), was analyzed using binary logistic regression model to obtain the odds likelihood of *E. coli* presence in calf fecal samples.

CHAPTER FOUR

RESULTS

4.1 Sample Characteristics

Table 7 summarizes sample characteristics of the dairy farmers in Nakuru County, showing that at least half of the smallholder dairy producers had attained secondary level education whereas almost all large commercials were possessing tertiary level. The majority of the surveyed dairy farmers were aged between 41-50 years, with regard to dairy farming experience the farmers were experienced for 6-10 and above 20 for the smallholder and large commercial dairy farmers respectively.

Table 7. Dairy Farmers Characteristics in Nakuru County, Kenya

Variables	Indicator	Herds	
		Smallholder (%)	Large commercial (%)
Age (Years)	31-40	18.6	50.0
	41-50	50.0	50.0
	Above 50	31.4	0.00
Education	Primary	18.8	0.00
	Secondary	50.0	0.00
	Tertiary	31.2	100
Farming experience (Years)	2-5	18.7	0.00
	6-10	37.5	25.0
	11-20	18.8	25.0
	Above 20	25.0	50.0

Dairy farm characteristics were significant between the stallholders and large commercial dairy farmer. Majority (68.7%) of the smallholder were getting 5-10 litres of milk per day per cow compared to 50% of the larger commercial dairy farmers who were getting an average of about 15 liters of milk per day per cow. Significance were also observed on the total farm area in ha ($p<0.05$), area under dairy production in ha ($p<0.001$) and the total number of dairy calves ($p<0.001$) whereby the large commercial dairy farmers were far better the smallholder farmers. Insignificance was notice in the primary livelihood whereby 81.2% of the smallholders were practicing mixed farming and 50% of the large commercial where for business dairy farming (Table 8).

Table 8. Dairy Farm Characteristics in Nakuru County, Kenya

Variables	Scale	Herds		Chi square ($\chi 2$)statistic
		Smallholder (%)	Large commercial (%)	
Milk production per day per cow (Litres)	5-10	68.7	50.0	9.4**
	11-15	31.3	0.0	
	Above 15	0.0	50.0	
Primary livelihood	Dairy farming	6.3	25.0	4.8
	Mixed farming	81.2	25.0	
	Business	12.5	50.0	
Farm total area (Acres)	0.5-5	37.5	0.0	11.7*
	5.5-10	50.0	0.0	
	Above 10	12.5	100.0	
Area under dairy Production (Acres)	0.25-3	81.3	0.0	20.0***
	3.5-5	18.7	0.0	
	Above 10	0.0	100.0	
Total dairy calves	Less than 5	100.0	0.00	20.0***
	21-50	0.0	25.0	
	Above 50	0.0	75.0	

*P<0.05; **P<0.01; ***P<0.001

4.2 Producer Attitudes Towards Calf Housing, Feeding and Health Management Practices

Table 9 shows the attitudes of smallholders and large commercial dairy producers towards best practices recommended for calf housing, feeding and health management. Compared to large commercial producers, smallholders expressed more ($p<0.05$) negative attitude towards practicing recommended housing (importance and frequency of pen disinfection, importance of calf beddings and frequencies of change), feeding (concentrate supplementation, colostrum feeding, feeding on particular plan and weaning procedures) and health (importance of vaccination ,control of ecto parasites and importance of using anthelminthic) vaccination, deworming and ecto parasite control) management. The results showed no differences in housing (Pen ventilation and grouping of the calves) and Health (importance of treating calves).

Table 9: Producer Attitudes Towards Recommended Calf Housing, Feeding and Health Management Practices.

Variable	Farm	Median (mean rank)	p-value
Pen disinfection is important	Smallholder	3.0 (8.7)	0.003
	Large commercial	5.0 (17.8)	
Pen disinfection should be done frequently	Smallholder	3.0 (8.8)	0.005
	Large commercial	5.0 (17.5)	
Calves should be grouped	Smallholder	3.0 (9.5)	0.148
	Large commercial	5.0 (14.4)	
Calf pen should be well ventilated	Smallholder	4.0 (10.1)	0.617
	Large commercial	5.0 (12.0)	
Calf bedding is important	Smallholder	2.0 (8.8)	0.005
	Large commercial	5.0 (17.5)	
Beddings should be changed	Smallholder	3.0 (8.8)	0.007
	Large commercial	5.0 (17.3)	
Abrupt weaning is favours young calves	Smallholder	2.0 (12.4)	0.002
	Large commercial	1.0 (3.0)	
Calves should be fed on a particular plan	Smallholder	3.0 (8.9)	0.011
	Large commercial	5.0 (16.9)	
Newly calf born should be fed with colostrum	Smallholder	3.0 (8.9)	0.011
	Large commercial	5.0 (16.9)	
Calves should be supplemented with concentrates	Smallholder	3.0 (8.8)	0.007
	Large commercial	5.0 (17.3)	
Vaccinating dairy calf is important	Smallholder	3.0 (9.1)	0.029
	Large commercial	5.0 (16.3)	
Treatment of dairy calves is important	Smallholder	1.0 (10.2)	0.793
	Large commercial	1.0 (9.0)	
Control of ecto parasites in my farm is important	Smallholder	2.0 (8.8)	0.007
	Large commercial	5.0 (17.1)	
Use of anthelimithes is important	Smallholder	1.0 (8.7)	0.003
	Large commercial	5.0 (17.6)	

* Likert scale (1-5 Points) denoting level of agreement

4.3 Producer Management Practices on Calf Housing, Feeding and Health

Table 10 shows implementation of the recommended calf management practices by smallholder and large commercial dairy producers. Compared to large commercial dairy producers, smallholders were poorer ($p<0.05$) in implementing recommended calf housing practices. Pen disinfection was of less value to improve calves welfare (mean rank 9.2 Vs 15.8), recommended feeding practices were less practices by the smallholders compared to the large commercial dairy producer as shown by the following results, feeding calves with colostrum, Feeding calves on specific plan, Amount of milk fed to calves at start and Amount

of concentrates fed to calves were both significantly different between the smallholder and large commercial dairy calves producers.

Table 10. Producer Management Practices on Calf Housing, Feeding and Health

Variable	Farm	Median	(Mean ranks)	p-value
Calf pen disinfection adds value to the Calve welfare	Smallholder	3.0	(9.2)	0.050
	Large commercial	5.0	(15.8)	
Frequency of pen disinfection	Smallholder	3.0	(12.3)	0.003
	Large commercial	1.0	(3.4)	
Importance of using bedding in your farm	Smallholder	3.0	(9.7)	0.211
	Large commercial	4.0	(13.9)	
Frequency of bedding changes	Smallholder	5.0	(10.8)	0.617
	Large commercial	5.0	(9.1)	
Practice of grouping calves	Smallholder	2.0	(11.0)	0.494
	Large commercial	1.0	(8.5)	
I do wean calves abruptly	Smallholder	2.0	(10.0)	0.494
	Large commercial	2.0	(12.5)	
Feeding calves with colostrum	Smallholder	4.0	(9.0)	0.022
	Large commercial	5.0	(16.5)	
Feeding calves on specific plan	Smallholder	2.0	(8.7)	0.003
	Large commercial	4.5	(17.8)	
Amount of colostrum fed to calves	Smallholder	4.0	(9.8)	0.810
	Large commercial	4.5	(10.8)	
Amount of milk fed to calves at start	Smallholder	4.0	(9.2)	0.039
	Large commercial	5.0	(15.9)	
Amount of milk fed at the peak	Smallholder	2.0	(9.6)	0.178
	Large commercial	4.5	(14.3)	
Amount of concentrates fed to calves	Smallholder	2.0	(8.5)	0.000
	Large commercial	5.0	(18.5)	
Outsource animal feed	Smallholder	3.0	(9.9)	0.385
	Large commercial	3.0	(13.0)	
I do vaccinate calves in my farm	Smallholder	2.0	(8.7)	0.002
	Large commercial	5.0	(17.9)	
I do deworm calves in my farm	Smallholder	1.0	(10.9)	0.617
	Large commercial	1.0	(9.0)	
I do treat sick calves in my farm	Smallholder	4.0	(9.9)	0.385
	Large commercial	5.0	(13.0)	
I do control ectoparasites in my farm	Smallholder	2.0	(12.1)	0.011
	Large commercial	1.0	(4.0)	
I do you use antihelmithis	Smallholder	1.0	(11.3)	0.290
	Large commercial	1.0	(7.5)	

* Likert scale (1-5 Points) denoting frequency of practice

Vaccination of the dairy calves and controlling of the ecto parasite as the recommended health management practices was significantly different between the smallholder and the large commercial dairy farmers (Smallholders were practicing poorer). The result showed statistical similarities in use of the calf bedding and frequencies of changing, treatment of the sick calves, use of antiheminthics, deworming, grouping of calves as well as weaning producers whereby the parameters were statistically the same ($p>0.05$) .

4.4 Influence of Feeding and Health Management Systems on Calf Performances

Table 11 shows difference on performance between calves in smallholder and large commercial dairy herds. Compared to large commercial herds, smallholder herds had calves with lower ($p<0.05$) blood haemoglobin concentrations (5.9 vs 8.3 g/dL), average daily weight gain (307.3 vs 435.4g/day) and packed cell volume (36.9 vs 42.0%). The large commercial dairy calves had higher coliforms means than the smallholder (7.0 vs 6.9 cfu/mL) contrary to the total viable counts (7.0 vs 7.1 cfu/mL).

Table 11: Dairy Calf Performances

Variable	Herds	Mean	Mean difference	Standard error of difference
Hb concentration (g/dL)	Smallholder	5.9	-2.42	0.28*
	Large commercial	8.3		
Average dairy gain (g/day)	Smallholder	307.3	-128.10	13.00*
	Large commercial	435.4		
Packed cell volume (%)	Smallholder	36.9	-5.13	1.13*
	Large commercial	42.0		
Total viable counts(cfu/mL)	Smallholder	7.1	-0.04	0.04
	Large commercial	7.0		
Coliforms (cfu/mL)	Smallholder	6.9	-0.07	0.06
	Large commercial	7.0		

*$p<0.05$

The laboratory results showed that smallholder herds had higher prevalence ($p<0.006$) of fecal *E. coli* (70.1 vs 52.2%), which was 2.569 times more likely present (Table 12).

Table 12: *Escherichia coli* Prevalence (%) and Odds of Presence in the Herd

Farm	Calf sample (n)	% positive	Odds ratio	95% CI	p-value
Smallholder	67	70.1	2.569	1.318 - 5.005	0.006
Large commercial	90	52.2			

CHAPTER FIVE

DISCUSSION

The research interest was to determine whether attitudes and management practices that producers hold and implement in calf housing, feeding and health significantly differs between smallholder and large commercial dairy producers. Data was available from a small sample of producers (4 large and 16 smallholder herds) measured on nominal and ordinal scale. The hypothesis testing applied non parametric, Mann-Whitney U test on the median and mean rank.

5.1 Dairy Producer Attitudes on Calf Housing, Feeding and Health

An attitude towards calf housing, feeding and health management practices is important attribute to implement the recommended best management practices. Attitudes can be influenced by the level of education and age (Table 7) whereas the very young or very old farmers tend to ignore some of the recommended management practices. Negative attitude by the dairy producers were noticed (Table 8) in the farm productivity whereby the milk production per cow per day was 5-10 litres and above 15 litres for the smallholders and large commercial dairy farmers respectively this could be due to inadequacy in the knowledge of dairy farming, low purchasing power and/ or negligence in managing their herds. This is supported by Sumner *et al*. (2018) who concluded that information, economy and ignorance can influence a person's attitude and behavior toward a phenomenon. Smallholders had more negative attitudes towards the recommended calf housing; feeding and health management practices and so poorly implemented the best management practices.

Calf pen disinfection and frequency of disinfecting as one the producer attitudes was considered by the smallholder as of less importance. This could encourage an environment favorable for multiplication of disease pathogens which compromises the calf's welfare consequently affecting calf performance. This is in agreement with Jorgensen *et al*., (2017) and Pempek *et al*., (2017) who recommended on the existence of direct relationship between calf pen, pen disinfection and their influences on the calf performance.

Apart from pen disinfection, calf pen should be well design to allow air circulation. A well ventilated calf pen helps in reducing the incidences of respiratory diseases due to minimization of air borne pathogen load, early detection of disease infections, and easy treatment of sick calves and reduce pathogen loads in the calf pen (Lindsey and Sonia, 2016;

Jorgensen *et al*., 2017). During the research it was observed that there were no differences on providing ventilation to the calves this could have been attributed by the trainings from their cooperatives and the extension services received. However, both farmers showed no significance in practicing the grouping of the dairy calves where by nearly all of them where keeping the calves in separate calf pens (Table 10). The use of a single calf pen can promote calf performance as it ensures early detection of sick calf, avoids risks for direct contacts and risks of disease transmission via feeding and drink troughs. The separation idea was supported in the previous studies by Marce´ et *al*. (2010) who said that individual calf pen is important in ensuring calf performance since it avoids competition for feed, water and enough time for the calf to relax consequently increase in weight gains. This is in agreement with the reports by USDA, (2008) which indicates that majority of the dairy farmers are practicing individual pen.

Individual housing was preferred by some farmers on the basis of ease of management and perceived benefits to calf health; however the practice has been criticized on welfare grounds as it limits the opportunity for the calves to perform social behaviors. Social housing early in life is known to benefit calves by reducing weaning distress and improving performance after weaning when calves are typically introduced into group housing (De Paula *et al*., 2012; Gaillard *et al.*, 2012). Furthermore the daily weight gains could have been influenced by the housing system of the calves (Table 11). The farmers were keeping their calves in individual pens this can hinder social feeding behavior since development of normal social behavior is improved by social housing; this is supported by Duve and Jensen, (2011) and Miller-Cushon *et al*. (2014) who found that social housing improves growth and welfare of dairy calves, through reducing stress and supporting weight gain around weaning however this argument was previously challenged by De Paula *et al*. (2010) due to its weakness of challenges for feed access and competition for access to milk.

Dairy calves need to be kept in a clean, dry pen with beddings. Furthermore the bedding need to be changed and through cleaning of the floor. The research found that the smallholders were not effectively and in some cases they were not using the beddings in the pen. This attitude greatly could affect calf health by interfering with thermoregulation hence causing stress to the calf as previously noted by Phiri *et al*. (2010) who pointed out that without changing the calf beddings, dairy calf's health will be compromised consequently hindering calf performance. The large commercial was in agreement with the do's of the newborn calf

management strategies recommendation by Mee (2008) that the calf should be provided with beddings and they should be frequently changed. Furthermore, bedding should be dry since wetness has the direct relationship with *E. coli* preferences as put forward by Yeshiwas and Fentahun, (2017) who concluded that the occurrence of *E. coli* is high in muddy or wet livestock floor. This attitude is important since it ensures cleanliness of the calf pen for ensured calf welfare and performance; the concept is supported by Peña *et al*. (2016) by concluding that housing should be clean, dry and well ventilated for easier management.

Dairy calves feeding attitudes were greatly different between the smallholders and large commercial dairy farmers. Dairy calves need to be fed with colostrum of not less than four litres of good quality within 12 hours after birth failure to which can lead into mortality, reduced early calves' body weight and risk of disease such as diarrhea and respiratory illnesses. Consequences of the above outcome are increased weaning interval and higher cost of production (Vasseur *et al.,* 2010). The significance differences on the average daily gain 307.3Vs 435.4g/day (Table 11) observed could be due to poorer attitude in feeding.

Attitudes in feeding practices of the newly calf with colostrum, concentrates and feeding plans greatly affects calf performances (Menjo *et al*., 2009). Consumption of concentrates enables the development of the rumen necessary for the calf to digest solid feed. Negative effect on calf performance, may be due to the reduction in concentrate intake, this is in agreement with Gleeson and O'Brien (2012) who demonstrated an improvement in performance with calves remaining indoors until 10 weeks of age on *ad-libitum* concentrates compared to calves going to grass at 4 weeks on a restricted concentrate intake. Feeding of colostrum ensures calf health and survival welfare. Improvement in milk feeding, amount and kind of feed fed to the calves promotes and increases early calves' body weight (Vasseur *et al*., 2010). This is also in agreement with (Hill *et al.,* 2015) who said that feeding multiple time daily or increased feeding promotes increase in average daily gain in daily calves.

The smallholder's dairy calves were greatly affected by the *E. coli* loads of 70.1% compared to 52.2% for the large commercial (Table 12), this could be attributed by the feeding habits attitude. Feeding dairy calves with colostrum is very important since colostrum provides the mucosal barriers for preventing disease pathogen (Lindsey and Sonia, 2016). Level of serum immunoglobulin GI (IgGI) is also associated with the amount of colostrum fed to calves and timing of colostrum ingestion. Due to the fact that smallholder were largely mixed farmers

while large commercials were mostly for business dairy farming (Table 8), dairy calves were not given enough colostrum hence reduced levels of immunoglobins. Reduced level of IgGI leads to increased mortality as has been put forward by Gomez (2016) who further reported that that approximately 30% of pre weaning calf mortality occurs during the first 3 weeks of life and this mortality can be attributed to failure in the transfer of passive immunity, lower daily weight gains together with lower milk produced during the first lactation (Uetake, 2013). Foe ensured enough colostrum supply, in cases where colostrum from the dam is not enough, artificial colostrum should be provided to ensure levels of IgGI is reached.

Smallholders' attitudes of supplementing the dairy calves were not effectively practiced compared to the large commercial dairy farmers. This could to be due to low purchasing power of the smallholder farmers since all producers were out sourcing animal feed for supplementation (Table 10). Method of weaning greatly affects the amount of feed eaten, development of the rumen and post-weaning weight gain. Calves should be weaned gradually; this can be achieved by switching to once-a-day milk feeding if feeding twice-a-day or by reducing the volume of milk fed over a 7-10 day period. This approach will lead to an increase in concentrate intake and will avoid poor weight gains post weaning. Dairy calves need to be fed with concentrates to ensure provision of maximum energy. This practice was not fully practiced by the smallholder farmers' hence compromising calf performance by reduced average weight daily gains. Concentrates should be taken in the expense of liquid feeding hence maintain weight gains (Heinrichs, 2011; Bateman *et al*., 2012; Chapman *et al*., 2016).

Feeding of the dairy calves should be done on schedule basis; this will allow proper digestion to take place. Conditional feeding reduces the calf stress during post weaning because gradual weaning reduces the amount of milk consumed hence increase starter consumption which in turn will positively affect post weaning growth. Dairy calf should be fully prepared for weaning, this will reduce the chance she will need preferential treatment after weaning. Low intake of starter due to abrupt weaning will result into reduced weight gains consequently increase age for weight (Roland *et al*., 2016). Smallholder dairy farmers were neither feeding on plan nor weaning on schedule basis which could have been resulted into decreased average daily gain as opposed to the large commercial dairy farmers (Table 11) consequently there could be an increased weaning age for the smallholders and vice versa. Improper feeding regime and weaning practices compromise the rumen development hence affecting post weaning growth (Hill *et al.*, 2010; Sweeney *et al*., 2010; Roland *et al*., 2016), this is supported

by (Kertz and Loften, 2013) who concluded that successful weaning can be reached when there is adequate amount of starter consumed by the calf.

Vaccination, control of ectoparasites and use of antihelmisthics can be used as the biosecurity measures in ensuring calves health. Preventive measures prevent infectious diseases hence minimal usage of antibiotics consequently reducing cost of production. According to Chang'a *et al*. (2010) young livestock are affected by helminthes in many tropical and subtropical environments, so administering anthelminthics 2–4 times a year, depending on climate and management practices, has been recommended for helminth control. Surprisingly, smallholder's attitudes were condemning vaccination as the threat to dairy calves which may have lead into high susceptibility and reduced performance (Tables 11 and 12) of their animals. This proclaiming of the risks due to vaccination was put forward by Pempek *et al*. (2017) who pointed out that some of dairy producers claim vaccination as harmful to the calves' health. According to Pereira *et al*. (2014), vaccination, controlling and treatment of the animals are producer driven so the dairy producer needs to put more efforts in safeguarding the dairy calve for better performing of the dairy calves consequently dairy herds.

5.2 Producer Management Practices of Calf Housing, Feeding and Health

In order to reach the maximum potential of the dairy sector, calf management should be practiced towards implementing recommended calf management practices. Management is driven by the positive attitude of the dairy farmers. By using the likert scale (5 points) with frequencies of practices the research found that stallholder's were poorer in management of the dairy calves.

Dairy calf performance is related with management, understanding the factors associated with calf rearing will increase the chances of success in calf performance since it will ensure better understanding of effects and consequences of techniques adopted on health and performance of calves. The idea was previously suggested by Hötzel *et al*. (2014) by saying that the decisions regarding the management of young cattle markedly affect dairy farming performance, furthermore suggesting that to improve morbidity and mortality rates and calves' welfare, farmers need to understand how morbidity and mortality are related to daily management practices. This agrees with the research done by Fruscalso *et al*. (2017).who said that better understanding of effects and consequences of techniques adopted on calf feeding, housing health helps in improving calf performance.

Disinfecting of the pen is crucial management practice in ensuring the calves welfare because it interrupts pathogen cycle. In comparison with the large commercial dairy farmers, smallholders were rarely disinfecting dairy calf pen as shown by the mean rank 9.2 Vs 15.8 for smallholder and large commercial dairy farmers respectively (Table 10). Apart from calf pen disinfection, the pen should be able to provide comfort zone for calves. Provision of good housing to the calf helps in controlling heat stress which has direct relationship with the feed intake and so influencing growth. During the research it was noted that some of the smallholders were keeping their calves in the enclosed houses and/or kitchen which compromise with the animals' welfare. Housing practice management system needs to be adjusted according to heat or cold weather to enable calves withstands critical temperatures for better performance (Lindsey and Sonia, 2016). According to Roland *et al*. (2016), there is direct relationship between the type of housing and respiratory disease so properly designed calf pen will promote welfare and minimize the incidences of the respiratory disease hence increase calf performance.

Larger portion of the smallholder perceived calf bedding as not important. Implementation of the biosecurity measures such as vaccination, deworming and controlling of the ecto parasites will ensure calf performance; this was not the case for the smallholder herds. Vaccination is very important aspect for dairy calves; however, this seems to be less important for smallholders. These findings are in agreement with previous research showing that dairy producer considered vaccination harmful to calves health (Pempek *et al*., 2017). The outcome of this management practices is that calf performance was compromised in that the daily weight gain was lower in smallholder dairy calves. Furthermore, the result from the research showed weaker implementation of biosecurity measures in smallholders as opposed to large commercial dairy farmers.

There is possibility that due to the dairy farming experience and level of the education between producers (Table 7), large commercial were able to manage their farm very closely as opposed to stallholders which was possibly due to the greater specialization and care associated with calf rearing. Many of the smallholder dairy farms are smallholdings where farmers often lack the resources to develop the most effective rearing systems for young stock. Instead, their attention was primarily directed towards milk production, emphasizing feeding and managing their milking cows. Young stocks may receive insufficient attention because they do not generate income. The research findings noted the big difference on the

smallholders feeding practices when compared to the large commercial dairy farmer (Table 10). Colostrum feeding and proper amount of milk fed about 12L/day ensures calf health and performance. For the guaranteed of passive immunity, colostrum feeding should be timely fed, enough volume and of good quality. Timing of colostrum feeding is negatively correlating with the transfer of passive immunity whereby the lower the time interval, the greater the efficiency of immunoglobulin absorption and vice versa (Glauber and Carla, 2015).

5.3 Calf Performance in Smallholder and Large Commercial Dairy Herds

The research objective was to determine the extent to which calf growth and health indicator variables significantly differs between smallholder and large commercial dairy herds. Data was available from fairly large sample (157 calves) measured on continuous scale. Hypothesis testing used two independent samples t test.

Calf's weight gains are important for ensured calf performances. The weight gains can be achieved through proper feeding and health care management. Improved weight gains, potential for heifer calves with increased preweaning average daily gain results into increased milk production later in life due to feeding practices (Rincker *et al*., 2011; Gelsinger *et al.*, 2016; Rosenberger *et al*., 2017). However, feeding regimens can lead to reduced feed efficiency during the weaning transition (liquid to solid feed) which could be to the reason that preweaning starter intake is negatively influenced by a high milk replacer feeding rate (Van Niekerk *et al.,* 2020**).**

For sustainable dairy herds maintaining daily gain is paramount aspect. The research done by Lukuyu *et al.* (2012) and Makau *et al*. (2018) suggests the average daily gain should be at least 400g/day/calf. This can be attained through proper feeding strategies since feeding has impacts on calves' performances. Survivability and health of the calf is determined by feeding the calves with colostrum which serve as protective colostral immunoglobulins (Ig). The variations in colostrum feeding between the smallholders and large commercial dairy calves showed the extent at which the calves are at risk. Failure of passive transfer (inadequate circulating IgGI concentration) from colostrum will lead into reduced immunity hence increased calf mortality. For ensuring the weight gains is maintained dairy calves need to be fed with lower milk rations before weaning to ensure taking of more solid feed hence reduced weaning stress leading to improved weight gains (Bach *et al*., 2013; Rosenberger *et al*., 2017), however weaning shouldn't be done abruptly, this is in agreement with previous research

which pointed out the effect of abrupt weaning as increase in the signs of hunger associated with low energy intake consequently reduced weight gains. An appropriate weaning strategy is a means of improving calf growth rates (Khan *et al*., 2011; Atkinson *et al*., 2017).

For the guaranteed of passive immunity, colostrum feeding should be timely fed, enough volume and of good quality. Timing of colostrum feeding is negatively correlating with the transfer of passive immunity whereby the lower the time interval, the greater the efficiency of immunoglobulin absorption and vice versa (Glauber and Carla, 2015).There is possibility that due to the dairy farming experience and level of the education between producers (Table 7), large commercial were able to manage their farm very closely as opposed to stallholders which was possibly due to the greater specialization and care associated with calf rearing this is in agreement with previous research which pointed out the effect of abrupt weaning as increase in the signs of hunger associated with low energy intake consequently reduced weight gains (Sweeney *et al*., 2010).

Appropriate feeding strategies are a means of improving calf growth rates (Khan *et al*., 2011; Atkinson *et al*., 2017). For the guaranteed of passive immunity, colostrum feeding should be timely fed, enough volume and of good quality. The risk of failure of passive immunity transfer in bottle feeding is greater than in naturally suckled calves because of intake of inadequate colostrums volume and IgGI and the mothering effect does not provide suitable gain to advocate leaving calves with the dam. During bottle fed the colostrums might be contaminated with many environmental pathogens due to careless management systems (Yeshiwas and Fentahun, 2017). This is in agreement with Windeyer *et al*. (2014) who noted that risks facing dairy calves in the early weeks of their lives such as inadequate colostrum for transfer of passive immunity and inadequate milk to achieve their potential for growth and avoid hunger is due to farmer's education level. Dairy farmers should be well informed by setting benchmark of measuring performance using specific indicators and then comparing performance with that of peers with the intention of improving on those indicators. Increasing farmer awareness and education on health-related practices, such as colostrum management, may encourage improvement in welfare outcomes for calves through the use of benchmarking, data can be used to improve performances by identifying the gaps hence driving the improvements. This is supported by the previous study which showed that benchmarking calf growth and transfer of immunity resulted in some farms changing their

management in ways that improved calf performance (Atkison *et al.,* 2017; Sumner *et al*., 2018).

During the research it was physically noted that several dairy calves in the smallholders were showing the signs of diarrhea (Table12). This could be associated with poor mode of feeding of the smallholder dairy farmers. This is in agreement with the research done by Yeshiwas and Fentahun,(2017) who found higher prevalence *E. coli* in hand (bottle) feeding method colostrum and calves kept with calf pens having bedding material than those with direct sucking of colostrum and pens without bedding material respectively. Furthermore, the research done by Safaa *et al*. (2019) noted that feeding calf colostrum by using the bottle may be a source of *E. coli* contamination. Numerous infectious agents causing diarrhea in animals are zoonotic and they have been associated with food-borne diseases. This was previously concluded by Chang'a *et al*. (2010) who recommended that the most important constraints in dairy calves is diarrhea and its prevalence appears to be management related especially when calves are housed in unhygienic conditions. Diarrhea being one of the most important disorders in young calves is a syndrome of great aetiological complexity that may cause economic losses directly through mortality and indirectly from poor growth (reduced weight gains, Table 11). In addition to the influence of various environments, management, nutritional and physiological factors, the infectious agents capable of causing diarrhea in the neonatal calf are numerous. Despite that diarrheal is caused by bacteria, virus, parasites and other etiological agents *E. coli* is getting recognized as leading cause (Islam *et al*., 2015; Kadam *et al.,* 2018).

The calf performance was greatly affected mostly in the smallholder farmers than large commercial dairy farmers. Dairy calves in the smallholders were found to have lesser packed cell volume (Table 12). The lowered packed cell volume (PCV) could be the signs of lower amount of blood, this is in agreement with previous research which found that by contrast, lower PCV can be used for the diagnosis of anemia or other health problems (Turkson and Ganyo, 2015; Marcato *et al*., 2018).

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

i. Smallholder dairy producers have more negative attitudes than the large commercial dairy producers towards the recommended best practices in calf housing, feeding and health management practices.

ii. Smallholder dairy producers implement calf housing, feeding and health management practices more poorly than the large commercial producers.

iii. Dairy calves attained lower average daily weight gain, reduced immunity levels, higher prevalence of coliform loads and poorer health status in smallholder farmer than the large commercial dairy farms.

6.2 Recommendations

i. Smallholders' farmer needs to change their attitude towards positive ways of implementing recommended calf management practices.
ii. Extension services should be provided and enforcement towards implementing daily farm management practices.
iii. Feeding and health management should be practiced in connection of ensured calves biosecurity measures

6.3 Areas for Further Research

i. Further research on the specific colliform which significantly affects calf's health.
ii. Research on economic impacts due to producers' negative attitudes and poorly management practices of the dairy calves.
iii. Variation in contributions of the greenhouse gas emissions by the large commercial dairy producers compared to the smallholders dairy producers.
iv. Influence of biosecurity measures towards dairy calves performance.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

INFLUENCE OF PRODUCER ATTITUDES AND MANAGEMENT PRACTICES ON CALF PERFORMANCE IN SMALLHOLDER AND LARGE- COMMERCIAL DAIRY HERDS IN NAKURU COUNTY, KENYA

Introduction

This survey will be conducted by a post graduate student of Egerton University in the Department of Animal Sciences in the partial fulfillment for MSc Degree in Livestock Production Systems. The information provided will be used for academic work only and will be treated with ultimate confidentiality.

A: GENERAL INFORMATION

Serial number_____ Date _____

County: NAKURU

A: RESPONDENT INFORMATION		
Name of respondent		Mobile Phone Number:
Respondent Sex:	[ ]	1=Male, 2=Female
Household headship/Farm manager	[ ]	1=Male headed 2=Female headed
Respondent Age	[ ]	1= Below 20 years, 2= 20-30, 3=31-40, 4=41-50, 5=Above 50
Respondent Education level	[ ]	1=None, 2=Primary, 3=Secondary, 4=Tertiary
Dairy Farming experience in years	[ ]	1=<1 , 2= 2-5 , 3=6-10, 4=11-20, 5= > 20
B: FARM CHARACTERISTCS		
Total land area (acres)	[ ]	1= 0.5-5, 2= 5.5-10, 3=10 and above
Area under dairy production	[ ]	1= 0.5-3, 2=3.5-5.0, 3=5-10, 4= 10 and above
Herd size	[ ]	1= less than 5, 2=5-10, 3=Above 10
Milk production per cow/per (In litres)	[ ]	1=1-4, 2=5-10, 3=11-14, 4=15-20, 5= Above 20

Farming system used [ ] 1=Intensive, 2=Semi intensive, 3=others (specify)

Number of dairy calves [ ] 1=<5, 2=6-10, 3=11-20, 4=20-50, 5=>50

Dairy calves less than 90 days [ ] 1=< 3, 2=3-5, 3=6-10, 4=11-20, 5= >20

Primary occupation [ ] 1=Dairy farming, 2=Mixed farming, 3=Cash and food crops; 4=Salaried employment; 5=Business

Give information on the various individual dairy cattle breeds on the farm in the order of farmer's preferences

No	Breed	Registered stud group (1= Yes 2= No)	Insemination type	Insemination source	Diseases	Treatment 1.Yes 2.No	Drugs used
1							
2							
3							
4							
5							

Breed codes; 1= Friesian, 2= Ayrshire, 3=Guernsey 4= Jersey, 5= Crosses, 6=Others (Specify)

Insemination type ;1= AI, 2= Bull, 3=Both 1 and 2

Source of insemination; 1=Private vet, 2=Cooperative vet 3= Government vet/employee, 4=Bull 5= Bull and private vet, 6= NGO

Disease cases 1= Tick-borne diseases 2= Respiratory / Pneumonia 3 = Diarrhea's 4 = Intestinal worms 5= Others (specify)

Drugs used in treatment; 1=Tetracycline, 2= Amoxicillain, 3=Procaine, 4=Ampicillin, 5= Macrolides

B:HOUSING INFORMATION

Please give information on the various housing variables in the farm

Pen disinfection is important [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree,

5=Strongly agree
Pen disinfection should be done frequently [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree Frequency of practice [ ] 1= Never, 2=Rarely, 3=Sometimes, 4=Often, 5= Always How frequently you disinfect your pen [ ] 1=Everyday, 2=Weekly, 3= After cleaning, 4=, Every two weeks 5= Once per month
Calves should be grouped [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree 5=Strongly agree Practice of grouping calves [ ] 1= Never, 2=Rarely, 3=Sometimes, 4=Often, 5= Always What is the number of calves per pen [ ] 1=1, 2= 2, 3= 3, 4=4, 5 = 5 and above
Calf pen should be well ventilated [ ] **1**=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree Pen Ventilation type in your farm [ ] 1=Natural, 2=Mechanical, 3= Tunnel, 4= Others (Specify)
C: **FEEDING INFORMATION** Please give information on the various feeding variables in the farm
Abrupt weaning favours young dairy calves [ ]1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree I do wean calves abruptly [ ] 1= Never, 2=Rarely, 3=Sometimes, 4=Often 5= Always
Calves should be fed on particular plan [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree Feeding calves on a specific plan/Time table [ ] 1=Unimportant, 2= Of little importance, 3= Moderately important, 4= Important, 5= Very important Milk allowance at start (Litres/Calf/day) [ ] 1=1, 2=2, 3=3, 4=4, 5= 5 and above

Milk allowance at peak (Litres/Calf/day): 1=0.5, 2= 1, 3=1.5, 4=2, 5= Above 2

Newly born calf need to be fed with colostrum [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4.Agree, 5=Strongly agree

Feeding calves with colostrum[ ] 1= Not much, 2= Little, 3= Somewhat, 4= Much, 5= A great deal

What is your colostrum source [ ] 1= Dam only, 2=Other cows, 3=Pooled fresh, 4= Pasteurized, 5=Others

What is the amount of colostrum delivered (Litres/calf/day [ ]: 1= 1-2, 2=3 ,3=4, 4=5, 5=Above 5

Colostrum delivery method [ ] 1=Nurse from dam,2= Bottle only 3=Nurse and bottle,4=Others

Calves should be supplemented with concentrates [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4.Agree, 5=Strongly agree

What is the amount of concentrate fed to calf (Kg/day/calf) [ ] 1=1, 2=2, 3=3, 4=4, 5=5

Basal diet

	Napier	Legumes	Fodder trees	Crop residue	Lurcene	Pasture	
Source							
Units							

Source of animal feeds; 1= On farm, 2= Off farm, 3= Both 1 and 2

Feeding units; 1=Kg, 2=wheelbarrows, 3=Pickups, 4=Donkey/hand carts, 5= *Ad libitum*, 6=Others

D:HEALTH INFORMATION

Please give information on the various health variables in the farm

Calf beddings is important [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree 5=Strongly agree

Importance of using bedding in your farm [ ] 1= Unimportant, 2= Of little importance, 3= Moderately important, 4= Important, 5= Very important

What beddings are used in your farm [ ] 1=Straw, 2= wood shavings, 3= sand, 4= No bedding 5= Use of movable of cages

Bedding should be changed [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree

5=Strongly agree How many times per month do you change beddings [ ] 1= Once per month, 2=Twice, 3=Three times, 4=Four times, 5= More than four times
Vaccinating dairy calves is important [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree I do you vaccinate calves in my farm [ ] 1= Never, 2=Rarely, 3=Sometimes, 4=Often, 5= Always What diseases do you Vaccinate against in your farm [ ] 1=FMD, 2=LSD, 3=CBPP, 4=Anthrax,5= Brucellosis,6=BQ
Deworming of calves is important in my farm[ ]1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree I do deworm calves in my farm [ ] 1= Never, 2=Rarely, 3=Sometimes, 4=Often, 5= Always
Treating sick calves is of value for my herd [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree I do treat sick calves in my farm [ ] 1= Never, 2=Rarely, 3=Sometimes, 4=Often, 5= Always If yes What drugs frequently used in treatment; 1= Streptomycin, 2=Ox-tetracycline, 3= Ampicillin, 4=Streptomycin, 5=Macrolides
Control of ectoparasites like ticks etc is important for the betterment of dairy calves [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree I do controll ectoparasites in my farm [ ] 1= Never, 2=Rarely,3=Sometimes, 4=Often, 5= Always What methods do you use in controlling ecto parasites [ ] 1=Use acaricides, 2=Use of paddocks 3=Rotational grazing 4=Traditional treatments 5=Moving cages Use of accaricides is of important in my farm [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree 5=Strongly agree I do use accaricides in my farm[ ] 1= Never, 2=Rarely,3=Sometimes, 4=Often, 5= Always If acaricides is used , technique applied [ ] 1=Dipping 2=Hand spray 3=Hand wash 4=Pour on 5=Spray race

Use of antihelminthics is important [ ] 1=Strongly disagree, 2=Disagree, 3=Undecided, 4=Agree, 5=Strongly agree I do you use anti helminthes [ ] 1= Never, 2=Rarely,3=Sometimes, 4=Often, 5= Always Antihelminthics is used as [ ] 1=Only on individual animals, 2=As a preventive measure
Any incidences of zoonotic diseases within the last 5 years [ ] 1=Yes, 2=No, 3=No idea

If yes, please specify and give the number of cases [ ] Other general comments: ……..
E: PERFORMANCE INFORMATION Please give information on the various performance variables in the farm
Do you access extension services [ ] 1=Yes, 2=No
If yes, the service is offered by [ ] 1.Government, 2. NGO, 3. Cooperative, 4. Private 5. Others
How often you access extension: [ ] 1=None, 2=Once , 3=Twice 4=Thrice 5= > 4 Times
Do you hire labour [ ] 1.Yes 2. No
Frequency of hired labour use; 1=Occasionally 2=Daily 3=Weekly 4=Once every 2 weeks 5=Monthly
Age for weight [ ] kg: 1=
Weaning age [ ] Weeks: 1=
ADG [ ] Kg/month: 1=
Total viable count (TVC) " Microbial load"
E. coli load [ ] Bacterial counts in faeces (cfu/mL)
Coliform count
PCV (%)
Hb Conc(g/dL)
Concentration of pathogens in faeces
Calf scours/Diarrhea

Knowledge assessment and respondent answers regarding their attitude and management

1. Changing practices to control diseases is too time consuming [ ] 1=Yes 2= No
2. What my fellow producers do on their farm matters to me [ ] 1=Yes 2= No
3. I am concerned about the health of my herd [ ] 1= Yes 2= No
4. My fellow producers made changes to prevent and control disease on my farm [ ] 1=Yes 2=No
5. I am aware about what I am supposed do for betterment of dairy calves [ ] 1=Yes 2= No
6. I am informed on the daily activities taking place in my farm dairy husbandry [ ]1=Yes 2= No

7. Major challenges facing dairy production in my farm [ ]

1=Shortage of feeds during dry season, 2= Shortage of water during dry season, 3= Inadequate extension services/staff, 4= Heat stress hence affecting conception and production, 5= High price of the concentrates.

THANK YOU

APPENDIX 2: ANOVA OUTPUTS

Respondent information

Production system * Respondent sex

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.692[a]	1	.101		
Continuity Correction[b]	1.113	1	.292		
Likelihood Ratio	3.968	1	.046		
Fisher's Exact Test				.249	.148
Linear-by-Linear Association	2.558	1	.110		
N of Valid Cases	20				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 1.40.

b. Computed only for a 2x2 table

Production system * Respondent age

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.500[a]	2	.287
Likelihood Ratio	3.278	2	.194
Linear-by-Linear Association	2.375	1	.123
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is 1.00.

Production system * Respondent education level

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.111[a]	2	.047
Likelihood Ratio	7.651	2	.022
Linear-by-Linear Association	4.564	1	.033
N of Valid Cases	20		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .60.

Production system * Dairy farming experience in years

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.622[a]	3	.654
Likelihood Ratio	2.138	3	.544
Linear-by-Linear Association	1.517	1	.218
N of Valid Cases	20		

a. 7 cells (87.5%) have expected count less than 5. The minimum expected count is .60.

2. FARM CHARACTERISTCS

Production system * Herd size

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	20.000[a]	1	.000		
Continuity Correction [b]	14.238	1	.000		
Likelihood Ratio	20.016	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	19.000	1	.000		
N of Valid Cases	20				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is .80.

b. Computed only for a 2x2 table

Production system * Milk production/Cow/day in litres

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.423[a]	2	.009
Likelihood Ratio	8.854	2	.012
Linear-by-Linear Association	3.211	1	.073
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .40.

Production system * Primary goal

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.821[a]	2	.090
Likelihood Ratio	4.493	2	.106
Linear-by-Linear Association	1.619	1	.203
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .40.

Production system * Farming system used

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.821[a]	1	.028		
Continuity Correction[b]	2.515	1	.113		
Likelihood Ratio	4.493	1	.034		
Fisher's Exact Test				.061	.061
Linear-by-Linear Association	4.580	1	.032		
N of Valid Cases	20				

a. 3 cells (75.0%) have expected count less than 5. The minimum expected count is 1.20.
b. Computed only for a 2x2 table

Production system * Total land area (acres)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.667[a]	2	.003
Likelihood Ratio	12.378	2	.002
Linear-by-Linear Association	7.917	1	.005
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is 1.20.

Production system * Area under dairy production

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.000[a]	2	.000
Likelihood Ratio	20.016	2	.000
Linear-by-Linear Association	17.331	1	.000
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .60.

Production system * Insemination type

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.896[a]	2	.086
Likelihood Ratio	4.140	2	.126
Linear-by-Linear Association	3.805	1	.051
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .20.

Production system * Source of insemination

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.955[a]	3	.019
Likelihood Ratio	9.776	3	.021
Linear-by-Linear Association	.002	1	.961
N of Valid Cases	20		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .20.

Production system * Total dairy calves in the farm

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.000[a]	2	.000
Likelihood Ratio	20.016	2	.000
Linear-by-Linear Association	18.689	1	.000
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .20.

Production system * Dairy calves less than 90 days

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.000[a]	3	.000
Likelihood Ratio	20.016	3	.000
Linear-by-Linear Association	15.724	1	.000
N of Valid Cases	20		

a. 7 cells (87.5%) have expected count less than 5. The minimum expected count is .20.

3. Producer attitudes

Test Statistics[a]

	Pen disnfection is important	Pen disnfection should be done frequently	Calves should be grouped	Calf pen should be well ventilated	Calf bedding is important
Mann-Whitney U	3.000	4.000	16.500	26.000	4.000
Wilcoxon W	139.000	140.000	152.500	162.000	140.000
Z	-2.828	-2.740	-1.508	-.601	-2.747
Asymp. Sig. (2-tailed)	.005	.006	.132	.548	.006
Exact Sig. [2*(1-tailed Sig.)]	.003[b]	.005[b]	.148[b]	.617[b]	.005[b]
Exact Sig. (2-tailed)	.003	.003	.179	.555	.005
Exact Sig. (1-tailed)	.001	.003	.093	.292	.004
Point Probability	.001	.003	.037	.069	.003

a. Grouping Variable: Production system

b. Not corrected for ties.

Test Statistics[a]

	Beddings should be changed	Abruptweaning favours young dairy calves	Calves should be fed on a particular plan	Newly calf born need to be fed with colostrum	Feeds for calf should be supplemented with concentrates
Mann-Whitney U	5.000	2.000	6.500	6.500	5.000
Wilcoxon W	141.000	12.000	142.500	142.500	141.000
Z	-2.621	-2.966	-2.559	-2.501	-2.614
Asymp. Sig. (2-tailed)	.009	.003	.010	.012	.009
Exact Sig. [2*(1-tailed Sig.)]	.007[b]	.002[b]	.011[b]	.011[b]	.007[b]
Exact Sig. (2-tailed)	.007	.002	.009	.015	.010
Exact Sig. (1-tailed)	.005	.001	.009	.009	.005
Point Probability	.005	.001	.008	.008	.005

a. Grouping Variable: Production system

b. Not corrected for ties.

Test Statistics[a]

	Vaccinating of dairy calves is important	Deworming of calves is important in my farm	Treat sick calves is important	Controll of ecto parasites like ticks,flee etc is important is important for the betterment of dairy calves	Use of antihelminthics is important in my farm
Mann-Whitney U	9.000	13.500	21.000	5.500	3.500
Wilcoxon W	145.000	133.500	27.000	141.500	139.500
Z	-2.265	-1.765	-.630	-2.658	-2.900
Asymp. Sig. (2-tailed)	.024	.078	.529	.008	.004
Exact Sig. [2*(1-tailed Sig.)]	.029[b]	.100[b]	.793[b]	.007[b]	.003[b]
Exact Sig. (2-tailed)	.027	.139	1.000	.006	.003
Exact Sig. (1-tailed)	.020	.081	.702	.006	.003

Point Probability	.017	.072	.702	.006	.002

a. Grouping Variable: Production system

b. Not corrected for ties.

Test Statistics[a]

	Frequency of practice	Frequency of pen disinfection	Importance of using bedding in your farm	Frequency of bedding changes	Practice of grouping calves	I do wean calves abruptly
Mann-Whitney U	11.000	3.500	18.500	26.500	24.000	24.000
Wilcoxon W	147.000	13.500	154.500	36.500	34.000	160.000
Z	-2.031	-2.779	-1.313	-.541	-.876	-1.090
Asymp. Sig. (2-tailed)	.042	.005	.189	.588	.381	.276
Exact Sig. [2*(1-tailed Sig.)]	.050[b]	.003[b]	.211[b]	.617[b]	.494[b]	.494[b]
Exact Sig. (2-tailed)	.058	.004	.237	.627	.591	.538
Exact Sig. (1-tailed)	.030	.003	.131	.312	.375	.376
Point Probability	.012	.002	.021	.047	.307	.376

a. Grouping Variable: Production system

b. Not corrected for ties.

Test Statistics[a]

	Feeding calves with colostrum	Feeding calves on a specific plan/Time table	What is the amount of colostrum delivered (Litres/day/calf)	Milk allowance at start (Litres/Calf/Day)	Milk allowance at peak (Litres/Calf/Day)	What is the amount of concentrate fed to calf (Kg/day/calf)
Mann-Whitney U	8.000	3.000	27.000	10.500	17.000	.000
Wilcoxon W	144.000	139.000	147.000	146.500	153.000	136.000

Z	-2.437	-3.020	-.319	-2.320	-1.463	-3.346
Asymp. Sig. (2-tailed)	.015	.003	.750	.020	.143	.001
Exact Sig. [2*(1-tailed Sig.)]	.022[b]	.003[b]	.810[b]	.039[b]	.178[b]	.000[b]
Exact Sig. (2-tailed)	.021	.001	.872	.028	.156	.000
Exact Sig. (1-tailed)	.014	.001	.459	.026	.092	.000
Point Probability	.014	.001	.173	.025	.005	.000

a. Grouping Variable: Production system

b. Not corrected for ties.

Test Statistics[a]

	Source of animal feeds	I do you vaccinate calves in my farm	I do deworm calves in my farm	I do treat sick calves in my farm	I do control ectoparasites in my farm	I do you use anti helminthics in my farm
Mann-Whitney U	22.000	2.500	26.000	22.000	6.000	20.000
Wilcoxon W	158.000	138.500	36.000	158.000	16.000	30.000
Z	-1.258	-3.029	-.916	-1.090	-2.970	-1.427
Asymp. Sig. (2-tailed)	.208	.002	.360	.276	.003	.154
Exact Sig. [2*(1-tailed Sig.)]	.385[b]	.002[b]	.617[b]	.385[b]	.011[b]	.290[b]
Exact Sig. (2-tailed)	.530	.001	.579	.582	.007	.267
Exact Sig. (1-tailed)	.282	.001	.491	.291	.007	.207
Point Probability	.282	.001	.491	.248	.007	.207

a. Grouping Variable: Production system

b. Not corrected for ties.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hbconc	Equal variances assumed	1.234	.268	-8.629	155	.000	-2.42212	.28071	-2.97664	-1.86761
	Equal variances not assumed			-8.553	137.496	.000	-2.42212	.28320	-2.98210	-1.86214
ADG	Equal variances assumed	34.883	.000	-9.850	155	.000	-128.098	13.004	-153.787	-102.409
	Equal variances not assumed			-10.703	141.585	.000	-128.098	11.969	-151.758	-104.438
PCV	Equal variances assumed	1.269	.262	-4.523	155	.000	-5.13290	1.13491	-7.37479	-2.89101
	Equal variances not assumed			-4.661	153.740	.000	-5.13290	1.10135	-7.30863	-2.95718
LTVC	Equal variances assumed	8.422	.004	-.919	155	.360	-.03600	.03918	-.11340	.04140
	Equal variances not assumed			-.879	115.920	.381	-.03600	.04094	-.11709	.04509
LCOL	Equal variances assumed	11.017	.001	-1.175	155	.242	-.06956	.05920	-.18650	.04738
	Equal variances not assumed			-1.123	115.101	.264	-.06956	.06194	-.19225	.05313

Classification Table[a]

			Predicted	
			Ecoliyes	
	Observed		0	1	Percentage Correct
Step 1	Ecoliyes	0	47	20	70.1
		1	43	47	52.2
	Overall Percentage				59.9

a. The cut value is .500

Variables in the Equation

								95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Psystem(1)	.943	.340	7.684	1	.006	2.569	1.318	5.005
	Constant	-.089	.211	.178	1	.673	.915		

a. Variable(s) entered on step 1: Psystem.

Production system * Incidences of zoonotic diseases within the last five years

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.091[a]	2	.129
Likelihood Ratio	5.595	2	.061
Linear-by-Linear Association	3.198	1	.074
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .80.

Production system * If yes, Please specify and give the number of cases

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.625[a]	4	.031
Likelihood Ratio	11.019	4	.026
Linear-by-Linear Association	.006	1	.938
N of Valid Cases	20		

a. 10 cells (100.0%) have expected count less than 5. The minimum expected count is .60.

APPENDIX 3: NACOSTI LETTER OF RESEARCH AUTHORIZATION

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
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Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/38317/31235**

Date: **30th July, 2019.**

Albert Ngateireho Francis
Egerton University
P.O. Box 536-20115
NJORO.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of producer attitudes and management practices on calf performance in smallholder and large commercial dairy farms in Nakuru, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Nakuru County** for the period ending **29th July, 2020.**

You are advised to report to **the County Commissioner, and the County Director of Education, Nakuru County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA., MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nakuru County.

The County Director of Education
Nakuru County.

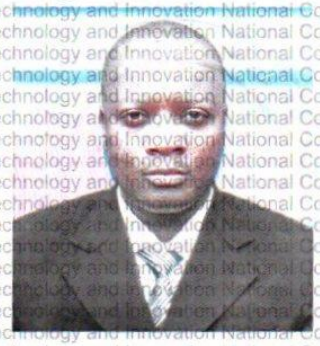
APPENDIX 4: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. ALBERT NGATEIREHO FRANCIS
of EGERTON UNIVESITY, 0-20115
NAKURU,has been permitted to conduct
research in *Nakuru County*

on the topic: *INFLUENCE OF PRODUCER ATTITUDES AND MANAGEMENT PRACTICES ON CALF PERFORMANCE IN SMALLHOLDER AND LARGE COMMERCIAL DAIRY FARMS IN NAKURU, KENYA*

for the period ending:
29th July,2020

Permit No : NACOSTI/P/19/38317/31235
Date Of Issue : 30th July,2019
Fee Recieved :Ksh 1000



.....
Applicant's Signature

.....
Director General
National Commission for Science, Technology & Innovation

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. The License is valid for the proposed research, location and specified period.
2. The License and any rights thereunder are non-transferable.
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4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.
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APPENDIX 5: ABSTRACT OF PUBLISHED PAPER

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Dairy producer's attitudes toward implementing calf management practices on smallholder and large commercial dairy herds in Kenyan Rift valley

Francis AN, Ondiek JO and Bebe BO

Abstract
Practicing best calf management practices in housing, feeding and health are important for growing the future replacement stock. This is important for sustainability of the dairy herd where a significant proportion of the national dairy herds are smallholders with poorer calf performance than is in large commercial herds. Kenya's national dairy herds comprise over 75% smallholders, some affiliated to cooperatives offering regular extension advises on best calf management practices to their members. This study tested the hypothesis that producer attitudes reflect calf management practices that are implemented in large commercial and smallholder herds. The hypothesis was tested with a sample of large commercial dairy herds and smallholder herds affiliated to cooperative societies. Producer attitudes and management practices in calf housing, feeding and health were captured regarding standard management practices on a five point scale of agreement. The responses were analyzed to reveal the underlying differences between the herds using non-parametric chi square test and Mann-Whitney U test statistics. Compared to large commercial dairy producers, smallholders expressed more negative ($p<0.05$) attitudes towards practicing the recommended housing (calf pen disinfection, spacing in pen, bedding), feeding (colostrum feeding, concentrate supplementation) and towards health (vaccination, deworming and ecto parasite control). The negative smallholders' attitudes were reflected in poorer ($p<0.05$) implementation of the recommended calf housing practices (pen disinfection), feeding practices (colostrum and milk feeding, concentrate supplementation and weaning procedure) and health practices (vaccination and ecto parasite control). To attain improved calf performance and sustainable dairy herds, smallholder dairy producers need change of attitude towards implementing the recommended calf management practices. In housing, the target areas are pen disinfection, housing calves in individual pens to avoid crowding and improved bedding. In feeding, the target areas are colostrum and milk feeding and concentrate supplementation while in health the target areas are vaccination, deworming and ecto parasite control practices.

Keywords: Calf feeding, calf health, calf housing, calf performance, replacement stock

Introduction
Practicing best calf management practices in housing, feeding and health is important for rearing the future replacement stock. This is important for sustainability of the dairy herd where a significant proportion of the national dairy herd attain poorer calf performance. Kenya has such dairy herd in which smallholder's comprise75% of the national herd and with poorer calf performance than in the fewer remainder medium and large commercial herds [3]. Good calf management practices enhance calf survivability and performance and subsequently, quality replacement stock for the future herd [17].
Important calf management is in housing, feeding and health. Calf housing should be well ventilated, partitioned into individual pens which are regularly disinfected, cleaned and the bedding are kept dry to provide calf comfort, good welfare and ease early disease detection of diseases. This way, good housing contributes to improved calf performances [5]. Good calf feeding practices begin with colostrum feeding, essential for passive immunity to calf. Colostrum feeding is followed with milk feeding, which has to be warm, hygienic and in enough quantity corresponding to calf body weight to support sufficient growth. Supplemental concentrate is necessary after weaning to sustain high growth rates [16, 4].