EVALUATION OF CURRENT PERFORMANCE OF DAIRY CATTLE IN ASAS AND KITULO FARMS IN THE SOUTHERN HIGHLANDS OF TANZANIA

BY

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ABSTRACT

This study was carried out to evaluate the current performance of dairy cattle at ASAS and Kitulo farms in the Southern Highlands of Tanzania. The objective was to assess the effects of genetic and non-genetic factors on lactation and reproductive performance, calf mortality rate, longevity traits and constraints affecting performance of dairy animals. Ayrshire and Friesian cows were involved in the study. Data were analysed using General Linear Models procedure of Statistical Analysis System (SAS). Average ages at first calving (AFC) at ASAS farm were 1059.5±19.41 and 1105.7±12.99 days for Ayrshires and Friesians, respectively. Breed and calving period significantly ($P < 0.05$) influenced AFC. At Kitulo farm AFC was 1151.7±9.63 days. Both parity and period of calving significantly ($P < 0.001$) influenced CI. Mean calving intervals (CI) at ASAS farms were 410.8±8.1 and 423.4±6.8 days for Ayrshire and Friesian cows, respectively. At Kitulo farm mean CI was 421.6±1.43 days. Mean lactation milk yields (LMY), lactation lengths (LL) and dry periods (DP) at the ASAS farm were 2696.8±75.4kg, 305.8±5.7 and 92.9±2.6 days, and 3000.1±62.9kg, 318.7±4.8 and 96.3±2.2 days for Ayrshires and Friesians, respectively. Breed ($P < 0.001$), parity ($P < 0.001$) and period of calving ($P < 0.05$) significantly influenced LMY and DP. At Kitulo farm mean LMY, LL and DP were 2608.3±24.0 kg, 322.3±1.4 and 91.2±0.52 days. Only period had a significant ($P < 0.01$) effect on LL. Overall abortion, stillbirth, pre-weaning and post-weaning mortality rates were 4.8, 3.7, 6.5 and 11.0% for ASAS farm. Corresponding rates at Kitulo farm were 11.2, 7.6, 12.1 and 13.0%. Mean lifetime milk production at ASAS farm for Ayrshires and Friesians were 11 303.6 and 13 517.5 kg while at Kitulo farm it was 13 481.2 kg. Management improvement including testing and vaccination of heifers against brucellosis and rehabilitation of infrastructures is therefore recommended.

DECLARATION

I, HERIEL FANUEL MASSAWE, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation has neither been nor concurrently being submitted for a degree award in any other institution.

Massawe Heriel Fanuel **Date**

The above declaration is confirmed

Prof. Kifaro, G.C. **Date**

(Supervisor)

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DEDICATION

This thesis is dedicated to my beloved wife (Elice), my adorable children (Grace and Easter) and my wonderful parents.

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LIST OF ABBREVIATIONS

AFC	Age at First Calving
ANOVA	Analysis of Variance
ASAS	Ahmed Salum and Sons
CBPP	Contagious Bovine Pleural Pneumonia
DASP	Department of Animal Science and Production
DP	Dry Period
F_1	First Filial generation
F_2	Second Filial generation
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GIT	Gastro Intestinal Tract
HF	Holstein Friesian
Kg	Kilogramme
LL	Lactation Length
LMU	Livestock Multiplication Unit
LMY	Lactation Milk Yield
MALD	Ministry of Agriculture and Livestock Development
MDPL	Milk per Day of Productive Life
MDTL	Milk per Day of Total Life
MLDF	Ministry of Livestock Development and Fisheries
MT	Metric Tonne
MWLD	Ministry of Water and Livestock Development

NLTCAL	Number of Life Time Calvings
PL	Productive Life
SAS	Statistical Analysis System
SHZ	Southern Highlands Zone
SUA	Sokoine University of Agriculture
TL	Total Life
Tsh	Tanzanian shiling

CHAPTER ONE

1.0 INTRODUCTION

Tanzania ranks third in Africa in livestock numbers with about 21 million heads of cattle (Njombe *et al.,* 2011). The national herd consists predominantly (98%) of the indigenous stock of zebu breed. Only a small proportion (2%) of the national herd is composed of exotic and cross breeds including Jersey, Ayrshire, Friesian and their crosses (MLDF, 2010).

Despite the large cattle population their productivity in terms of both milk and meat is relatively low. The livestock sector contributes about 5.9% of gross domestic product (GDP) and 30% of agricultural GDP. The dairy industry contributes 30% of livestock GDP, beef 40% and other livestock commodities contribute 30% (MFEA, 2010).

In Tanzania, milk production does not match with the human population growth (Sumberg, 1997). This has been reflected by the rise in milk imports from 3,459 MT in 1997 to 7,111 MT in 2004 worth about US$ 10 million. This level of imports shows that the demand for processed milk is grossly undersupplied (Njombe and Msanga, 2008). Annual total milk production from improved and indigenous cattle has increased from 814 million litres in 2000/01 to 1.65 billion litres in 2009/10 (Njombe *et al.,* 2011). The increase was mainly due to increased herd size rather than the productivity per milking cow.

The overall per capita milk consumption in Tanzania is low (43 kg/annum) compared with other East African countries like Kenya (80 kg/annum) while the world recommendation by FAO is 200 kg/annum (Njombe *et al*., 2011). Milk production performances are affected by genetic and non genetic factors such as the breed of the cow, year and season of calving, geographical location, nutrition and management. The influence of genetic and non-genetic factors in tropics has been reported by several authors (Kifaro, 1995; Balikowa, 1997; Msanga *et al.,* 2001). The effects of these factors on dairy cattle could result into long calving intervals and reduced milk production. The number of calves in the farm per year is very important for herd replacement and it depends on reproductive performance of the herd. Therefore, a significant increase in productivity could be obtained if attention is paid to problems of reproductive efficiency (Mukasa-Mugerwa *et al.,* 1992). Hence, an important starting point in any animal improvement is to conduct assessment and improving the reproductive performance of the herd. The government of Tanzania introduced a policy aimed at increasing milk production in Tanzania (MALD, 1983), by the establishment of high quality herds in some regions of the country. Some of the farms established in the southern highlands zone were Kitulo Livestock Multiplication Unit, Iwambi and Uyole research herd.

In 1994 the government of Tanzania privatized some of these farms because of poor management which caused poor production hence the farms were said to operate at a loss. The purpose of privatization was to improve the productivity so as to realize the purpose of increasing milk production in the country. Southern Highlands Zone of Tanzania comprises of five regions namely; Mbeya, Rukwa, Ruvuma, Iringa and Njombe. These regions have 2 212 915 cattle whereby 2 109 609 (95.2%) are indigenous breeds and 103 306 (4.8%) are dairy cattle comprising of pure dairy breeds and their crosses (Njombe *et al.*, 2011). Dairy cattle in Southern Highlands Zone are kept mostly by smallholder, medium scale farms and a few large farms. Medium and large farms are owned by the government and private owners.

Kitulo Livestock Multiplication Unit (LMU) is a government farm and is found in Makete district in Njombe region. The type of dairy cattle kept is Friesian breed. Marketing of milk from Kitulo LMU is largely made in Mbeya city. Kitulo LMU has played a key role in distributing dairy cattle to smallholder dairy keepers in the Southern Highlands Zone and other parts of the country.

ASAS dairy farm is a private farm found in Iringa municipality about 20 km from the town centre. The types of dairy cattle kept are Friesian and Ayrshire breeds. ASAS farm owns a dairy processing factory which has a capacity of processing 12 000 kg of milk per day. Milk supplied daily from the farm is about 2750-3200 kg while smallholder dairy keepers supply about 1500 kg of milk. Furthermore, 7500 kg of milk are supplied by large farms within Iringa region including Kitulo farm.

One strategy that can be used to improve milk and production of dairy heifers in any large scale livestock farm is to carry out periodical evaluation of production performance in terms of milk yield, reproductive performance and practical constraints affecting the farm. This exercise was carried out once in Kitulo 19 years ago and it has never being conducted at ASAS farm since its establishment. Therefore the intention of this study was to evaluate the performance of dairy cattle at ASAS and Kitulo farms in the Southern Highland Zone of Tanzania. Thus, the main objective of this study was to evaluate dairy cattle productivity at ASAS and Kitulo LMU dairy farms in the Southern Highland Zone of Tanzania.

Specific objectives were:

i. To assess lactation performance, reproduction, calf mortality and herd life traits of the farms during the last decade
ii. To study the effects of non- genetic factors on traits mentioned in (i)
iii. To identify key constraints affecting performance of dairy animals in the farms

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Reproductive Performance Trait

Reproductive performance can sometimes be used interchangeably with fertility. It can be defined as the ability of an animal to produce mature germ cells, producing a young one and the frequency at which it can thereafter produce offsprings (Kifaro, 1984). The life time productivity of a cow is influenced by age at puberty, age at first calving and calving intervals (Mulangila *et al.*, 1997).

In the view of Gupta *et al.* (1994), a normal healthy reproductive cycle in female cows includes the onset of oestrus, successful conception and normal parturition. Late conception will result into reduced profit because cows with longer calving intervals will be at peak milk production during a smaller portion of their reproductive lifetime. This is because cows will reach peak lactation between 4^{th} and 6^{th} lactation. Pryce *et al.* (2000) reported that age at calving and calving interval play an important role in measuring reproductive performance in dairy cattle and have a very high correlation with life time performance traits.

High yielding dairy cattle have poor reproductive performance and the extent of such an adverse effect of lactation appeared more prominently in pure breeds than the crossbred animals (Pongpiachan *et al*., 2003). Mwatawala (2006) suggests that problems of long calving intervals, short lactations and long dry periods could be reduced by improved management than genetic manipulation of the animals.

2.1.1 Age at first calving

First calving marks the start of productive life of a cow. It is the number of days (months or years) from birth to when the heifer calves and is closely related to generation interval and therefore, influences response to selection (Mukasa-Mugerwa, 1989).

In modern production systems where the breeding is controlled, heifers are usually mated when they are mature enough to withstand the stress of parturition and lactation. This increases the likelihood of early conception after parturition. In the traditional production systems, however, breeding is often uncontrolled and heifers are bred at the first opportunity. This frequently results in longer subsequent calving intervals (McDowell, 1985). There is variation in AFC among cattle breeds depending on growth rate and age at sexual maturity. Mukasa-Mugerwa (1989) found the average age at first calving (AFC) in *Bos taurus* and *Bos indicus* x *Bos taurus* crosses in the tropics to be 34 months. Therefore, this trait has been found to be affected by genetic and non-genetic factors. The latter include season of birth, nutrition and management which can change from year to year. Mulangila (1997) found a significant influence of genotype on age at first calving. Syrstad (1988) reported that *Bos indicus* cattle mature later than *Bos taurus* cattle. He found the average AFC for *Bos taurus* cattle to be 31.6 months. Balikowa (1997) and Msuya (2002) both reported a mean AFC to be 36.7 months in dairy cattle under smallholder farms in Southern highlands of Tanzania and Kagera region, respectively. Also Niazi and Aleem (2003) and Ajili *et al*. (2007) reported the mean AFC of 29.3 and 32.7 months in Pakistan and Tunisia, respectively. In the study by Sattar *et al.* (2005)

on reproductive performance of Holstein Friesian in Pakistan, they found out AFC to be 27.2 months.

Early calving means more number of calves and more lactations (Choudhuri *et al.*, 1994), although the negative effects of early calving are increased incidences of dystocia and reduced milk yield in subsequent lactation (Little and Kay, 1979) cited by Kifaro (1984). Studying the performance traits in Friesian x Kenana and Butana crosses in Sudan, Ageeb and Hillers (1991) observed a mean AFC of 37.2 months.

In most parts of tropics there are two seasons, wet and dry seasons. The dry season is accompanied by scanty pastures of low nutritive value while the wet season is accompanied by abundant feeds with high nutritive value. Therefore, nutritive values of pasture vary from season to season, from year to year and from one location to another. Studying the Sahiwal x Aryshire crosses, Trail and Gregory (1981) found the effects of season of calving to be significant ($P < 0.01$) but month of calving was not. Similar results have been reported by Balikowa (1997) and Ageeb and Hillers (1991). Other studies that have revealed significant difference in AFC due to season of birth include that of Kifaro (1984) and Mangurkar *et al*. (1985). The former author reported longer AFC by 73 days in heifers that were born during March – May than those born during December – February (1028 vs. 955 days). The latter author observed longest AFC by 14.8, 48.4 and 82.0 days in calves that were born during June- August, compared to those born during March-May, December-February and September–November (933.6 vs. 918.8, 885.2 and 851.6 days, respectively). On other hand Kasonta (1988), Kifaro (1995) and Msuya (2002) reported non significant effects of season on AFC.

Kasonta (1988) found that the year of birth significantly ($P < 0.001$) affected AFC. Tadese *et al.* (2010) reported that period of birth significantly ($p < 0.001$) influenced AFC, while the effect of season of birth was not significant. Further they found out that the overall mean AFC to be 39.2±7.5 months with coefficient of variation of 19%. Location is one of non genetic factors affecting dairy cattle productivity. This factor has indirect influence on AFC.

According to Payne (1990), large differences in climate between locations are associated with fluctuations of the following; livestock feeds, incidence of diseases and parasites, storage and handling of animal products. All these affect dairy cattle productivity directly or indirectly. The effect of climate on productivity of cattle is indirect. This is due to rainfall fluctuation between locations which leads to variability in biomass production. According to Bayer and Water (1995) cited by Mulangila (1997), management of dairy cattle may differ with change in climate thereby causing variation of reproduction and lactation traits. A reduction in age at first calving can be achieved through better feeding, management, disease control and efficient heat detection and timely service programme (Javed *et al.*, 2004).

2.1.2 Calving interval

The calving interval is a single most important element in maintaining milk production in a dairy herd. It is affected by both genetic and non genetic factors. Non- genetic effects are more important because the trait has low heritability and repeatability (Mwatawala, 2006). Therefore calving interval is mainly influenced by management factors.

Holness *et al*. (1980) reported that resumption of ovarian activity in the postpartum period does not necessarily lead to conception and methods of stimulating oestrus must be considered in relation to their effect on conception and, indirectly, calving intervals. Lovince (2004) reported a long mean calving interval (480.4±2.4 days) in Turiani division, Morogoro, Tanzania. She associated the longer calving intervals with the inability of the farmers to detect heat, early embryonic death and failure to obtain bulls on time when cows were on heat.

A study by Tadesse and Dessie (2003) showed that CI of Holstein Friesians in India varied between 348.8 and 462 days. In his study Million (2001) reported a mean CI of 459±2.4 days for Holstein Frieasin (HF) crosses in central highland of Ethiopia. Tadesse *et al.* (2010) and Niazi and Aleem (2003) reported mean CIs of 436 days and 445±90.8 days for HF in Ethiopia and Pakistan, respectively. Genotype of the cattle has been reported to have effect on the calving intervals. Variations in CIs of dairy cattle in tropics have been reported to be ascribed to effects of parity. Msuya (2002) reported that, mean calving intervals tended to decrease with parity. Significant ($p<0.01$) effect of parity on CI between the first and subsequent parities has been reported in the study conducted by Kifaro (1984) in the Southern highlands of Tanzania. Similarly the mean length of CI reported by Agyemang and Nkhonjera (1986) in Malawi, were about 16% longer for cows in parity one compared to those in parity two (527 vs. 455 days). Decrease in CIs between parity one and subsequent parities has also been reported by Udo (1993). Thus CIs were 432.4±6.0, 420.2±6.7, 418.5 ± 7.7 and 419.8 ± 8.8 days for parities 1, 2, 3, and 4, respectively. Larger differences of CIs between parity one and subsequent parities, have been observed by

Mangurkar *et al.* (1985). They reported calving intervals of 38.6 days longer (440.2 vs. 401.6 days) between parity one and five. A trend in the above studies, suggests that lengths of CIs were decreasing between parity one and subsequent parities. Also it implies that there was an improvement of reproductive physiology hence reduction in days open of cows in the second and subsequent lactations. Several findings have indicated CI to fluctuate significantly between years (period of calving). Kifaro (1995) reported that year accounted for 3 – 31% of sum of squares and significantly ($p<0.001$) influenced CI of dairy cattle in four farms while CIs of the fifth farm were not significantly influenced by year effects.

Year effect on calving intervals in the tropics has been reported to be indirect due to dynamic climatic changes which are frequently associated with disease pattern and changes in management by farmers (Mulangila, 1997).

Season of calving influence calving intervals through feed availability, which varies greatly in wet and dry season. Kifaro (1995), Balikowa (1997) and Msuya (2002) reported that season of calving was not an important factor. The influence of location on performance of dairy cattle in the tropics is indirect. This is ascribed mainly to the influence of several factors e.g. influence due to effects of climatic conditions and management practices to which cattle are exposed (Payne, 1990). In Malawi, differences in climatic conditions and management practices between locations were reflected in higher CIs by about 11% for cows in Blantyre South and Blantyre East (512 vs. 461 days) (Agyemang and Nkhonjera, 1986).

2.2 Lactation Performance

2.2.1 Lactation milk yield

The productivity of dairy cattle in Tanzania is low, producing on average about seven litres of milk per day in the wet season and decline to nearly three litres per day in the dry season (Msangi and Kavana, 2002).

The peak milk yield of the cow depends on her body condition status at calving, her inherited potential, health status and feeding regime after calving (Mgeni, 2010). A cow with good body condition at calving and systematic feeding regime after calving tends to increase peak milk production. Peak milk production plays an important role in determining lactation milk production, since there is high correlation between these two parameters (Mayeres *et al*., 2004). Cows must have high persistency and high peak of milk production for high lactation milk yield (Milang'ha, 2002; Lee and Chaundhary, 2006). According to Abdallah and McDaniel (2000), the improvement of milk production traits leads to decreased fertility of the cows, since the high yielding dairy cattle had poor reproductive performance. The amount of milk produced is determined by breed of the cow, environment and interaction between the two (Kifaro, 1995). The effect of genetic factors on lactation milk yield can be observed from the genetic constitutions of animals between and within breeds.

Every breed of cows has its potential for milk production. Exotic breeds have high potential for milk production followed by crossbreds and finally indigenous breeds. Variation in lactation milk yield for exotic breeds in tropics has been reported by various authors (Msuya, 2002; Haile, *et al.,* 2009; Njubi, *et al.,* 2009; Effa, *et al.*, 2011). Lubago *et al*. (2006) noted the lactation milk yield for Friesian, Brown Swiss and Jersey cows in central Ethiopia to be 2165±27, 1921±55 and 1737±55 kg, respectively. In the work of Balikowa (1997) on dairy cattle performance, milk yield of the high grades were not significantly different from those of other crosses. In their study, Sattar *et al*. (2005) reported an average lactation milk yield for 499 records in Holstein-Friesian cows to be 2772.76 ± 65.00 litres. Other studies by Makuza and McDaniel (1996) in Zimbabwe and Ajili *et al*. (2007) in Tunisia, reported means for LMY of HF to be 4791 and 5905 kg/cow, respectively. Also genotype of the cattle has been reported by Guo-li *et al*. (2006) to significantly affect lactation yields and lactation lengths. Gimbi (2006) argued that, most of the variation in production level among herds is environmental, although genetic differences could also exist within the same breed.

Season of calving has been found to be an important area of interest to many dairy cattle breeders and has been extensively studied. Several authors have reported a significant effect of season on lactation milk yield (Nkala, 1992; Mulangila, 1997). Kifaro (1984) observed that seasonal effects tended to decrease as lactation advanced from 60 to 300 days. The effect of season on milk yield has been explained by difference due to climatic and feeding practices between seasons. During dry seasons, most tropical grasses are highly resistant to digestion by ruminants. This condition is associated with mobilization of body reserves for milk production, loss of weight and reduced number of lactating cows (Msuya, 2002). Udo (1993) reported that improved feeding during the dry season significantly reduced total lactation yield differences between wet and dry season calvers in central Tanzania. He further noted that the magnitude of seasonal effects vary from one herd to another and from year to year in the same herd and from one district to another. The study by Nkala (1992) on performance of crossbred dairy cattle on two farms of Buhuri and Livestock Research Centre in Tanga region, observed that total lactation milk yield of cows at Buhuri was 40% superior to those at Livestock research centre (2100±76 vs. 1495±75) kg. The difference in performance was attributed to variability in feed resources and management as a whole.

Tadese *et al.* (2010) observed mean lactation milk yield to increase from first to third parity. They found out that the differences among parity three to six were not significant. Also they observed a declined trend after parity six. Ahmed *et al.* (2007) observed an increasing trend of LMY in HF crosses in Sudan from first to third parity and then a decreasing trend followed. Mackinnon *et al.* (1996) also reported a decrease in milk yield after the third parity on crosses of Ayrshire, Brown Swiss and Sahiwal in Kenya. In Pakistan, a study conducted by Sattar *et al*. (2004) revealed significant ($P<0.05$) effect of parity on lactation milk yield in Jersey cows. Normally a cow gives a comparatively small amount of milk in first lactation and her maximum yield in fourth to sixth lactation (Mwatawala, 2006).

Year of calving has been reported to affect lactation milk yield (Ageeb and Hillers, 1991; Udo, 1993; Fadlelmoula, *et al*., 2007). The effect of the year of calving has been reported to account for about 30 to 38% of total variance of milk yield in India, Pakistan and Jamaica (McDowell, 1985). Balikowa (1997) observed an increase of milk yield from 1812.6±75.5 kg to 2348.4±217.6 kg from 1991 to 1994 and the increase was associated with changes in management and climate between years.

2.2.2. Lactation length

Schmidt and Van Vleck (1974) as quoted by Mgeni (2010) defined lactation length as time or period from when a cow starts to secrete milk after parturition to the time of dry off. A lactation length of 305 days is recommended to take advantage of 60 days dry period and yearly calving interval. In most modern dairy farms, a lactation length of 305 days is commonly accepted as a standard. However, such a standard lactation length might not work for smallholder dairy cows in which the lactation length is extended considerably in most cases (Masama *et al*., 2003; Msangi, *et al.*, 2005).

Different breeds have different mean lactation lengths and a wider variation exist in lactation length depending on genotype (Kiwuwa *et al.*, 1983). Syrstad (1995) reported significant increase of lactation length with increasing proportion of exotic blood in dairy cattle in the tropics. Balikowa (1997) reported LL for exotic and high grades to be 392.0 and 365.3 days, respectively. In the study on reproductive performance of dairy cows in smallholder production system in central Ethiopia, Lubago *et al*. (2006) reported lactation length of Friesian, Brown Swiss and Jersey to be 341±3, 337±5 and 326±3 days, respectively. Crossbreeding between *Bos taurus* and *Bos indicus* has been observed to prolong lactation length. Msuya (2002) reported mean lactation lengths for F_1 and crosses having >50% Friesian inheritance to be 355 and 345 days, respectively. Syrstad (1989) reported that F_2 crosses to have shorter lactation length than their F_1 parents. This information showed that longer lactation lengths lead to high milk yield. Hence cows with long lactation lengths were expected to have higher total lactation yield than those with short lactations length. Kifaro (1984) showed positive relationship between total lactation yield and persistency which was consequently associated with longer lactation length. Vargas *et al.* (2000) associated lower conception rates and calving intervals with longer lactation lengths. Therefore cows which normally experience longer lactation lengths of more than 400 days are likely to have poor reproductive performance.

Several authors (Kasonta, 1988; Udo, 1993; Kifaro, 1995; Balikowa, 1997; Msuya, 2002), have reported an increase in lactation length with parity. Kifaro (1995) reported significant differences between parities on three out of five institutional farms in the southern highland zone of Tanzania. He found that the duration of lactations increased with lactation number up to the third or fourth lactation. A study by Sattar *et al*. (2004) reported non-significant effect of parity on lactation length in Jersey cows in Pakistan.

A study by Agyemang and Nkhonjera (1986) reported that year and month of calving had significant effects on the length of lactation of crossbred cattle on smallholder farms in Malawi, the average being 390.9 days with coefficient of variation of 38%. In Zimbabwe Collins-Lusweti (1989) studied the effect of environmental factors on dairy cattle performance and observed significant ($p<0.01$) effect of herd and year of calving on lactation length. He found that cows calving in September had a lactation length of 322.4 days where as those calving in April had a lactation length of 415 days. A Study by Nkala (1992) showed that cows which calved between June and September, October and November and December and February had longer mean lactation lengths than those that calved between March and May. Their respective lactation lengths were 278±7, 277±8 and 278±7 vs. 265±7 days. Influence of season on LL was found to be significant in the study conducted by Kasonta (1988). But other studies (Collins – Lusweti, 1989; Nkala, 1992; Udo, 1993; Msuya, 2002), reported non-significant effects of season of calving on duration of lactation.

Various studies have reported on the significant effects of location on lactation length. Agyemang and Nkhonjera (1986) reported LL of dairy cows managed in different provinces in Malawi averaged between 361 and 417 days. In another study by Nkala (1992) lactation length was 276±8 days for cows at Buhuri farm while it was 273±6 days for cows at Tanga livestock research centre in the coastal zone in Tanzania.

2.2.3 Dry period (DP)

Balikowa (1997) defined the dry period as the periods when the cow does not produce milk. This takes eight weeks before the next parturition or two months before next lactation. He further noted that drying off is accomplished by allowing the udder pressure to reach the point at which milk secretion is stopped, finally the milk remaining in the udder is absorbed by the blood. There is direct relationship between length of DP and milk production in the following lactation. The degree to which DP influences milk yields is determined by its length and plane of nutrition of the cow before the time of calving (Niazi and Aleem, 2003). DP length is influenced by both genetic and non genetic factors. Kifaro (1995) observed large influence of CI on DP, therefore with increase in CI there will be prolonged DP. Kifaro (1995) reported mean DP's for five institutional farms in Tanzania to range between 86 and

165 days with a coefficients of variation (CV) ranging between 50% and 75%. Sattar *et al*. (2004) reported shorter (76.2 and 192.48 days) dry period in Friesian and Jersey cows in India and Pakistan, respectively**.** In their latter study, Sattar *et al*. (2005) found out that average dry period for 298 records in Holstein-Friesian cows to be 224.99 ± 10.00 days. Balikowa (1997) reported a mean DP of 128 days in Southern Highlands of Tanzania whereas Mulangila (1997) reported a fairly high mean DP of 200 days in coastal area of Tanzania. Kifaro (1984) noted that preceding DP accounted for 10.9% of the total variation in milk yield for Friesian cows.

Effects of non genetic factors such as parity, location, season and year of calving have been reported to have influence on lengths of dry periods. Parity has been reported as a source of variation in DP (Kifaro, 1995; Mulangila, 1997; Msuya, 2002). The first author found the effect of parity to be significant in three out of five institutional farms in Southern Highlands zone of Tanzania. The effect of parity has been reported to have minor influence on lengths of dry period. E.g. dry period lengths reported by Nkala (1992) in Tanzania between parity one and subsequent parities, ranged between 138 and 162 days. He found a non significant influence of parity on DP (P>0.05) in Tanzania for Jersey, Ayrshire and Friesians between parity one and subsequent parities. Vargas *et al*. (2000) analysed dry periods for effects of breed and lactation number and only parity was a significant source of variation showing a clear trend of dry periods to decrease during the first three lactations.

In Malawi, effects of year of calving on dry period length were reported by Agyemang and Nkonjera (1986). Cows that calved in 1973 and 1982 had 44 and 144 days of dry period, respectively. Nkala (1992) reported non significant influence of year of calving on DPs. Agyemang and Nkonjera (1986) reported the range of 84 to 170 days of dry periods in cows that calved between January and September. In that study the effect of season was not significant although cows that calved during March to May had longer dry periods (152 days) than those that calved between June and September (135 days). The effect of location on DP has been reported by several workers (Nkala, 1992; Mulangila, 1997; Msuya, 2002). The former author observed a significant influence of districts on dry periods.

2.3 Lifetime Performance Traits

2.3.1 Productive life

Herd life or stayability is the duration a cow remains in the herd and obviously that is highly associated with number of calves she can leave behind with the amount of milk she can produce in her life time and with the required animal herd recruitment rate. In dairying it is desirable that cows selected for milk will produce more milk during their high productive periods and leave calves of high genetic merit.

Selection of cows is done early in life, after first or second lactation hence association between early life performance traits and herd life is of interest. Furthermore, reasons for terminating herd life are of interest for breeding management and diseases control purposes.

Length of production life is usually measured as time from first calving to disposal and describes the ability of a cow to avoid culling (Strandberg and Roxström, 2000). Different breeds have different productive life span. Herd life or productive life is an important component of dairy profitability. Javed *et al*. (2003) and Bashir *et al*. (2007) defined herd life as days from first calving to culling. The last author reported maximum age to be 84 months. Genetic selection for increased herd life is expected to result in improved general health, production and reproduction which can increase dairy farm profitability. Teodoro and Madalena (2005) envisaged that Holstein Friesian cows kept in India had productive life span which ranged from 1 326 to 2 967 days.

The lifetime productivity of a cow is influenced by age at puberty, age at first calving and calving intervals (Mukasa-Mugerwa, 1989). Kifaro *et al*. (1994) reported the length of productive life at Mbarali and Uyole to be 2 071 days or 5.7 years and 1 154 days or 3.2 years, respectively. Saeed *et al.* (1987) noted that animals with long productive life are also highly productive in other respects, so it is advantageous to keep them in the herd as long as possible. This might, however, increase the generation interval and thus reduce the response to selection. Kabuga and Agyemang (1984) reported that, HF cows kept in Ghana had productive life span of 8 years (2 922 days).

2.3.2 Life time milk production

Javed *et al*. (2004) defined life time milk yield as the milk produced in total days of the cows during its life. Murdia and Tripathi (1993) observed that the effort made in early selection of animals for their productivity should lead to maximum output in total lifetime. Therefore an animal is most profitable when its total life time milk production is maximum. The life time milk production is a determinant of net economic merit of dairy animals (Rao and Rao, 1996).

Kabuga and Agyemang (1984) studied 103 calving records of 35 Canadian HF imported into Ashanti (Ghana) and found the average lifetime production per cows to be 16 186 kg and ranged from 13 235 to 23 659 kg. Sadek *et al*. (1989) mentioned that total milk yield of HF cows in Egypt was 13 015 kg after completion of five lactations. Murdia and Tripathi (1993) analysed the data on 3 073 performance records of 1 064 Jersey cows at various state farms in India and reported that cumulative milk yields at the end of 2nd, 3rd, 4th and 5th lactation were 6 014.31±62.96, 9 363.57±97.92, 12 561.4± 138.7 and 15 893.41±211.52 kg. It was further reported that average lifetime milk production was 8 170.20±109.45 kg up 10th lactation on an average 1 005.52±2.96 days. Kifaro *et al*. (1994) observed that, average milk yield per day of total life span ranged between 2.9 and 3.5 kg while milk yield per day of productive life ranged from 4.8 to 6.1 kg. Also they observed that life time milk production of the cows averaged 10 925, 12 522, 8 132, 11 798 and 7 350 kg at Ihimbu, Iwambi, Kitulo, Mbarali and Uyole farms, respectively.

2.4. Calf Mortality

Growth of a herd depends on the survivability of calves. There are economic loses that are incurred in calf rearing; death therefore results in loss due to cost and loss of animal of high genetic value, fewer herd replacements and reduced selection differential (Kifaro, 1995). Razzaque *et al*. (2008) reported the loses of calves in Kuwait dairy farms were due to inadequate management practices leading to diarrhoea, pneumonia, dehydration and infection by *E. coli*, Rotavirus, *Salmonella species* and *Pasteurella haemolytica*.

Death of calves implies a loss of future breeding stock and replacement dairy cows, a loss of slaughter cattle, a loss of future draught oxen and a loss of milk production in breeds milked with the calf at foot. Time of death during the lactation period determines the quantity of milk lost.

2.4.1 Still births and abortions

Meyer *et al*. (2000) and Berry *et al*. (2007) defined still birth as the calf that dies just prior to, during or within 24 to 48 hours of parturition. The former authors pointed out that dystocia was the major cause of stillbirths, however 50% of stillborn calves were from unassisted births. Gitau *et al.* (2010) defined abortion in dairy cattle as a loss of the fetus between the age of 42 days and approximately 260 days. Pregnancies lost before 42 days are usually referred to as early embryonic deaths, whereas a calf that is born dead between 260 days and full term is defined as a stillbirth.

In Mexico Segur-Correa and Segura-Correa (2009) noted the prevalences of abortion and dystocia to be 1.4% and 1.3%, respectively. The probability of stillbirth increased at an increasing rate in primipara as animals calved at a younger age relative to the median age at first calving.

The majority (75%) of stillbirths occur within one hour of calving with the remainder occurring either prepartum (10%) or post partum (15%) and traditionally over 50% of still births have been directly attributed to dystocia (Mee, 2004)). Other significant risk factors, which have been associated with bovine stillbirth include age at first calving (Ettema and Santos, 2004), primiparity (Pryce *et al*., 2006), twinning (Silva del Rio *et al*., 2007), foetal gender, gestation length and season of calving (Meyer *et al*., 2001). Ghavi Hossein-Zadeh *et al*. (2008) observed that the overall incidence of calf stillbirth in Holstein cows of Iran was 4.9% and varied among herds from 2.9 to 9.8%. A study by Gulliksen *et al*. (2009) showed that the abortion and stillbirth rates in Norwegian herds were 0.7% and 3.4%, respectively.

2.4.2 Pre-weaning and post-weaning mortality

Calf mortality before weaning accounts for almost a third of calf crop loses and is higher in subtropical and tropical regions (Riley *et al*., 2004). Hansen *et al*. (2003) reported higher postnatal mortality of Danish Holstein calves born to young cows (23 months of age or less) than among calves born to older cows. Prenatal mortality is an important cause of production losses in the livestock industry (Segur-Correa and Segura-Correa, 2009). Late mortality, occurring from the prenatal period to weaning, is usually considered to be mainly affected by environmental factors such as sporadic diseases or accidental losses. A study by Roy (1970) cited by Kifaro (1995) observed that, genetic and environmental factors influence rates of calf losses. Death rates have been shown to vary significantly with breed. He observed that Channel Island dairy breeds had higher calf mortality than Ayrshire which in turn had higher incidence than Shorthorn or Friesians. Management systems such as herd size, design of calf pens (pens on floor or elevated stalls, ventilation system) and level of supervision have been associated with calf deaths. In Mali overall calf mortality rate during the first year of life was 17% (Natalie, 2005). This leads to a partial loss of lactation of every 6th cow and a loss of one sixth of all potential slaughter cattle, draught oxen and future dairy and breeding stock. A study by Razzaque *et al.* (2009) on economic importance of calf mortality on dairy farms in Kuwait revealed that mortality rates of calves were 25%. Prasad *et al*. (2004) reported overall mortality rate of 13.46% in Karan Friesian in India. The calf mortality rate during the first year of life in Norwegian herds was found to be 7.8 % (Gulliksen *et al*., 2009).

2.4.3 Causes of calf mortality

In a study conducted by Gitau *et al.* (2010) on causes of calf mortality in peri-urban areas of Nairobi, diseases or conditions of the respiratory system were the most common (17.7%) while gastrointestinal tract (GIT) infections was a second cause affecting 16.1% of the cases. A small number, (3.3%) died from bloat giving the total cases associated with GIT as 19.4%. Severe calf malnutrition and septicaemia were the third most reported causes of calf mortality in similar proportions at 14.3% and 14.4% respectively. Other causes of calf mortality mentioned were tick-borne diseases (8.6%), helminthiasis (2.9%) and poisoning (1.8%). Sample size of that study was 507 calves.

In another study by Karimi *et al*. (2008) also in Kenya, they reported the most common causes of calf mortality to be theileriosis and anaplasmosis. Also they pointed out that poor calf management practices such as inadequate housing and overcrowding were major predisposing factors for morbidity in early stage of growth. Mortality, however, was found to be higher after four months of age when colostral antibodies wane and calves start getting exposed to tick borne diseases.

Natalie (2005), pointed out that the causes of death were mainly management problems, consisting of accidental losses (14%), starvation (10%) and sepsis (5%); digestive disorders, consisting of gastrointestinal parasites (12%), non-parasitic diarrhoea (10%) and ileus (7%); and perinatal mortality (16%). Further she noted that minor causes of death were vector-borne diseases (4%), respiratory disorders (4%) and nervous disorders (2%). In study made in the eastern zone of Tanzania by Shoo *et al*. (1992), they found the most common causes of death were diarrhoea (6%), pneumonia (3%) and weak calf syndrome (3%). This indicated that diarrhoea and gastrointestinal diseases were the most common disease conditions found in dairy calves.

2.5 Constraints Affecting Dairy Cattle Production

2.5.1 Inadequate feeds

There are several factors contributing to the lower productivity of tropical livestock. Besides the environmental factors causing heat stress, poor quality of nutrition, lack of adequate health care facilities and improper or poor management practices have adversely affected the livestock production in the tropics. A study by Lucy (2001), reported the influence of environmental factors in on productivity of dairy cattle in the tropics. These factors included: location, herd, rations, seasons and years.

Season of the year is known to affect the chemical composition and nutritional quality of forages and, consequently, animal productivity. A study conducted in Mexico revealed that, seasonal variation in the supply and quality of forage was likely a primary limitation on cattle productivity in Tizimín herds (Baba, 2007).

Kabirizi *et al*. (2006) noted a major constraint to small holder dairy sector to be inadequacy of feed resource in Uganda. In a study conducted in Kenya (Nherera, 2005) it was revealed that energy intake was the first limitation on milk production. In addition to restricting milk production and animal growth, deficits of dietary energy also constrained reproductive performance.

2.5.2 Diseases

The most important and readily measurable direct effects of diseases are manifested by losses in productivity. These include the illness leading to condemnation, poor weight gain, poor milk yield, poor feed conversion and poor reproductive capacity.

According to Maingi and Njoroge (2010), the main production constraints as perceived by farmers included diseases, high cost of drugs, high cost of supplementary feeds, inadequate pastures and inadequate extension services. Of the main diseases, East Coast Fever (ECF) was ranked first followed by anaplasmosis and babesiosis. Others were respiratory problems, worms and eye infections in that order of importance. In another study by Lema *et al*. (2001) diarrhoea was found to be one of the most important constraints in food animal production in central highlands of Ethiopia.

2.5.3 Management

Management is very important aspect in animal productivity. Husbandry practices like cleanliness of the barn influences calf health, as calves housed in unclean barns are at higher risk of disease than calves housed in clean barns. Diarrhoea may be nutritionally induced or caused by infectious agents (viruses, bacteria, fungi, or protozoa). Its prevalence appears to be management related especially when calves are housed in unhygienic conditions (Mekonnen *et al.*, 2006; Wudu *et al*., 2008).

In Zimbabwe, a study by Ngongoni *et al*. (2006) observed the performance of cows in terms of low milk yields, low calving rates, late age at first calving and long calving intervals were attributed to low levels of nutrition and management.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Description of the Study Farms

3.1.1 Kitulo LMU

Kitulo LMU is situated at an altitude of 2630-2820 m.a.s.l. in Makete district Njombe region, about 50 km South-east of Mbeya town. The farm is situated in a temperate climate where maximum daily temperatures range from a monthly average of 14.5° to 18.5ºC, minimum temperatures range from 7° to 8ºC in July and August. Average rainfall is 1420 mm per annum. The farm has a total area of about 5000 ha, out of which 666 ha are planted with temperate pasture species which include *Lorium perenne*, *Lorium multiflurium* and *Infolium repens*. At Kitulo farm calves are allowed to suckle for five days so as to get colostrum which is very important for immune system of the young one. After wards calves are introduced to bucket feeding where they are given 4 kg/day for a period of 2 months and 2 kg of milk per day for one month. Calves are weaned at an age of 3-4 months, but sometime it depends on the health status of the calves.

Grass constitutes the major proportion of the feed supply. Whenever there was a short supply during dry season, *Chloris gayana* hay was substituted. Hay was bought from Uyole some 50 km away due to the fact that the climatic condition of Kitulo does not allow the conservation of hay. Milking cows were supplemented with home made concentrate composed of maize bran, rice polish, (60-70%), sunflower seed cake or cotton seed cake (25%), mineral supplement 2% and 1% salt during milking. The amount of concentrate offered depended on the volume of milk from each cow and it ranged from 3 to 4 kg/day. Cows were machine milked twice a day and recording was conducted twice per month. The recording days were 15th and 30th of each month. Animals were regularly vaccinated against common infectious diseases such as Rinderpest, Contagious Bovine Pleuropneumonia (CBPP), Anthrax, S19 (for heifers), Blackleg and Foot and Mouth Diseases. Regular preventive treatments were administered against prevalent ectoparasites by dipping twice per month from November to May. Ticks are inactive during the other periods of the year. Preventive treatments against internal parasites were conducted to all herds where weaned calves were dewormed after every 3 months while adult animals were dewormed after every 4 months.

3.1.2 ASAS dairy farm

ASAS dairy farm is a private farm owned by a family company (ASAS). The farm is located 20 km east of Iringa town at an altitude between 1300 and 2800 m.a.s.l. The mean temperatures range from 17.5 to 21.4°C and the mean annual rainfall is about 1115 mm. The farm has a total area of about 60 ha, out of which 20 ha are planted with Rhodes grass and 5 ha are planted with lurcene (alfa-alfa) and the rest (40 ha) are occupied by natural pastures (*Hyperrhenia spp*, *Panicum maximum*, *Cenchrus ciliaris* and *Brachiaria spp*). Like Kitulo farm, calves were allowed to suckle for five days. Then calves were introduced into calf pens for bucket feeding. The amount of milk offered in the first 2 months was 3 kg/day while 2 kg/days was offered to the calves before weaning. Weaning was done at the age of 3-4 months. Male calves were weaned earlier than females.

Grass constituted the major proportion of the feed supply. Whenever there was a short supply during dry season, crop residues like maize straws, beans stovers and *Chloris gayana* hay were substituted. Crop residues were mainly bought from neighbouring villages. Milking cows were supplemented with commercial dairy meal and sometimes with home made concentrate composed of maize bran, rice polish, (60-70%), sunflower seed cake or cotton seed cake (25%), mineral supplement 2% and 1% salt during milking sessions. The amount of concentrate offered depended on the volume of milk from each cow and it ranged from 2 kg to 4 kg/day and definitely higher milkers consumed more. Cows were hand milked twice a day and records for each cow were taken daily. After evening milking all animals (milking herd, dry herd, heifers, weaners and bulls) were kept in a barn and supplemented with concentrate and fresh alfa-alfa.

Animals were regularly vaccinated against common infectious diseases such as Rinderpest, Contagious Bovine Pleuropneumonia (CBPP), Anthrax, Blackleg and Foot and Mouth diseases. Preventive treatments were administered against prevalent of ecto- parasites by dipping the animals twice a week in January to July and once a week in August to December. Preventive treatment against internal parasites were also conducted to all herds where weaned calves were dewormed after every 3 months while adult animals were dewormed thrice per year.

3.2 Data Collection and Analysis

3.2.1 Data collection

3.2.1.1 Reproduction traits

The period from birth to first calving date was considered as age at calving while the period between two consecutive calvings was considered as calving interval. Data recorded from 1990 to 2007 on age at first calving and calving interval were used. For easy and systematic data collection, a form was designed for collecting records from books, cows' individual cards and reports on age at first calving and calving interval.

Months of the year were grouped into four seasons based on rainfall pattern and availability and quality of pasture. Season 1 was the beginning of the rain season which starts from December to February. Season 2 was the period of heavy rain which started from March to May. Season 3 indicated the beginning of the dry season which lasted from June to August. The last was season 4 which was the late dry season and starts from September through November. Periods of the birth for these traits were classified into three subclasses, 1990-1995, 1996-2001 and 2002-2007.

3.2.1.2 Lactation performance traits

Data collected on lactation performance included total lactation milk yield, lactation length and dry period. Daily milk yield of each cow was recorded from the date of calving to dry off date. For Kitulo where records were taken twice per month, average of each month was calculated and then multiplied by the number of the days in particular months to get the amount of milk yield per month. Then the total milk yield was obtained by summing up the amount of yields for the whole lactation period. The total amount of milk recorded from calving date to dry off date was considered as total lactation milk yield (TLMY). Total lactation milk yield was expressed in kilogram (kg). Lactation length (LL) was calculated as periods in days from calving date to dry off date. Dry period (DP) was calculated as the interval in days between cessation of previous milking to the next calving dates. Periods of the birth in these traits were classified into three subclasses, 2000-2003, 2004-2006 and 2007-2009. Four seasons were maintained as in the previous traits.

3.2.1.3 Calf mortality

Incidences of abortions and stillbirths were assembled from stored data in calf registers or farm reports. Then summaries for each farm were used to determine total number of calvings, live births, abortions and stillbirths. Rate of abortion was computed as number of abortions as percentage of all calvings. Rates of still births were calculated as number of such incidences as a fraction of all calves born and expressed in percentage. Calculations were done in each year and for the whole study period.

Pre-weaning mortality rate was computed as the number of calves that died as fraction of calves born and for post-weaning mortality this was computed as the number of calves that died as a proportion of calves weaned. This was done within sex, year and age subclasses.

3.2.1.4 Causes of calf mortality

Causes of death for each calf were obtained from post mortem results. To obtain the number of calves that died of a specific disease/condition, each specific cause was compiled and coded as follows;

- Septicaemia including diarrhoea, calf scours, Salmonelosis and collibacilosis were coded as 1

- Respiratory infection e.g. Pneumonia and lung abscess as 2
- Poison including plant, chemical and snake bite were coded as 3
- Miscellaneous, metabolic disorders, bloat, foreign body, dog bites and navel infection. All these were coded as 4
- General weakness and unknown causes were coded as 5
- Worm infestation were coded as 6
- Accident and drowning in water 7
- Tick borne diseases were coded as 8
- Coccidiosis coded as 9
- Black quarter was coded as 10

Cause specific mortality rate was computed as the proportion of number of deaths due to a specific cause to the total number of deaths and it was expressed in percentage using following formula;

$$\text{Cause specific mortality rate} = \frac{\text{Number of deaths due to specific cause (n)} \times 100}{\text{Total number of deaths}} \quad \text{......1}$$

3.2.1.5 Life time performance traits

A data base containing ID of cows, date of birth, first calving date, dry off date after the first lactation, first and second lactation milk yields, number of life time calvings, date of calving before disposal, date of disposal and total milk yield from first calving date to date of disposal were collected. The following variables were derived: Age at first calving (in days), total life span as interval (in days) from birth date to date of disposal, length of productive life as interval (in days) from first calving to date of disposal, calving interval and lactation length in first lactation, milk yield per day of productive as total life time milk yield divided by length of productive life time and milk yield per day of total life as total life time milk yield divided by total life span.

3.2.1.6 Constraints affecting the performance of animals

Information for constraints affecting performance of animals in the farm were obtained by using the checklist to assess the productivity of the farm, the management of the animals and assessing the infrastructures of the farm which includes pasture availability and grazing area. Each parameter assessed was given a score and ranked according to its situation and severity. Also informal conversation with managers was made in both farms.

3.2.2 Data analyses

All data on reproduction and lactation performance were analysed by using General Linear Models procedure of Statistical Analysis System (SAS, 2000) package. Data of the two farms were analysed separately because Ayrshire breed was not represented at Kitulo. Data was analysed for fixed effects of period of calving, parity and season of calving. Effect of breed was involved in the analyses of data from ASAS farm. Calving intervals of less than 260 days were removed for further analyses because they were less than the gestation period in dairy cattle. Records made in parities above five were pooled into parity five at Kitulo farm or pooled into parity four at ASAS Farm.

Annual rates of abortions and stillbirths were computed. Differences between years were tested by Chi-square. Similarly, annual pre and postweaning mortality rates were calculated. Chi-square was used to test differences in the rates between sexes and years.

Analyses of life time performance traits were done by calculating means, standard errors and standard deviations. Correlations between traits were performed by using correlation option of SAS system.

Analyses of the constraint affecting the farms were performed by assessing the overall situation of the farm which included the grazing area (paddock, watering troughs and pasture), calf pens and farm implements. The assessed situation was ranked according to the prepared checklist and then the constraints affecting the farms were ranked according to the scores given.

Models I and II were used for data analyses. For data concerning LMY, LL and CI model I was used for analysis. AFC was analysed for fixed effects of period and season of calving (Model II).

Model I:

Yijkl = μ + Si + Rj + Pk + (SR)ij +(SP)ik + (RP)jk + eijkl …………………………2

Where:

Yijkln = LMY, LL, CI, DP of l^{th} cow in k^{th} parity, j^{th} period of calving and i^{th} season of calving.

μ = overall mean common to all observation

Si = the effect of i^{th} season of calving

Rj = the effect of j^{th} period of calving

Pk = the effect of k^{th} parity

(SR)ij = the effect of interaction between i^{th} season and j^{th} period of calving

(SP)ik = the effect of interaction between i^{th} season of calving and k^{th} parity

(RP)jk = the effect of interaction between j^{th} period of calving and k^{th} parity

eijkl = random residual error term

The following model was used to analyse data for AFC at ASAS farm.

Model II

Yijkn = μ + Bi + Sj + Pk + (SP)jk +(BS)ij +(BP)ik + eijkn………………...3

Where:

Yijkn = Age at first calving of n^{th} cow born in k^{th} period of birth,

j^{th} season of birth and of i^{th} breed

μ = overall mean common to all observation

Bi = the effect of i^{th} breed

Sj = the effect of j^{th} season of birth

Pk = the effect of k^{th} period of birth

(BS)ij = the effect of interaction between i^{th} breed and j^{th} season

(SP)jk = the effect of interaction between j^{th} season and k^{th} period of calving

(BP)ik = the effect of interaction between i^{th} breed and k^{th} period of calving

eijkn = random residual error term

CHAPTER FOUR

4.0 RESULTS

4.1 Reproductive Performance Traits

4.1.1 Age at first calving (AFC)

Effect of breed at ASAS farm significantly (P < 0.05) influenced age at first calving (AFC) (Appendix 1). The overall means for AFC for Ayrshire and Friesian breeds were 1059.5±19.4 and 1105.7±13.0 days, respectively (Table 1). Friesian heifers were significantly older than Ayrshire at first calving by 46.2 days.

Periods of calving significantly (P < 0.05) influenced AFC whereas season of calving had insignificant (P > 0.05) effect on AFC. AFC at ASAS farm had a decreasing trend from season of calving one (Dec-Feb) through season four (Sept-Nov).

Again Table 1 shows that at Kitulo farm, overall mean AFC was 1151.7±9.6 days. AFC at Kitulo farm had decreasing trend from period one (1990-1995) through period three (2002-2007) (Appendix 2).

Period of calving significantly (P < 0.001) influenced AFC where as season of calving was not significant. AFC in period of calving two (1996 – 2001) was higher than other periods while AFC in season of calving one (Dec – Feb) was higher than other seasons (Appendix 3).

Table 1: Least squares means (LSM) ± standard errors (s.e) of age at first calving (days) for various factors at ASAS and Kitulo farms

		ASAS		Kitulo	
Factor	**Levels**	**n**	**LSMeans**	**n**	**LSMeans**
Breed	Ayrshire	146	1059.5±19.41[a]		-
	Friesian	258	1105.7±12.99[b]	317	1151.7±9.63
Period of calving					
	1990-1995	19	1049.3±25.85[b]	44	1217.0±26.43[a]
	1996-2001	26	1127.0±20.89[a]	165	1174.1±13.96[a]
	2002-2007	101	1071.5±11.59[b]	108	1078.8±16.81[b]
Season of calving					
	Dec-Feb	54	1106.7±17.81	96	1161.2±22.75
	Mar-May	41	1079.0±20.91	91	1171.9±20.13
	Jun-Aug	36	1074.3±20.50	75	1180.7±22.77
	Sept-Nov	15	1070.3±31.31	55	1112.7±25.45

Means with the same superscript within a column and factor do not differ significantly (P > 0.05)

4.1.2 Calving intervals

Least squares means (Table 2) show that, overall mean calving intervals (CI) at ASAS farm for Ayrshire and Friesian were 410.8±8.14 and 423.4±6.79 days, respectively. Mean calving interval for Friesians was longer by 13 days over Ayrshires.

Breed, period and season of calving had no significant (P > 0.05) effect on calving intervals. However period of calving two (2004-2006) had longer intervals than other periods. On other hand season of calving three (Jun – Aug) had longer intervals than other seasons.

Variations due to parity highly significantly (P < 0.001) influenced CI followed by interaction between parity x period of calving (P < 0.05) (Appendix 4). Parity four had shorter intervals than other parities. Generally, CI at ASAS farm had a decreasing trend from parity one through parity four (Appendix 5).

At Kitulo farm the overall mean CI was 421.6±1.43 days. Period of calving significantly ($P < 0.01$) affected calving intervals while season of calving had no significant effect on CI. Least squares means (Table 2) show that cows that calved in period two (2004-2006) had a longer mean calving interval than other periods (Appendix 6). Season of calving four (Sept-Nov) had shorter calving intervals than in other seasons (Appendix 7). Results also revealed that parity had a significant ($P < 0.001$) influence on CI. Parity one and five had longer CI whereas the shortest CI was observed in second parity.

Table 2: Least squares means (LSM) ± standard errors (s.e) of calving interval (days) for various factors at ASAS and Kitulo farms

		ASAS		Kitulo	
Factor	**Level**	**n**	**LSMeans**	**n**	**LSMeans**
Breed	Ayrshire	146	410.8±8.14	-	-
	Friesian	258	423.4±6.79	317	421.6±1.43
Season of calving					
	Dec-Feb	311	419.4±9.10	265	419.4±3.23
	Mar-May	214	415.2±8.96	298	422.9±3.21
	Jun-Aug	218	424.3±9.44	268	421.6±3.12
	Sep-Nov	222	409.6±9.20	223	415.7±4.22
Period of calving					
	2000-2003	151	411.0±17.74	432	415.1±2.80[b]
	2004-2006	249	423.5±5.95	395	427.3±2.54[a]
	2007-2009	565	416.9±5.30	227	417.4±4.08[b]
Parity					
	1	401	444.2±5.97[b]	122	429.4±5.32[bc]
	2	311	414.5±6.37[cd]	233	401.2±5.01[e]
	3	129	418.4±21.99[bc]	233	414.0±3.43[d]
	4	124	391.4±9.98[d]	233	420.8±3.23[cd]
	≥5	-	-	233	434.1±3.56[b]

Means with the same superscript within a column and factor do not differ significantly (P > 0.05)

4.2 Lactation Performance Traits

4.2.1 Total lactation milk yield

The mean total lactation milk yields (TLMY) at ASAS farm were 2696.8±75.4 and 3000.1±62.92 kg for Ayrshire and Friesian breeds, respectively. Appendix 8 shows that breed, parity and periods of calving significantly ($P < 0.001$, $P < 0.001$ and $P < 0.05$, respectively) influenced total lactation milk yield. Season of calving did not significantly ($P > 0.05$) influenced lactation milk yield. Period of calving three (2007-2009) had higher yields than other periods. Further more, season of calving one (Dec-Feb) had higher yields than other seasons. Milk yields were increasing with age and parity of the cows (Appendix 9).

The least squares means (Table 3) show that TLMY at Kitulo farm was 2608.3±24.0 kg. Parity significantly (P < 0.001) affected TLMY in the farm whereas season of calving had a minor effect. The highest yields were observed in period of calving one (2000-2003) while the lowest yields were observed in period three (2007-2009) and tended to decrease from period of calving one through period three (Appendix 10). Similarly season of calving one (Dec-Feb) had higher yields compared to other seasons (Appendix 11).

Table 3: Least squares means (LSM) ± standard errors (s.e) of LMY milk in kg for various factors at ASAS and Kitulo farms

		ASAS		Kitulo	
Factor	**Level**	**n**	**LSMeans**	**n**	**LSMeans**
Breed	Ayrshire	146	2696.8±75.40[a]	-	-
	Friesian	258	3000.1±62.92[b]	317	2608.3±24.01
Season of calving					
	Dec-Feb	311	2983.4±84.25[ab]	265	2648.2±54.08
	Mar-May	214	2799.7±82.96[c]	298	2611.4±53.71
	Jun-Aug	218	2821.5±87.39[bc]	268	2546.3±52.26
	Sep-Nov	222	2789.1±85.19[c]	223	2505.9±70.62
Period of calving					
	2000-2003	151	2866.7±164.20[bc]	432	2676.8±47.07[a]
	2004-2006	249	2746.1±55.13[c]	395	2569.8±42.47[a]
	2007-2009	565	2932.4±49.08[ab]	227	2487.3±68.31[b]
Parity					
	1	401	2386.7±55.24[c]	122	2239.6±88.95[c]
	2	311	2746.4±59.01[b]	233	2497.2±83.85[b]
	3	129	3152.0±203.67[a]	233	2642.4±57.42[ab]
	4	124	3108.7±92.39[a]	233	2733.7±54.01[a]
	≥5	-	-	233	2776.9±59.63[a]

Means with the same superscript within a column and factor do not differ significantly (P > 0.05)

4.2.2 Lactation length

Least squares means (Table 4) for lactation length (LL) at ASAS farm were 305.8±5.72 and 318.9±4.80 days for Ayrshire and Friesian cows, respectively. The effect of breed significantly ($P < 0.05$) influenced lactation lengths at ASAS farm (Appendix 12). However, the effects of parity, period and season of calving were not significant ($P > 0.05$). LL tended to increase as time went by (Appendix 13) and the difference in LL between the best season (Dec – Feb) and worst season (March – May) was 16 days. Table 4 shows the overall mean LL at Kitulo farm was 322.3±1.43 days. The results also revealed that only period of calving significantly ($P < 0.05$) influenced the LL. Periods of calving two (2004-2006) was longer than other periods (Appendix 14). Other factors (parity and season of calving) had no significant ($P > 0.05$) influence on LL. Appendix 15 shows that the LL had no clear trend, with regard to parity. On other hand season of calving had small differences between the seasons.

Table 4: Least squares means (LSM) ± standard errors (s.e) for LL in days for Kitulo and ASAS farms

		ASAS		Kitulo	
Factor	**Level**	**n**	**LSMeans**	**n**	**LSMeans**
Breed	Ayrshire	146	305.8±5.72[a]	-	-
	Friesian	258	318.9±4.80[b]	317	322.3±1.43
Season of calving					
	Dec-Feb	311	319.3±6.40	265	323.7±3.2
	Mar-May	214	303.9±6.31	298	324.7±3.2
	Jun-Aug	218	312.2±6.64	268	323.3±3.0
	Sep-Nov	222	313.8±6.48	223	319.5±4.2
Period of calving					
	2000-2003	151	305.7±12.48	432	316.5±2.8[c]
	2004-2006	249	312.5±4.20	395	328.4±2.5[b]
	2007-2009	565	318.8±3.73	227	323.5±4.0[bc]
Parity					
	1	401	314.4±4.20	122	333.3±5.3
	2	311	307.2±4.48	233	317.2±5.0
	3	129	318.6±15.48	233	321.2±3.4
	4	124	309.1±7.02	233	323.9±3.2
	≥5	-	-	233	318.5±3.5

Means with the same superscript within a column and factor do not differ significantly (P > 0.05)

4.2.3 Dry period (DP)

Table 5 shows that overall mean lengths of dry periods (DP) at ASAS farm were 92.9±2.64 and 96.3±2.20 days for Ayrshire and Friesian cows, respectively. Ayrshires had shorter DP by 3 days than Friesians, though their difference was small. The result revealed that all factor studied in this trait (breed, parity, period and season) had no significant (P > 0.05) effect on DP.

Least means squares (Table 5) show that DP for cows in parity one at ASAS was longer than in other parities (Appendix 16). Seasonal variations in length of DP were small.

At Kitulo farm the overall mean DP was 91.2±0.52 days. ANOVA results (Appendix 17) showed a significant (P < 0.001) effect of parity on DP, also period of calving significantly (P < 0.001) influenced DP. However, season of calving had small influence on dry period (DP) at Kitulo farm. DP for cows in parity two at Kitulo farm was longer than in other parities. On other hand period and season of calving at Kitulo farm had an increasing trend (Appendix 18 and 19).

Table 5: Least squares means (LSM) ± standard errors (s.e) for DP in days for Kitulo and ASAS farms

		ASAS		Kitulo	
Factor	**Levels**	**n**	**LSMeans**	**n**	**LSMeans**
Breed	Ayrshire	146	92.9±2.64	-	-
	Friesian	258	96.3±2.20	317	91.2±0.52
Season of calving					
	Dec-Feb	311	92.9±2.95	265	90.5±1.02
	Mar-May	214	100.4±2.90	298	92.3±1.02
	Jun-Aug	218	92.0±3.06	268	92.0±0.99
	Sep-Nov	222	93.0±2.98	223	94.9±1.34
Period of calving					
	2000-2003	151	89.3±5.75	432	89.6±0.89[c]
	2004-2006	249	99.5±1.93	395	92.0±0.80[b]
	2007-2009	565	94.9±1.73	227	95.6±1.29[a]
Parity					
	1	401	97.4±1.93	122	91.1±1.69[d]
	2	311	95.5±2.06	233	96.8±1.59[ab]
	3	129	91.8±7.13	233	87.9±1.01[d]
	4	124	93.6±3.23	233	94.2±1.02[bc]
	≥5	-	-	233	92.2±1.13[c]

Means with the same superscript within a column and factor do not differ significantly (P > 0.05)

4.3 Calf Mortality

4.3.1 Abortions and stillbirths

Table 6 shows that the overall abortion rates at ASAS and Kitulo farms were 4.82 and 3.71 %, respectively. At ASAS farm highest rate was observed in year 2000 (8.65%), where as lowest rate was observed in 2004 (0.9%), but at Kitulo highest rate was observed in 2001 (5.92%) and lowest rate in 2004 (1.43%) (Fig. 1). Generally Kitulo farm had lower rates compared to ASAS (Table 6). Chi-square test performed to asses differences between years was significant (P < 0.01) in both farms.

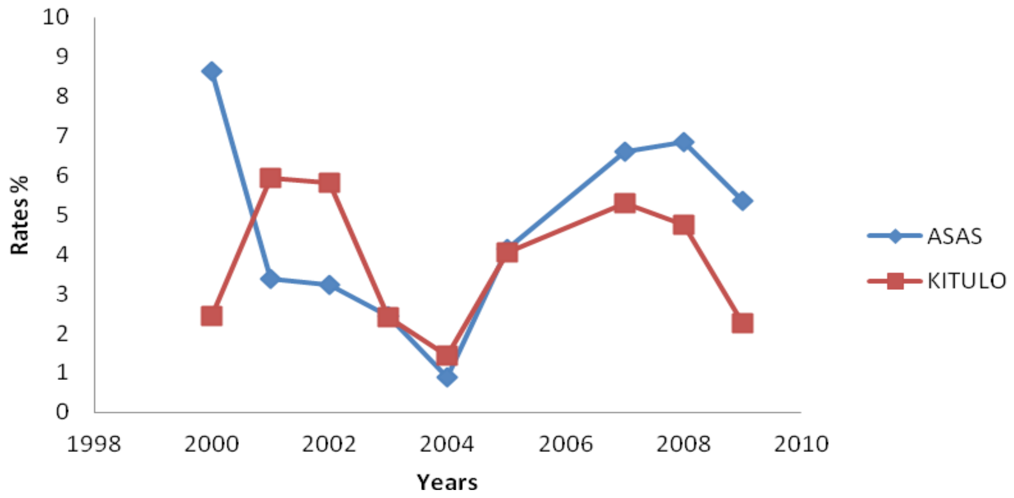

Figure 1: Abortion rates between years at ASAS and Kitulo farms

Rates of stillbirth showed that ASAS farm had higher rates compared to Kitulo. The overall rates were 11.22 and 6.49% for ASAS and Kitulo, respectively. Rates of stillbirth had an increased trend from 2000 through 2009 at ASAS and that the rates of stillbirths were higher than abortion rates in both farms (Table 6 and Appendix 20). Chi-square tests were significant both at ASAS (P < 0.01) and Kitulo farm (P < 0.01).

Table 6: Rates of abortion and still birth at ASAS and Kitulo farms

Aspect	ASAS	Kitulo
Years	2000-2009	2000-2009
Abortions		
Means %	4.82	3.71
Range [1]	0.9-8.65	1.43-5.92
Chi-square	25.37**	23.03**
Stillbirths		
Means %	11.22	6.54
Range[1]	5.95-16.67	4.29-9.47
Chi-squares	28.42**	21.95**

** = Significant at P < 0.01

[1] = Ranges of annual rates

4.3.2 Pre-weaning and post-weaning mortality rate

Table 7 shows that male calves had higher pre weaning mortality rates than female calves in both farms. Overall mean pre-weaning mortality rates at ASAS farm were 9.3 and 6.6% for males and females calves, respectively. At Kitulo farm mean pre-weaning calves mortalities were 12.0 and 10.4% for males and female calves, respectively. In general Kitulo farm had higher pre-weaning mortality rates than ASAS farm (Fig. 2).

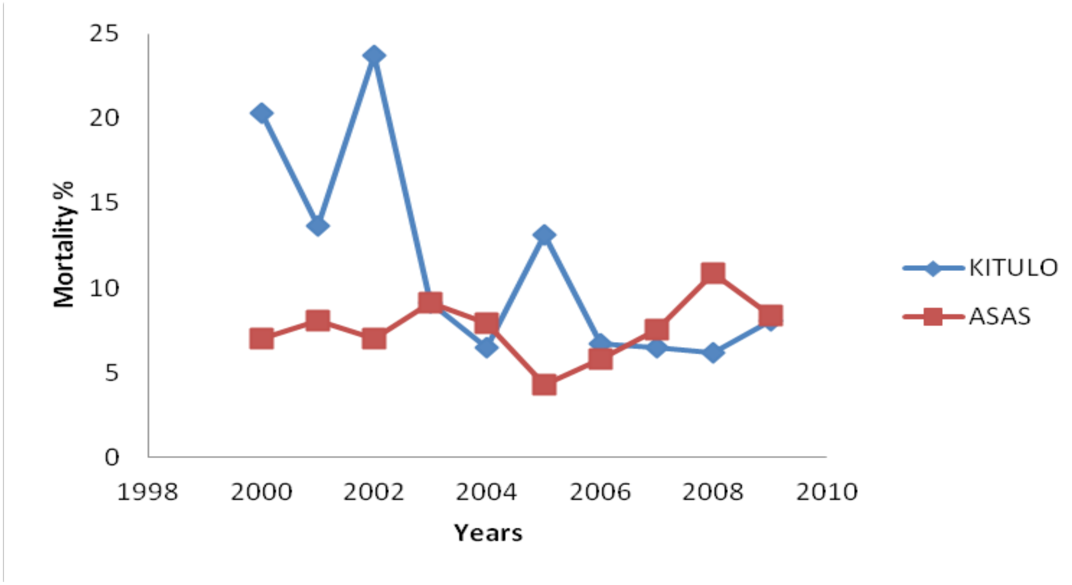

Figure 2: Pre-weaning calf mortality between years at ASAS and Kitulo farms

Post weaning mortality rates showed that the overall rates were 12.1 and 13.0% for ASAS and Kitulo, respectively. Annual mortality rates ranged from 9.3 to 16.4% at ASAS and 9.2-21.2% at Kitulo farm (Appendix 21). Results showed that mean post weaning mortality rates for heifer calves were lower than post-weaning mortality rates for bull calves (Table 7).

Table 7: Preweaning and postweaning mortality rate % at ASAS and Kitulo farms

Farm	Age class	No.of calves born	No. of calves died	Death rate	Range between years	Chi-square	Range between Males	Mean for males	Range between females	Mean for females	Chi-square
	Preweaned	2304	175	7.6	4.3-10.9	8.52ns	4.8-14.3	9.3	3.4-10.9	6.6	16.4***
	Weaned	1909	231	12.1	9.3-16.4	6.49ns	8.7-18.9	13.6	8.0-14.1	10.6	12.1***
ASAS	Birth-12 mo	2304	406	17.6							
	Preweaned	3628	400	11.0	6.2-23.7	94.36***	8.5-23.7	12.0	8.8-18.5	10.4	101.2***
	Weaned	3228	420	13.0	9.2-21.2	28.56**	4.7-26.7	14.2	5.1-19.5	12.2	35.5***
Kitulo	Birth-12 mo	3628	820	22.6							

ns=Not significant

*=Significant at P < 0.05

**=Significant at P < 0.01

***=Significant at P < 0.001

4.3.3 Causes of calf mortality

Causes of calf mortality are shown in Table 8. In ranking the major causes of calf mortality, septicaemia which included diarrhoea and calf scours contributed 40.1% of mortality followed by miscellaneous causes (16.1%), respiratory infection (14.3%) and general body weakness/unknown cases (14.2%). Other causes contributed between 2.4% and 3.6% of the total deaths at ASAS farm. On the other hand the major causes of mortality at Kitulo follow the same trend.

Table 8: Causes of calf mortality at ASAS and Kitulo farms

	ASAS		Kitulo	
Cause	**Cases**	**Rate %**	**Cases**	**Rate%**
Calves that died	509		820	
Septicaemia including diarrhoea and calf scours	204	40.1	187	22.8
Respiratory infection	73	14.3	162	19.8
Poisoning including plant snake bite and chemical	18	3.6	80	9.8
Miscellaneous (metabolic disorders, bloat, foreign body, dog bites and navel infection)	82	16.1	115	14.0
General weakness and unknown causes	72	14.2	107	13.1
Worm infection	18	3.6	68	8.3
Coccidiosis	16	3.1	23	2.8
Accidents and drowning in water	12	2.4	70	8.5
Tick borne diseases	14	2.8	-	-
Back quarter	-	-	8	0.1

4.3.1 Life time performance traits

Table 9 shows the means and standard errors of studied life time traits. Mean total life span ranged from 1525.0±154.93 to 3363.7±72.16 days. Length of productive life was shortest at Kitulo (2095.1±72.33 days) compared to that of ASAS farm (2594.2±155.3 for Ayrshire and 2 987.2±126.29 days for Friesian). Total life time productions at ASAS farm were 11 303.6 and 13 517.5 kg for Ayrshire and Friesian cows, respectively. At Kitulo farm total life time production was 13 481.2 kg (Appendix 22).

Number of life time calvings was highest at Kitulo (5.5±0.16 times) and lowest at ASAS (4.0±0.35 for Ayrshire and 4.7±0.29 times for Friesian). Milk yield per days of total life span at ASAS farm were 4.3±0.17 and 4.4±0.14 kg for Ayrshire and Friesian, respectively. At Kitulo farm milk yield per days of total life span was 3.7±0.08 kg. Milk yield per day of productive life at ASAS farm were 8.5±0.36 and 8.1±0.29 kg for Ayrshire and Friesian, respectively. On other hand milk yield per day of productive life for Kitulo Friesians was 6.5±0.16 kg.

Correlations between early life and productive traits showed that for most of the traits they were not significant ($P > 0.05$). Age at first calving (AFC) and total life (TL) were positively correlated in both farms and significant for Ayrshires ($P < 0.05$) at ASAS and Kitulo Friesians ($P > 0.01$).

AFC and total milk yield in life time (TM) were positively correlated and significant ($p<0.05$) only at Kitulo farm. First lactation milk yield (FLMY) had positive association with TL and PL in both farms. First calving interval (FCI) and first lactation length (FLL) often had negative association with other life time traits in both farms, except for Ayrshire (Table 10).

Table 9: Means and standard errors for early life time performance traits at ASAS and Kitulo farms

Farm	Breed	N	AFC	FLMY	FCI	FLL	TL	PL	NLC	TMY	MYDPL	MDTL
	AYRSHIRE	41	1069.2± 32.89	2326.2±343.07	434.9±10.56	325.9±10.77	1525.0±154.93	2594.2±155.31	4.0±0.35	11303.6±967.70	8.5±0.3	4.3±0.17
ASAS	FRIESIAN	62	1169.5±26.75	2583.5± 278.98	452.3± 8.59	329.8±8.75	1817.6±125.99	987.2±126.29	4.7±0.29	13517.5±786.93	8.1±0.29	4.4± 0.14
Kitulo	FRIESIAN	189	1268.6±15.32	2675.4±159.77	435.9±4.92	346.1±5.02	3363.7±72.16	2095.1±72.33	5.5±0.16	13089.7±450.71	6.5±0.16	3.7±0.07

AFC = Age at first calving (days). FLMY = First lactation milk yield (kg). FCI = First calving interval (days). FLL = First lactation length (days). TL = Total life span (days). PL = Productive life span (days). NCL = Number of life time calvings (number).

TMY = Total lifetime milk yield (kg). MYDPL = Milk yield per day of productive life (kg). MDTL = Milk yield per day of total life span (kg).

Table 10: Phenotypic correlations between early life and productive lifetime traits

	ASAS		Kitulo
Correlated traits	**Ayrshire**	**Friesian**	**Friesian**
n	41	62	189
AFC-TL	0.32*	0.21^{ns}	0.31**
AFC-PL	0.15^{ns}	0.05^{ns}	0.14^{ns}
AFC-TM	0.24^{ns}	0.06^{ns}	0.19*
AFC-MDPL	-0.09^{ns}	-0.02^{ns}	-0.08^{ns}
AFC-MDTL	-0.11^{ns}	-0.20^{ns}	0.13^{ns}
FLMY-TL	0.32*	0.13^{ns}	0.22*
FLMY-PL	0.28^{ns}	0.11^{ns}	0.19*
FLMY-TM	0.35*	-0.03^{ns}	0.12^{ns}
FLMY-MDPL	-0.26^{ns}	-0.17^{ns}	-0.21*
FLMY-MDTL	0.13^{ns}	-0.24^{ns}	-0.10^{ns}
FCI-TL	0.31*	-0.07^{ns}	0.11^{ns}
FCI-PL	0.28^{ns}	-0.06^{ns}	0.09^{ns}
FCI-TM	0.27^{ns}	-0.02^{ns}	0.01^{ns}
FCI-MDPL	-0.06^{ns}	-0.14^{ns}	-0.11^{ns}
FCI-MDTL	-0.01^{ns}	-0.29*	-0.17^{ns}
FLL-TL	0.05^{ns}	-0.14^{ns}	-0.13^{ns}
FLL-PL	0.03^{ns}	-0.15^{ns}	-0.15^{ns}
FLL-TM	0.18^{ns}	-0.33**	-0.19*
FLL-MDTL	0.15^{ns}	-0.21^{ns}	-0.01^{ns}
FLL-MDPL	0.24^{ns}	0.41***	-0.20*

AFC – Age at first calving   FLMY- First lactation milk yield   TL – Total life span   FCI – First calving interval   PL – Productive life   FLL – First lactation length   TM – Total milk yield MDPL – Milk yield per day of productive life

MDTL – Milk yield per day of total life span

ns= Not significant

*=Significant at P < 0.05

**=Significant at P < 0.01

4.5 Constraints Affecting the Farms

4.5.1 Inadequate feeds

According to the assessments performed, it was noted that feed deficit during the dry season was the major problem affecting the farms. It was noted that Kitulo farm bought hay from Uyole since the climatic condition does not allow hay making. Alternatively silage making could be possible, but they don’t practice. Although hay making has been practised at ASAS farm the deficit of feed during the dry season still exists because the biomass produced can not meet the requirements of the animals throughout the dry season. Therefore they have to buy crop residues from near- by villages so that it can sustain the animals throughout the dry season; hence high cost of production during this season.

4.5.2 Abortions and stillbirths

Abortions and stillbirths were another problem facing the farms. It was observed that the incidences had an increasing trend at ASAS farm. However the incidences were low at Kitulo farm.

4.5.3 Deterioration of farm structures

It was noted that farm structures at Kitulo farm had deteriorated, for instance, most of watering troughs, paddock fences and calf pens were in bad condition and some were completely out of use. This causes animals to have little access to water and therefore reduced milk production.

4.5.4 Labour, records and capital availability

Labour availability both skilled and unskilled labour are very important in farm productivity. It was noted that there were unstable availability of skilled labour especially at ASAS farm. It was noted that skilled worker once they go for further studies no one comes back to their work. It was also noted that records were not properly kept in both farms. For example unrelated events were kept in the same record book. It was further observed that there was great deficiency of money (insufficient money) for running daily activities at Kitulo farm.

4.5.5 Marketing of live animals and milk

It was observed that milk marketing at Kitulo is made at Mbeya town about 50 km away. Therefore the cost of milk is very low compared to the cost incurred in production and transportation of milk from the farm to the market. It was also noted that milk is sold to ASAS milk processing industry twice a week .The plant is located in Iringa town (more than 200 km). The price of selling milk to ASAS milk processors is 500 Tsh/kg. This price is very low when compared to the production cost. I.e. the price can not cover the cost of producing one kg of milk. Also the price of live animals is low compared to nearby private farms (two times). This is due to the fact that the government decides on the price of live animals and that greatly reduces the income of the farm.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Reproductive Performance Traits

5.1.1 Age at first calving (AFC)

The mean ages at first calving were 1059.5±19.41 and 1105.7±12.99 days at ASAS farm for Ayrshire and Friesian, respectively. At Kitulo AFC was 1151.7±9.63 days. Tadesse *et al.* (2010) reported similar findings in Ethiopia where Friesian heifers had first calf at 39.2±7.5 months. Other workers (Balikowa, 1997; Chenyambuga and Mseleko, 2009) reported nearly similar mean values of 34.5 and 38.4±0.5 months, respectively. Kifaro (1995) also reported similar findings in five institutional farms in the southern highland zone of Tanzania. However, it is higher than the mean of 32.4 months reported by Syrstad (1995) under tropical environments. Lower values of AFC (29.3 and 27.2 months) had been reported in Tunisia and Pakistan HF cows by Ajili *et al*. (2007) and Niazi and Aleem, (2003), respectively. The prolonged age at first calving in the present study could be attributed to poor nutrition and management practices including ratio of bulls used at the time of mating the heifers. Also good nutrition is a key factor to consider for heifers to exhibit fast growth rates and attain higher weights at younger ages hence early age at first calving.

Variations due to period of calving significantly affected age at first calving in this study. Similar results had been reported by Kasonta (1988) and Tadesse *et al*. (2010). There was a decreasing trend of AFC from 1217.0±26.43 during period of calving one to 1078.8±16.81 days in the period of calving three at Kitulo farm (Appendix 2). It is a decrease of about 138.2 days (11.36%). This implies a progressive improvement in management practices of the heifers and improved reproductive health. On other hand there was no clear trend observed at ASAS farm and this could be attributed by the effects of management and climatic changes between the periods.

Season of calving had no significant effect on age at first calving in both farms i.e. the effect of the season was small in both farms. The results are in agreement with information in Kasonta (1988), Kifaro (1995), Msuya (2002) and Tadesse *et al.* (2010) who reported season of calving to have no significant effect on age at first calving. Contrarily, Trail and Gregory (1981) found a significant ($P < 0.01$) effect of season on age at first calving. Cows born in season of calving one (Dec – Feb) were older at first calving compared to cows born in other seasons. Season four (Sept – Nov) had lowest age at first calving in both farms. This is in agreement with the observation by Asimwe and Kifaro (2007) who reported that AFC was influenced by the seasons in which the heifers were born. Mwatawala (2006) also reported similar effect of season on age at first calving where heifers born in light wet season calved 1.5 months earlier than those born at the beginning of dry season.

The variation could be caused by differences in quality and quantity of forage, a common phenomenon in the tropical environment. Calves born during the wet season tended to have higher age at first calving because they are weaned in the dry season, which cause a reduced growth rate among calves. At this time calves depend much on forage which is of low quality hence late maturity. While those born during the beginning of dry season had the lowest age at first calving, this can be attributed to the reason that calves are weaned at the time when quality of forage is high, therefore calves grow very fast and attain puberty at a lower age.

5.1.2 Calving interval (CI)

In this study breed and period of calving had no significant influence on CI at ASAS farm, though there were large differences between breeds and periods. Friesians had longer calving intervals than Ayrshires. The mean calving interval obtained in this study concur to the results by Kasonta and Rushalaza (1993) who reported mean calving interval of 418.0±89.8 days and it is lower than the mean calving intervals of imported Friesian cows (449 days) and local born Friesian cows (436 days) reported in Pakistan by Niazi and Aleem (2003) and 459±2.4 days reported by Million (2001) for Holstein Friesian (HF) crosses in central highland of Ethiopia. The result is higher than the mean calving interval of 402.6±3.0 days reported in Tanzania by Chenyambuga and Mseleko (2009). However, the calving intervals in the present study are above the recommended interval of 365 days expected on a commercial dairy farm. These long calving intervals are mainly associated with the longer time to conceive which could be related to mismanagement practices like poor nutrition and bull to cow (bull: cow) ratio used in the herd. Long calving intervals simply translate to having fewer calves born during the productive lifetime of the cow. For example, cows that conceive at 100 days after calving (12.8 months calving interval), on average will produce about 3 calves throughout their productive life time of 3-3.5 years (average productive life in commercial herds), whereas cows that conceive at 180 days after calving (15.5 months calving interval), hardly produce 3 calves throughout that time.

The current results indicate that parity had a significant effect on the length of calving intervals. The observation concurs with the study by Chenyambuga and Mseleko (2009) and Msuya (2002) who also reported significant influence of parity on calving intervals. Calving intervals decreased as the number of parities increased at ASAS farm (Appendix 5). There was a decrease of 53 days (12%) from first to fourth parity. The decrease in calving interval between the first and subsequent parities conforms to earlier studies by Kifaro (1984), Agyemang and Nkhonjera (1986) and Balikowa (1997).

However, there was no clear trend at Kitulo, although first and fifth parity had longer calving intervals but was not significantly different. The decrease in calving intervals with parity could be associated with improvement in reproductive health management and indicates that physiological maturity of cows is attained with advanced age. Kifaro (1984) associated longer calving intervals in first parity than subsequent ones to the big calving stress among heifers compared to older cows. Also partition of nutrients for milk production, growth and reproduction prolong CIs.

In this study, period of calving had a significant influence on calving interval at Kitulo and non significant at ASAS farm. Kifaro (1995) observed similar findings where he found significant effect of periods in four out of five institutional farms. These results are in agreement with argument that, period (year) effect on calving intervals in the tropics are indirect due to dynamic climatic changes which are frequently associated with forage fluctuations, disease pattern and changes in management (Mulangila, 1997) and it was evident at Kitulo farm where mean calving intervals decrease from 489±3 days (1995) to 421.64±1.43 days (2000-2009) which is a reduction of 68 days (13.9%).

Season of calving had no significant effect (P>0.05) on calving intervals but cows that calved during the dry and early rainy season had shorter calving intervals compared to the other seasons. The mean differences between seasons were not significant, showing that the season of calving did not influence calving interval in both farms. This result is in agreement with the report by Mukasa-Mugerawa *et al*. (1992). This is probably because cows that calved during the late dry and early rainy season take advantage of improved forage in terms of quality and quantity for a relatively longer period. Therefore those cows gained body weight and increased their conception rates, which in turn results into reduced length of calving intervals.

5.2 Lactation Performance Traits

5.2.1 Lactation milk yield

The results obtained in this study revealed that Friesian cows were superior to Ayrshire cows in terms of total lactation milk yield at ASAS farm. Friesian cows have higher milk production potential than Ayrshire under the same management. The mean lactation milk yields obtained are higher than the result by Lubago *et al.* (2006) who reported mean lactation milk yield of Friesian cows to be 2165.0±27.0 kg in Ethiopia. Nearly similar results have been demonstrated by Sattar *et al.* (2005). Its lower compared to 4791 kg lactation milk yield of Holstein Friesian (HF) breed in

Zimbabwe reported by Makuza and McDaniel (1996); 5905 kg/cow in Tunisian HF cow by Ajili *et al*. (2007), 3710kg/cow in Ethiopia (Tadesse *et al*., 2010) and 6536 kg/cows in the first parity of the Iranian cows (Hosein-Zadeh and Ardalan, 2011). This lower lactation milk yield of Friesian cows in the present study compared to the cited literature is an indication of poor nutrition and management condition of the farm which is attributed mainly to the changing in climatic condition over the years. On other hand it indicates that with good management practices like good nutrition and appropriate supplementation, Ayrshires could surpass fairly or poorly managed Friesian cows in lactation milk yield.

Parity was among the non genetic factors influencing lactation milk yield in this study. Parity significantly ($P < 0.001$) influenced the total lactation milk yield in both farms. The observation is in agreement with Tadesse *et al*. (2010). Mean lactation milk yield increased from first parity to fifth parity. The differences among parity three to five at Kitulo farm were significant ($P < 0.05$). The results showed that total lactation yield increased with increase in parity from parity one to three and from parity one to parity five (Appendix 9) at ASAS and Kitulo farms, respectively. Mwatawala (2006) and Migose *et al*. (2006) reported similar significant effect of parity on the milk yield. In this study peak milk yield was observed in parity three at ASAS whereas at Kitulo it was observed in fifth parity. The increase in lactation milk yield with increase in parity is due to the fact that mature cows use most of the nutrients for milk production and have the ability of gaining body weight and condition quickly after calving whereas the first calvers face lactation stress and partition nutrients for continuous body growth and milk production. Periods of calving significantly influenced the lactation milk yield in both farms. Similarly Balikowa (1997) reported a significant effect of year of calving on milk yields. Mean lactation yield was highest during period of calving three (2007-2009) and lowest yield was observed during period of calving period two (2004-2006) at ASAS farm. There was a decreasing trend in mean lactation milk yield at Kitulo farm from period one (2000–2003) through period three (2007–2009) (Appendix 10). This could be attributed to changing management, poor nutrition and climatic factors which played an important role in milk yield. Since concentrates are fed to supply energy and protein for increased milk production, at Kitulo there was a time when concentrates were not available. In addition to the limited availability, the high cost of concentrates and the declining milk to concentrate price ratio makes it difficult to feed adequate concentrates regularly resulting in low productivity. It was noted that the farm had critical financial situation when government stopped financing the daily operations which resulted into failure of the management to buy hay and supplements to lactating cows hence low milk production. Also it was noted that access of drinking water was a problem.

These animals had access to drinking water twice a day. This was due to the fact that most of watering troughs did not hold water for long time because of excessive leakage. Normally lactating cows should have free access to drinking water since the largest constituent (87%) of milk is water. Any restriction in water supply will result in a drop in milk production. The most dramatic effect is brought about by shortage of water as the cow has no means of storing water. Therefore withholding access to water or insufficient supply of water will result in a drop in milk yield. Season of calving had no significant effect (P > 0.05) on milk yield, although the differences between seasons were observed in both farms. The results are in agreement with the study by Tadesse *et al*. (2010) who reported a non significant effect of season on lactation milk yield. This shows that management and feeding level differences between seasons is small. It was observed that cows which commenced their lactations in season of calving one (Dec – Feb) had highest milk yield compared to other seasons. It means that most of their lactations were concentrated in the seasons of ample good quality forage and hence high milk yield. This argument relates to the study by Kifaro (1995) who observed significantly higher milk yields in the cows that calved in the late dry season and early rain season compared to other seasons.

5.2.2 Lactation length

The mean lactation lengths (LL) were 305.8±5.74 and 318.86 ±4.78 days for Ayrshires and Friesians at ASAS, respectively. At Kitulo the mean lactation length was 322.3±1.40 days. These results show that Friesians had longer lactation lengths than that of Ayrshires. The mean lactation length obtained in this study is slightly similar to the average lactation length reported by Syrstad (1995) in the tropics which ranged between 244 and 324 days. Kifaro (1995) also observed nearly similar overall mean lactation length of 321±2 days at Kitulo farm and he further reported lactation length of Ayrshire at Ihimbu farm to be 289±3 days which is lower than that of Ayrshire cows at ASAS farm.

Parity had no significant effect ($P > 0.05$) on lactation length in both farms. This conforms to the finding by Kifaro (1995) who found that lactation number had no significant effect on the duration of lactation. It is contrary to the finding by Chenyambuga and Mseleko (2009) who reported significant ($P < 0.05$) effect of parity on length of lactation period. In this study no clear trend was observed between the first and subsequent parities showing that lactation length depend mostly on management.

Period of calving had minor effects on lactation length at ASAS but had significant ($P < 0.01$) effects on lactation length at Kitulo. The former result (ASAS) is contrary to earlier study conducted by Mgeni (2010) who found significant ($P < 0.001$) influence of year of calving on lactation length. On the other hand lactation lengths at Kitulo farm are in line with the Mgeni (2010) finding. There was increasing trend in the mean lactation length from period of calving one (2000-2003) through period of calving three (2007-2009) at ASAS farm (Appendix 14), while at Kitulo farm there was no clear trend. The increase in lactation length from one period to another can be due to changes in management and policy of the farm. The longer lactation may also indicate the presence of managerial problems that resulted from irregular drying off-system of the lactating cows. On the other hand some farm policies decide to extend lactation length since it provides compensation for extended calving intervals. This is due to the fact that additional days in which cows are not pregnant beyond the required time post calving are costly.

The effect of season of calving on lactation length was not significant (P > 0.05) and this results is similar to the report by Agyemang and Nkhonjera (1986) in Malawi but contrary to Kasonta (1988) and Nkala (1992) who reported season of calving to have significant influence lactation length. Though season of calving has no significant effect on lactation length, cows that calved in the first season (Dec-Feb) had longer days than others at ASAS farm. At Kitulo farm season of calving two (2004-2006) had longer lactation length than other seasons. Big effects of lactation length are brought about by seasonal fluctuations in forage availability.

5.2.3 Dry period

The overall mean dry periods obtained in this study are within the range reported by Kifaro (1995) in five institutional farms in Tanzania which ranged between 86 and 165 days. Nearly similar results were reported by Shekimweri (1982) and Chenyambuga and Mseleko (2009), who reported mean dry periods of 97 and 107.5±4.5 days in Tanga and Iringa regions, respectively. A shorter mean dry period of 76.2 days has been reported in India by Sattar *et al*. (2004). The mean dry period obtained in this study was shorter than dry period of 132 days, 128.8±1.4 days and 129.5±5.13 days reported by Agyemang and Nkhonjera (1986), Mwatawala (2006) and Sattar *et al*. (2005), respectively.

Parity significantly (P < 0.001) influenced dry period at Kitulo farm. Effect of parity was insignificant at ASAS farm. Similar effect of parity on dry period has been reported by Kifaro (1995) in three out of five institutional farms in Tanzania. Vargas *et al*. (2000) also found only parity to be a significant source of variation where a clear decreasing trend was observed between the first three lactations at ASAS farm.

The variability of dry periods among parities may be attributed by improper management (milking and drying off practices) and physiological factors related to fertility of the cows. This indicates that dry period is of managerial nature and could be controlled by good management.

Effect of the period of calving on dry periods was significant (P < 0.01) at Kitulo farm and insignificant at ASAS farm. Dry periods were longest in period two (2004-2006) and period three (2007-2009) at ASAS and Kitulo farm, respectively. The results are in agreement with Kifaro (1995), Balikowa (1997) and Mwatawala (2006). They all reported period (year) effects to be significant. Variation due to period of calving could be attributed more to changes in management.

Season of calving had no statistically significant influence on length of dry periods. In this study cows that calved in season of calving two (March – May) had a longer days than other seasons. Variations between seasons were small in both farms. This result conforms to that reported by Balikowa (1997) who found insignificant influence of season on length of dry periods.

In general, dry periods are influenced by milk yield and time of conception and it reflects a high dependence on management and feeding levels. Therefore, any effort to improve this trait is by improving the management practices. For instance in the last 20 years at Kitulo farm, the mean dry period was 165 days but due to changing management it is reduced to 91.2 days (44.7% reduction).

5.3 Calf Mortality

5.3.1 Abortions and stillbirths

Rate of abortion at ASAS farm was highest in 2001 (8.65%) and lowest rate was observed in 2004 (0.9%). Generally, Kitulo had the lowest abortion rates compared to ASAS farm, though differences between farms were small. Higher rates of abortion at ASAS farm could be associated with presence of Brucellosis infection in the farm because heifers were not vaccinated against Brucellosis, and therefore there is a need for the farm to carry out brucellosis testing for the whole herd and conduct vaccination for the heifers intended for breeding.

It was observed that stillbirth was highest in 2009 (16.7%) and lowest in 2001 (5.95%) at ASAS. The highest rate at Kitulo was observed in 2001 (9.47%) and lowest was 4.29% (2004). Similar observation by Ghavi Hossein-Zadeh *et al*. (2008) reported the overall incidence of calf stillbirth in Holstein Friesian cows of Iran to be 4.9% and varied among herds from 2.9 to 9.8%. ASAS had the highest rate of stillbirth compared to Kitulo farm. The rate of stillbirth at ASAS was observed to increase from 2000 through 2009 (Appendix 20). The reason for the higher rates at ASAS could be due to unassisted calving and failure of the management to vaccinate heifers against Brucellosis. Since the calving difficulties increase the possibilities of stillbirth due to trauma and anoxia, therefore there is association between calving difficulties and incidences of stillbirths.

5.3.2 Pre-weaning and post-weaning mortality

In this study the pre-weaning calf mortality at ASAS farm ranged from 4.3% to 23.7% but did not vary much between years. The results are nearly similar to the observation by Chenyambuga and Mseleko (2009). Male calves had higher mortality rate compared to female calves. Some workers relate these results to the fact that female calves are treated better than male calves and some of the farms give male calves small amount of milk compared to female calves because most of the male calves are not retained in the farm. This finding is contrary to the observation made by Abbas *et al*. (2000) who reported pre weaning mortality of female calves to be higher than males (10.95% vs 8.56%). Management differences between farms have effects on mortality rate of the farm. For instance, at Kitulo calves were given milk after warming, so there was no assurance that calves were getting the milk at the required temperature because not all the time the attendant will warm the milk at required temperature. This practises exposed calves to gastrointestinal infections which leads to calf mortality. According to the informal conversation (Mapunda, 2010) it was noted that some unfaithful workers steal half of the amount of milk to be given to calves and sell them to neighbours. Therefore some calves starve and finally loose condition.

The overall mean post weaning mortality rates were 12.1% and 13.0% at ASAS and Kitulo farms, respectively. This is contrary to the results reported in Kenya by Bebe *et al*. (2001) who reported calves mortality rates of 16% in large scale modernised farms. Also Mwatawala (2006) and Chenyambuga and Mseleko (2009) reported higher overall calf mortality of 18.2% and 24.1% in Kagera and Iringa, respectively. Another higher overall calf mortality rate of 17% was observed in peri urban zone of Bamako Mali by Natalie (2005). In general post weaning mortality was higher than pre-weaning mortality. This result is similar to the observation by Karimi *et al.*

(2008) that calf mortality was higher after four months of age when colostral antibodies wane.

5.3.3 Causes of calf mortality

The major causes of calf mortality was diarrhoea and scours (25.1%) which conforms to the study by Shoo *et al.* (1992) where the major causes of mortality in their study was diarrhoea followed by respiratory infections. It is contrary to the finding by Karimi *et al.* (2008) who reported causes of calf mortality to be Theileriosis and anaplasmosis. Poor calf management practices such as inadequate housing and improper feeding practises were major predisposing factors for morbidity and mortality in early stage of growth of calves. This is apparently similar to the study by Natalie (2005) in Mali who found the causes of death in calves to be mainly management problems, consisting of accidental losses (14%), starvation (10%) and ileus (7%).

5.4 Life Time Traits

The mean life time performance obtained in this study are similar to those reported by Kifaro *et al*. (1994). Life time milk yields for Kitulo was low compared to ASAS. Ayrshire out yielded the Friesian from both farms in terms of milk yield per day of productive life (Table 10). Life time milk yield obtained in this study is higher than that reported by Kifaro (1995), but similar to the one reported by Sadek *et al*. (1989), who found total milk yield of Holstein Friesian cows in Egypt to be 13 015 kg after completion of five lactations. It also conforms to the finding reported by Chaudhry and Shafiq (1995) who reported the life time traits of 13 189.7±66.4 kg, 1

651.9±19.3 days, 3 530.0±40.5 days, 8.46±0.19 kg and 3.79±0.08 kg for LTMY, PL, TL, MY/PL and MY/TL, respectively. Variation in life time performance traits shows differences in management among the farms, culling policies and the potential of animal to produce milk.

Correlation between age at first calving and life time performance traits obtained in this study are in agreement with earlier findings by Kifaro *et al.* (1994) and Kifaro (1995). This indicates that early age at first parturition results in long productive life which leads to higher milk yield and higher number of calves born whereas delayed first parturition results in a short productive life and leads to few number of calves left behind.

5.5 Constraints Affecting the Farms

Major constraints affecting the farms were feeding during dry seasons which lead to low milk production. This was more intense in year 2005 where a remarkable reduction in milk production was observed at Kitulo. Since hay is not produced at Kitulo environment, the cost of feeding animals during the dry season becomes very high, not only cost but also the amount that can be offered to animals become critical because they have to buy hay from Uyole some 50 km away. The situation was the same at ASAS farm where they have to buy hay and crop residues from people around the farm and far villages. This is in agreement with Kabirizi *et al*. (2006) who noted a major constraint to dairy sector to be inadequacy of feed resource.

Calf mortality was another constraint affecting the farms, some mortality could have been reduced if proper measures would be employed by farm management such as provision of good shelter during adverse climatic conditions and proper calf feeding. This concurs with Razzaque *et al*. (2008) who reported the loses of calves in Kuwait dairy farms were due to inadequate management practices leading to diarrhoea, pneumonia, dehydration and other infections.

Abortions and still births were a problem at ASAS farm. This is due to failure of management to test and vaccinate the heifers against brucellosis before breeding age. Vaccination against Brucellosis for heifers is important and could reduce abortion in the farm.

Deteriorations of farm structures; Dairy cattle requires free access to drinking water. Limited access could result into reduced feed intake and hence reduced milk production. It was noted that lactating cows drink water twice a day, during morning and evening milking. This is due to the fact that the watering troughs in most of the paddocks were not holding water for long time and the only area where they can get access to water was in the trough located in milking parlour. Planted pasture (temperate grass) production was also very low because of poor management and long time use. According to Mushi, J. (personal communication, 2010) it was noted that a long time has passed since major pasture maintenance was done. For example pasture management like fertilization and weeding were not performed causing encroachments of noxious weeds which cause remarkable reduction of grass biomass.

Labour availability: this was observed in both farms and found that ASAS lacks more skilled labour than Kitulo. Also there was a problem of maintaining skilled labour at ASAS which causes important activities to delay or inefficiently performed. There was also lack of systematic record keeping and use of records for farm improvement.

Marketing of live animals and Milk: the price of milk was among the constraints affecting the productivity at Kitulo farm. The production cost of milk was high compared to the price of milk. This can be due to the location of the farms to be far from the reliable market. The cost incurred in transportation of milk to the market is very high because they have to travel 50 km to Mbeya or more than 200 km to Iringa, therefore making the benefits obtained to very minimal. Also due the policies of the government to decide the prices of live animals, the management fails sell the live animals at available market price which is higher than that given by the government hence reduce the farm income. Similar arguments of low milk price have been reported by Mwatawala (2006) and Mgeni (2010).

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From this study it can be concluded that:

i. Milk yield at Kitulo farm experienced decreasing trend from 2000 to 2009.

ii. In terms of milk production the overall performance of Friesians surpass that of Ayrshires.

iii. DP at Kitulo farm had a decreased trend from last decades which shows improvement in the management of the farm.

iv. Cows in both farms had longer calving intervals than the recommended interval in commercial dairy farms, resulting into few calves produced in the production life of the cows.

v. Rates calf mortality are in agreement to the mortalities reported in other studies conducted in tropics and other parts of the world.

vi. Rates of abortions and stillbirths at ASAS farm were higher compared to Kitulo farm.

vii. At ASAS farm breed, parity and period of calving significantly influenced milk yield; only breed and breed x season of calving had significant effect on lactation length and dry period. The effect of parity and parity x period of calving had significant effects on calving interval. Season of calving had small effect on traits analysed.

viii. At Kitulo farm parity and period of calving had a significant effect on milk yield, dry period and calving interval. Only period of calving had a significant effect on lactation length. Season of calving had no significant influence on traits analysed.

ix. Both farms faced a problem of feed availability during dry season which is a common phenomenon in the tropical environment.

6.2 Recommendations

From the results of this study it can be recommended that:

a) At ASAS farm;

i. The farm should immediately test and vaccinate all heifers against Brucellosis in order to reduce abortions in the farm.

ii. Management should find appropriate method of harvesting and preserving more forage which are abundant in the wet season.

iii. In the case of lack skilled labour, the farm management should look into ways of maintaining the skilled personnel in the farm who are very important in the productivity of the farm.

iv. There should be systematic record keeping in the farm, where all related records must be kept in the same cards or books.

b) At Kitulo farm

i. Rehabilitation of paddocks should be effected because most of the pastures have deteriorated, watering troughs are out of use (excessive leakage) and paddocks are encroached by bushes and weeds.

ii. The Government should empower the farm by providing grant for the farm machinery and inputs like fertilizer which will facilitate the improvement of existing pastures.

iii. Since the climate in Kitulo does not allow the seeds of imported temperate grass to set, the ministry responsible for livestock development should look for the possibility of importing temperate pasture seeds or building a green house where temperate pasture seeds will be produced.

iv. The management of the farm should look at the possibility of building a structure where weaned calves and sick animals can be protected during the adverse climatic condition.

v. The Government should give the farm mandate of deciding the price of cows since the present price is very low compared to private farms.

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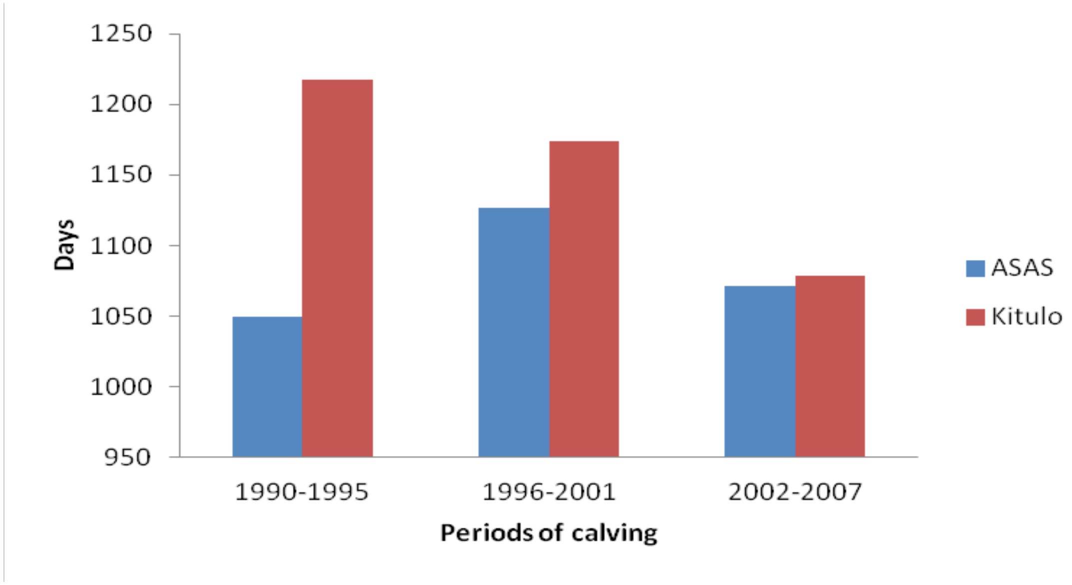
APPENDICES

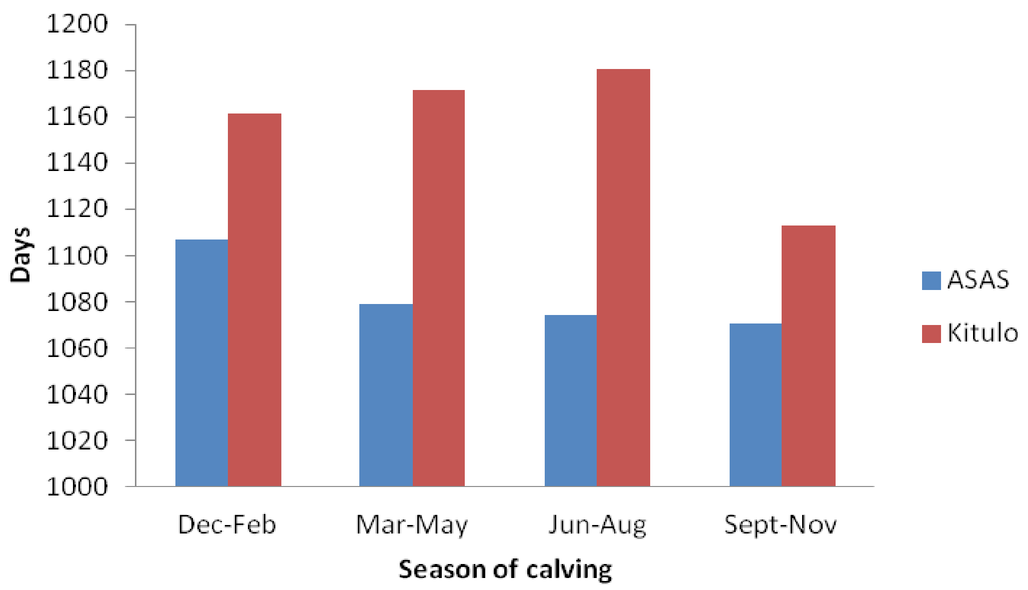
Appendix 1: Analyses of variance (ANOVA) of age at first calving at ASAS and Kitulo farms

Farm	Source	df	Type III SS x 10^4	Ms x 10^4	Fvalue	Pr>F
	Breed	1	11.50	11.50	4.04	0.04
	Season	3	5.89	1.96	0.69	0.56
ASAS	Period	2	20.27	10.14	3.56	0.03
	Breed x Season	3	10.43	3.48	0.06	0.73
	Breed x Period	2	34.48	17.24	1.22	0.30
	Season x Period	6	10.19	1.70	6.05	0.003
	Error	386	10.99	2.85		
	Season	3	13.65	4.55	1.55	0.20
Kitulo	Period	2	80.08	40.04	13.62	0.0001
	Season x Period	6	12.70	2.12	0.72	0.63
	Error	305	896.64	2.94		

Appendix 2: AFC in different years at ASAS and Kitulo farms



Appendix 3: AFC at different seasons at ASAS and Kitulo farms

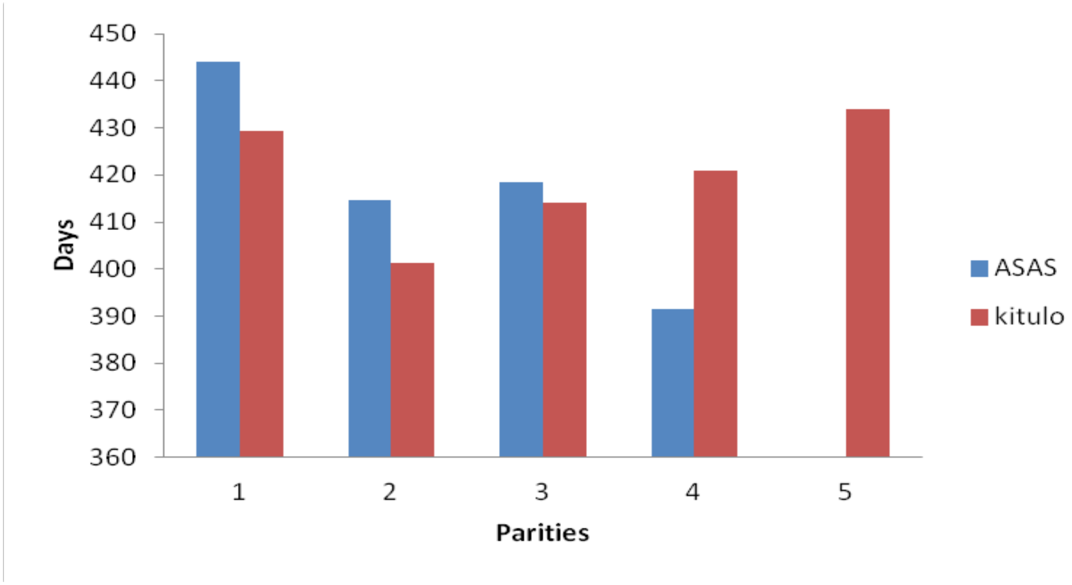


Appendix 4: Analyses of variance of calving interval at ASAS and Kitulo farms

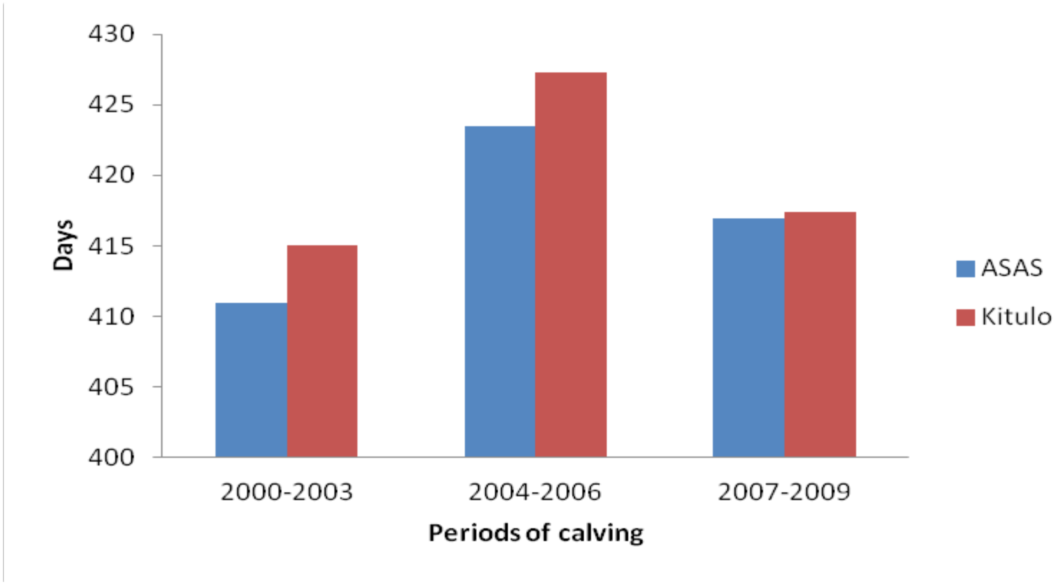
Farm	Source	df	Type III SS	Ms x 10^3	Fvalue	Pr>F

			$x10^3$			
ASAS	Breed	1	20.29	20.29	2.69	0.10
	Parity	3	183.87	61.30	8.11	0.0001
	Season	3	14.82	4.94	0.65	0.58
	Period	2	6.78	3.39	0.45	0.64
	Breed x Parity	3	12.98	4.33	0.57	0.63
	Breed x Season	3	13.18	4.39	0.58	0.63
	Breed x Period	2	0.48	0.12	0.02	0.98
	Parity x Season	9	79.95	8.88	1.18	0.31
	Parity x Period	6	105.09	17.52	2.32	0.03
	Season x Period	6	23.60	3.93	0.52	0.79
	Error	926		3.74		
Kitulo	Parity	4	77.99	19.50	8.99	0.0001
	Season	3	4.72	1.57	0.73	0.54
	Period	2	23.76	11.88	5.48	0.004
	Parity x Season	12	17.56	1.46	0.67	0.78
	Parity x Period	8	38.62	4.83	2.23	0.02
	Season x Period	6	12.62	2.10	0.97	0.44
	Error	1018		3.74		

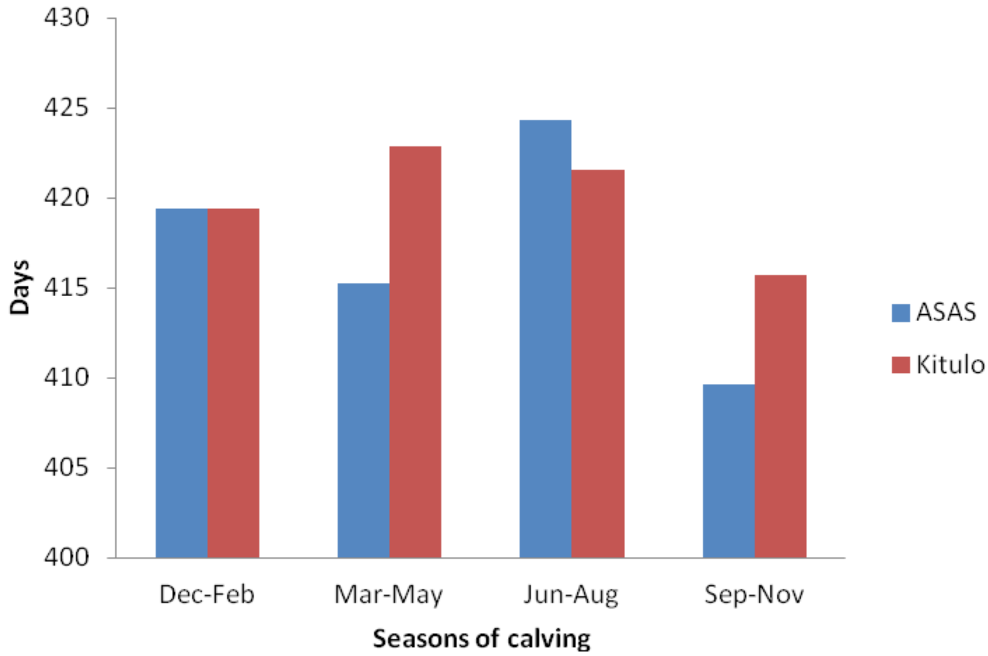
Appendix 5: CI at different parities at ASAS and Kitulo Farms



Appendix 6: CI between periods at ASAS and Kitulo Farms



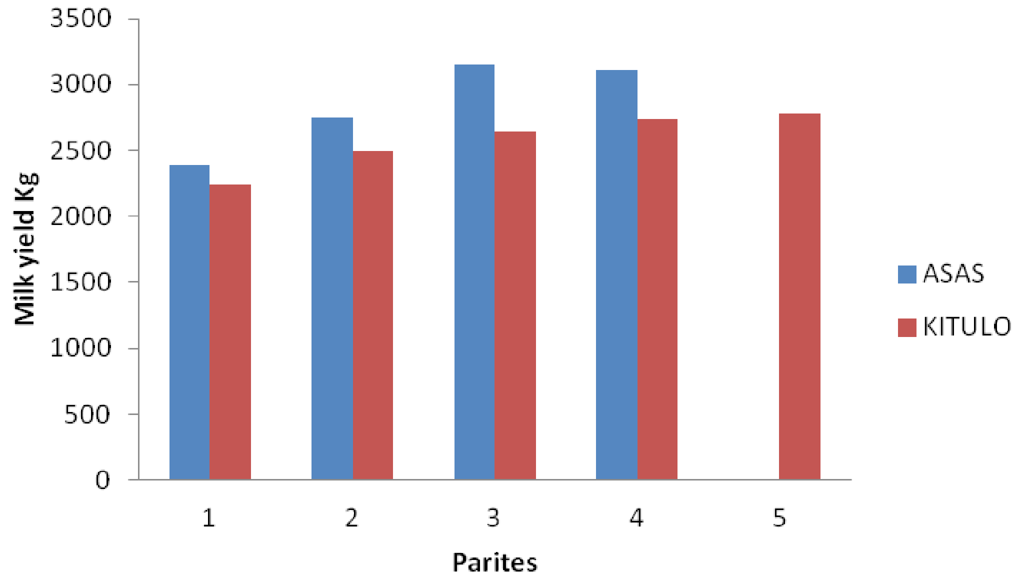
Appendix 7: CI between seasons at ASAS and Kitulo Farms


430
425
420
415
410
405
400
Days
Dec-Feb
Mar-May
Jun-Aug
Sep-Nov
Seasons of calving
ASAS
Kitulo

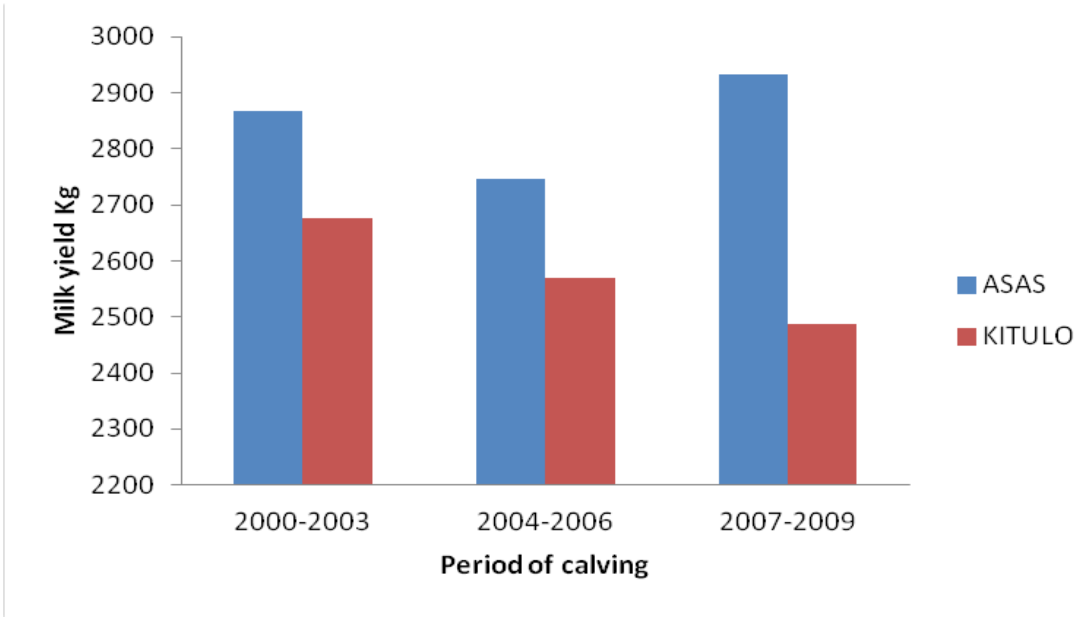
Appendix 8: Analyses of variance of lactation milk yield at ASAS and Kitulo farms

Farm	Source	df	Type III SS x10^5	Ms x 10^5	Fvalue	Pr>F
	Breed	1	1176.18	1176.18	18.16	0.0001
	Parity	3	360.89	120.23	18.58	0.0001
	Season	3	34.83	11.61	1.79	0.15
ASAS	Period	2	41.14	20.57	3.18	0.04
	Breed x Parity	3	3.75	1.25	0.19	0.90
	Breed x Season	3	41.29	13.76	2.13	0.09
	Breed x Period	2	7.37	3.69	0.57	0.57
	Parity x Season	9	65.83	7.31	1.13	0.33
	Parity x Period	6	29.69	4.95	0.76	0.59
	Season x Period	6	13.91	2.32	0.36	0.90
	Error	926		6.48		
	Parity	4	187.61	46.90	7.73	0.0001
	Season	3	22.03	7.34	1.21	0.30
	Period	2	37.16	18.58	3.06	0.05
Kitulo	Parity x Season	12	104.03	8.67	1.43	0.15
	Parity x Period	8	91.39	11.42	1.88	0.06
	Season x Period	6	8.73	1.45	0.24	0.96
	Error	1018		6.07		

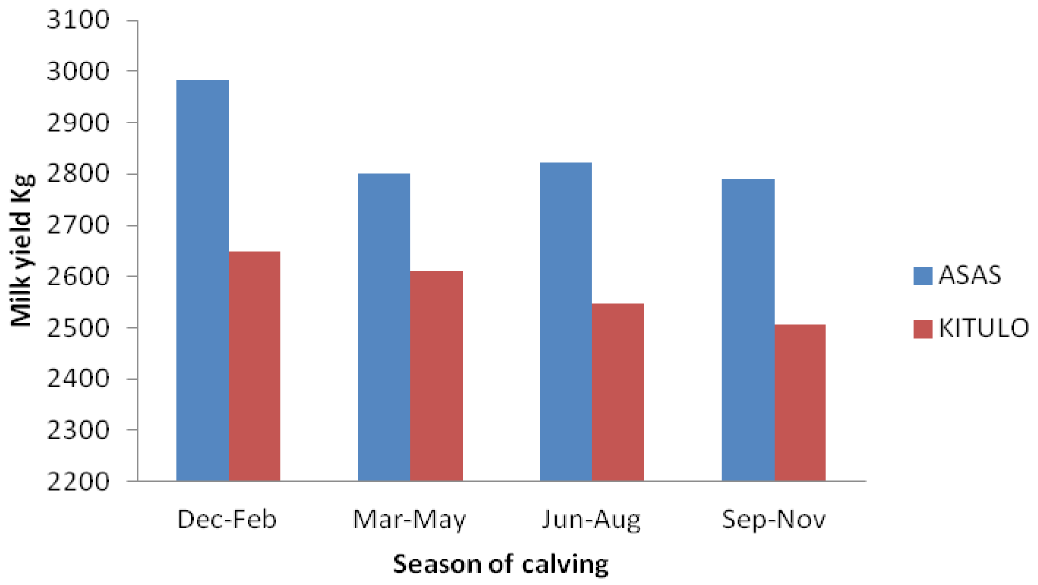
Appendix 9: Lactation milk yields between parities at ASAS and Kitulo farms



Appendix 10: Lactation milk yields between periods at ASAS and Kitulo farms



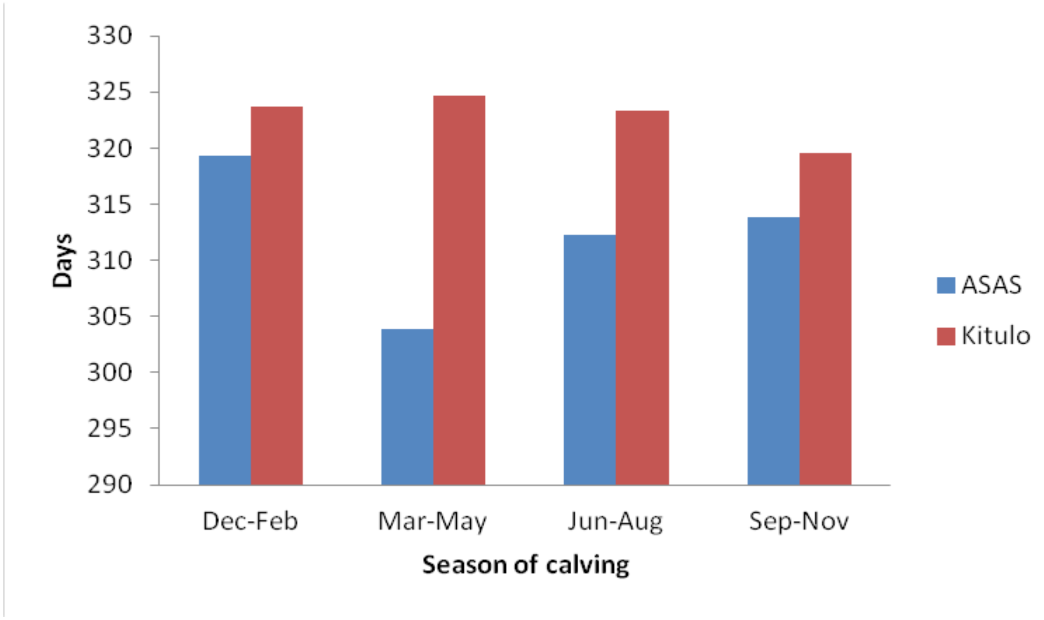
Appendix 11: Lactation milk yields at different seasons at ASAS and Kitulo farms



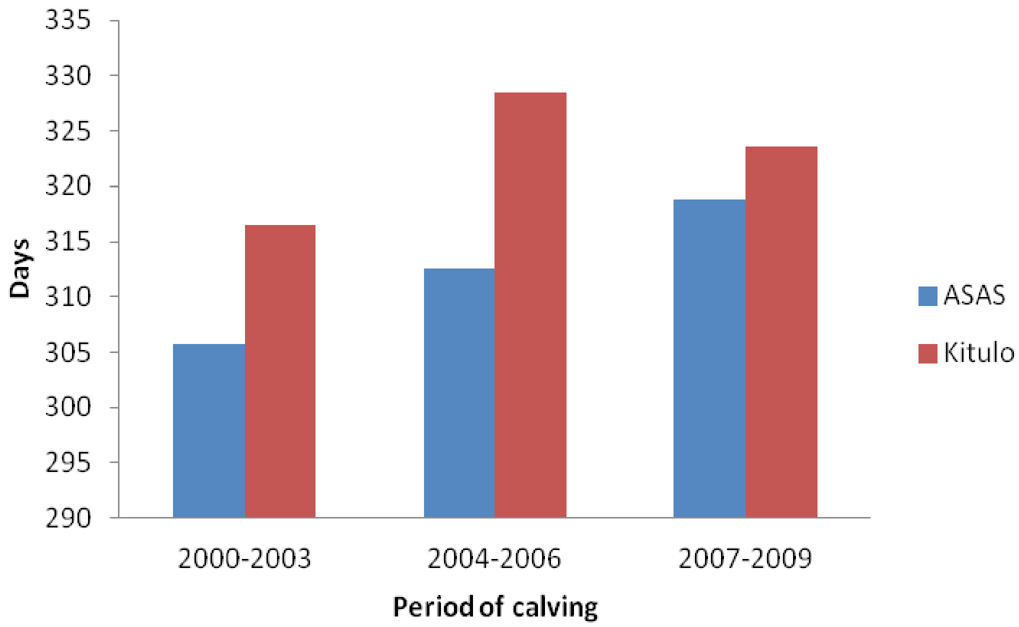
Appendix 12: Analyses of variance of lactation length at ASAS and Kitulo farms

Farm	Source	df	Type III SS x 10^3	Ms x 10^3	Fvalue	Pr>F
	Breed	1	21.79	21.79	5.82	0.01
	Parity	3	6.30	2.10	0.56	0.64
	Season	3	16.69	5.56	1.49	0.22
ASAS	Period	2	7.06	3.53	0.94	0.39
	Breed x Parity	3	5.96	1.99	0.53	0.66
	Breed x Season	3	16.39	5.46	1.46	0.22
	Breed x Period	2	8.10	5.05	1.08	0.33
	Parity x Season	9	66.11	7.35	1.96	0.04
	Parity x Period	6	56.44	9.41	2.51	0.02
	Season x Period	6	6.35	1.06	0.28	0.94
	Error	926	3465.59	3.74		
	Parity	4	14.45	3.61	1.69	0.15
	Season	3	2.28	0.76	0.36	0.78
	Period	2	20.88	10.44	4.88	0.01
Kitulo	Parity x Season	12	10.81	0.90	0.42	0.96
	Parity x Period	8	13.17	1.65	0.77	0.63
	Season x Period	6	3.27	0.54	0.25	0.96
	Error	1018		2.14		

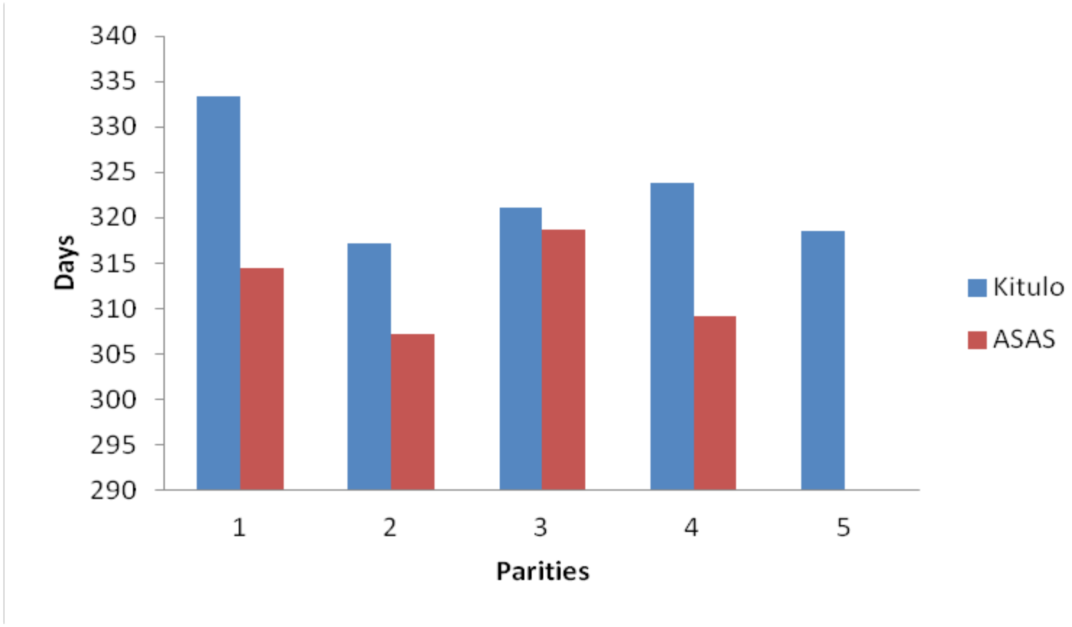
Appendix 13: LL in different seasons at ASAS and Kitulo farms



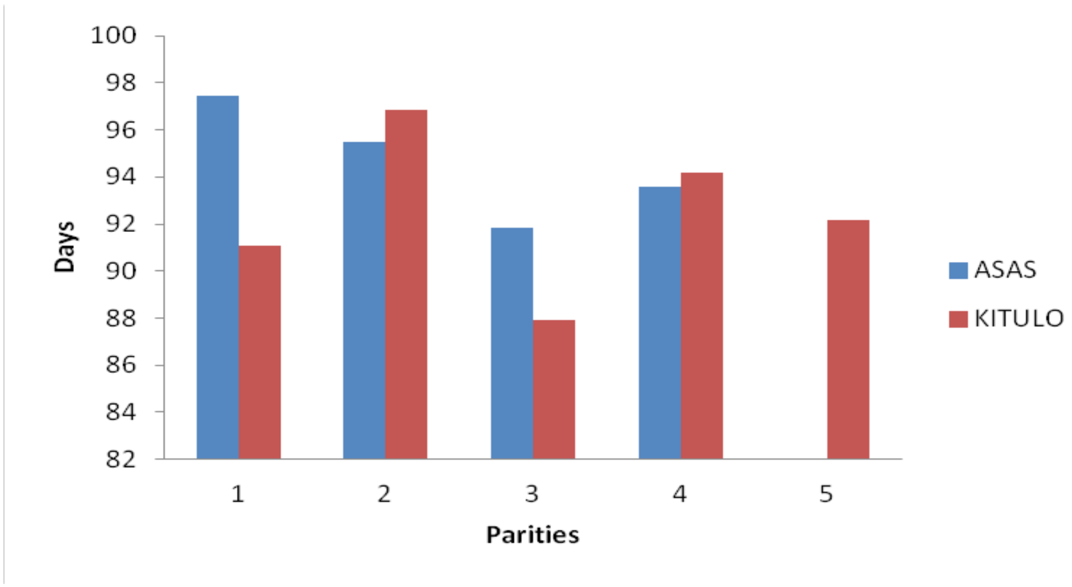
Appendix 14: LL in different periods at ASAS and Kitulo farms



Appendix 15: LL in different parities at ASAS and Kitulo farms



Appendix 16: DP between parities at ASAS farm and Kitulo farms

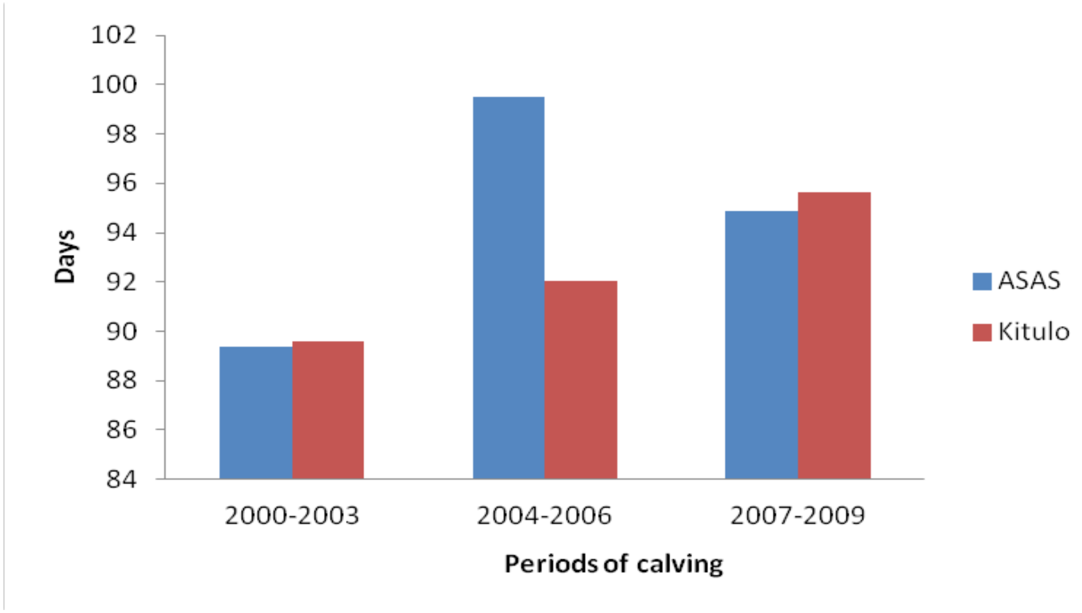


Appendix 17: Analyses of variance of dry period at ASAS and Kitulo farms

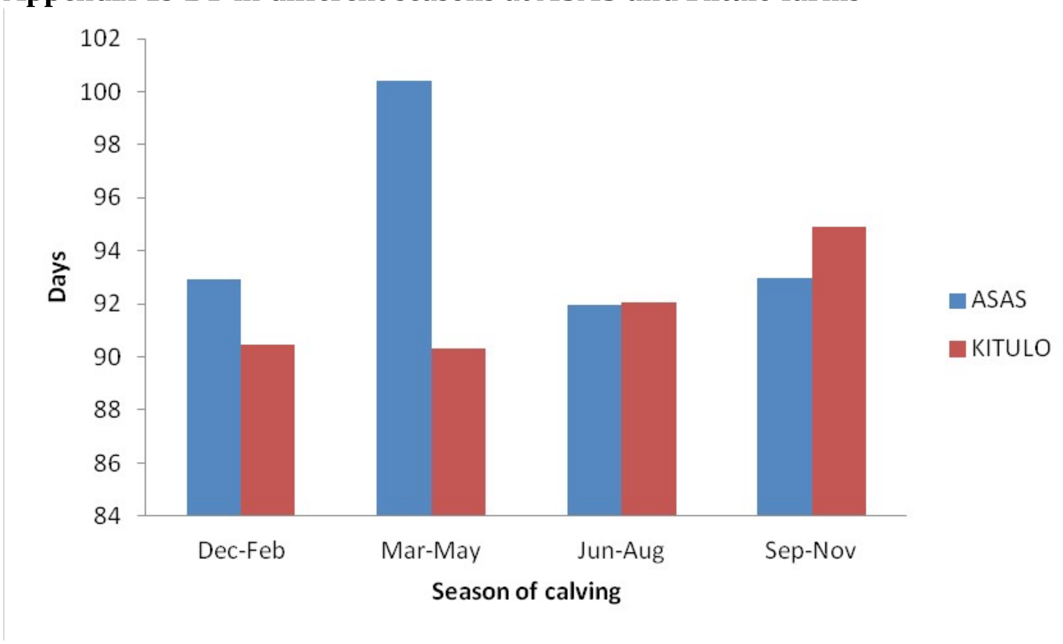
Farm	Source	df	Type III SS x 10^3	Ms x 10^3	Fvalue	Pr>F

ASAS	Breed	1	1.46	1.46	1.84	0.17
	Parity	3	1.19	0.40	0.50	0.68
	Season	3	6.05	2.02	2.54	0.06
	Period	2	3.84	1.92	2.42	0.09
	Breed x Parity	3	0.78	0.26	0.33	0.81
	Breed x Season	3	6.34	2.11	2.67	0.05
	Breed x Period	2	1.12	0.56	0.70	0.49
	Parity x Season	9	14.26	1.58	2.00	0.04
	Parity x Period	6	3.91	0.65	0.82	0.55
	Season x Period	6	9.64	1.61	2.03	0.06
	Error	926		0.79		
Kitulo	Parity	4	6.29	1.57	7.21	0.0001
	Season	3	1.64	0.55	2.50	0.06
	Period	2	3.46	1.73	7.92	0.001
	Parity x Season	12	4.83	0.40	1.84	0.04
	Parity x Period	8	5.96	0.74	3.41	0.001
	Season x Period	6	2.93	0.49	2.24	0.04
	Error	1018		0.22		

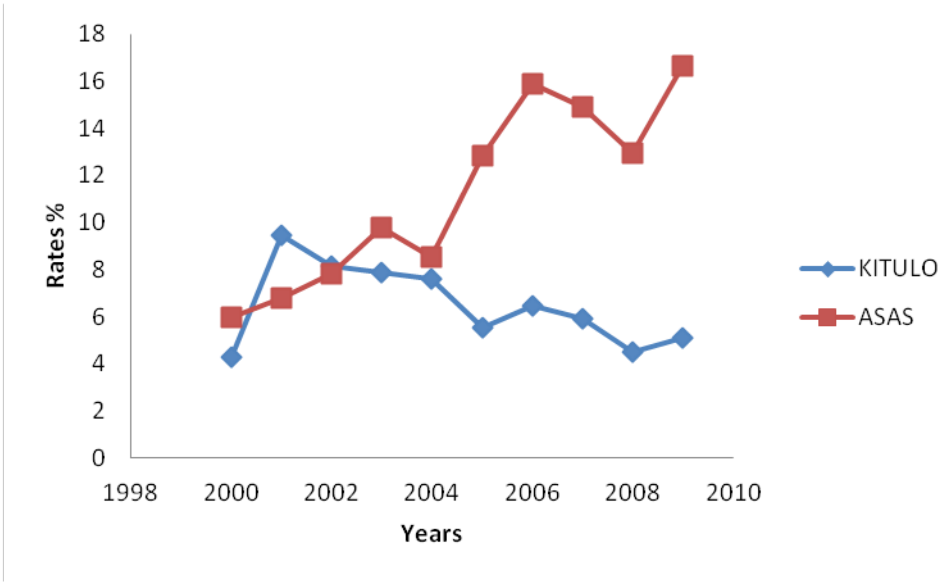
Appendix 18:DP in different periods at ASAS farm and Kitulo farms



Appendix 19 DP in different seasons at ASAS and Kitulo farms



Appendix 20: Rates of still birth between years at ASAS and Kitulo farms



Appendix 21: Post weaning calf mortality at ASAS and Kitulo farms

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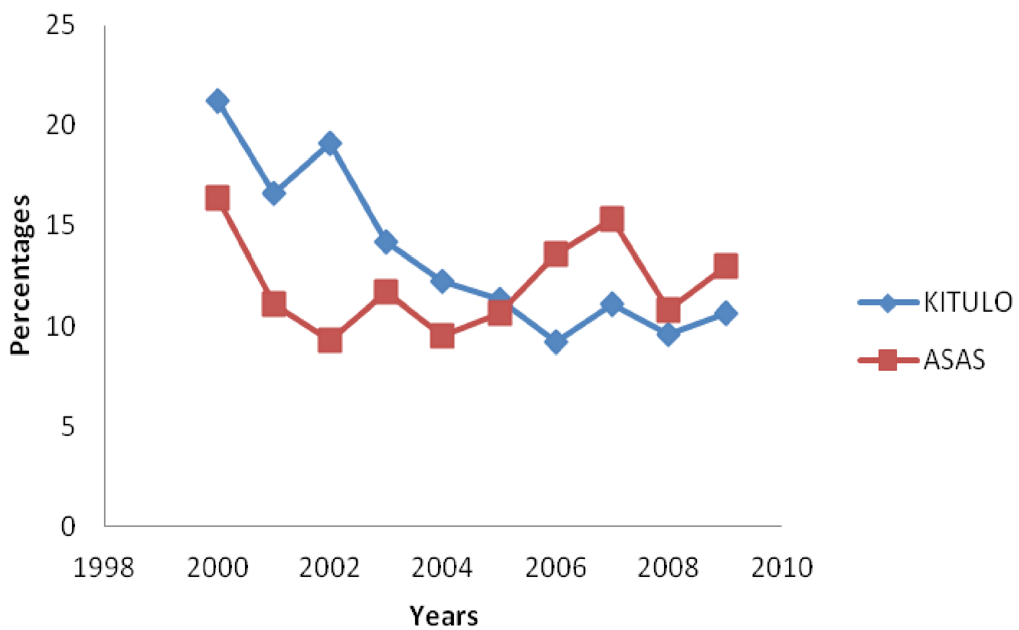

Appendix 22: Means and standard deviations of life time traits for ASAS and Kitulo farms

	Kitulo(F[1])		ASAS(F[1])		ASAS(A[2])	
Traits	Mean	s.d	Mean	s.d	Mean	s.d
Total life span (days)	3426.6 (189)	1031.5	2987.2 (62)	889.3	2594.2 (41)	893.4
Productive life (days)	2164.5 (189)	1013.3	1817.6 (62)	871.47	1525.1 (41)	856.0
Total lifetime milk prod (kg)	13481.2 (189)	6568.9	13517.5 (62)	5421.4	11303.6 (41)	4661. 2
No. of lifetime calvings	6.41 (189)	1.9	4.66 (62)	2.1	4.1 (41)	1.9
Milk yield/day of total life (kg)	3.79 (189)	1.1	4.5 (62)	1.0	4.4 (41)	1.0
Milk yield/day of productive life (kg)	5.68 (189)	2.3	8.1 (62)	2.3	8.5 (41)	3.3

1 - Friesians ( ) In brackets are number of observations

2 - Ayrshire