A STUDY OF DAIRY CATTLE PRODUCTIVITY IN KILOLO DISTRICT, TANZANIA

BY

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ABSTRACT

This study was carried out to evaluate the performance of dairy cattle managed under different production systems of smallholder dairy cattle keepers in Kilolo district. The breeds involved in the study were Friesian and Ayrshire crossbred cows. Also a survey was conducted on the production environments of Kilolo herds of crossbred dairy cattle. Primary data were collected using a structured questionnaire in which a total of 176 farmers in Kilolo district were interviewed. Statistical Package for Social Science (SPSS) was used to analyse the primary data and the biological data were analysed by using General Linear Model (GLM) procedure of Statistical Analysis System (SAS) computer software. The main constraints of dairy farming in the district were livestock diseases (63.6%), lack of dip tanks (51.7%) and feeding costs (44.3%). The average age at first calving (AFC) was 1004.4 ± 13.15 days. Friesian crosses were significantly older at first calving by 21 days compared to Ayrshire crosses. The overall mean calving interval (CI) was 482.2 ± 2.41 days. Year of calving and breed of cows significantly ($P < 0.001$) influenced CI. The mean total lactation yield (TLY), lactation length (LL) and dry period (DP) were 1612.9 ± 13.26 kg, 359.9 ± 3.61 days and 129.5 ± 5.13 days respectively. The season of calving had a significant effect on AFC, TLY, and DP. Breed had a significant effect on AFC, CI, TLY and LL. The total lactation yield and lactation lengths had a linear increase from parity one to three. The genotype with 50% *taurus* inheritance in all breed groups had lowest total lactation yield compared to those with 62.5 and 75% exotic inheritance. Crossbred cows with 62.5% *taurus* blood appeared to be the best milk producers and could therefore be recommended as the genetic group of choice for Kilolo production system.

DECLARATION

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

____________________________ __________________

Benson Levi Mgeni **Date**

(MSc. Tropical Animal Production candidate)

The above declaration is confirmed

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(Supervisor)

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DEDICATION

This dissertation is dedicated to the honey of my heart Atuwonekye Kilatu, my sons; Christian Mgeni and Gift Mgeni.

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LIST OF ABBREVIATIONS

AFC	Age at First Calving
ANOVA	Analysis of Variance
AI	Artificial Insemination
CI	Calving Interval
DO	Days Open
df	Degrees of Freedom
DASP	Department of Animal Science and Production
DP	Dry Period
ECF	East Coast Fever
F1	First Filial Generation
GLM	General Linear Model
LL	Lactation Length
LSM	Least Squares Mean
Mm	Millimeters
m	Meters
Ms	Mean square
NS	Not Significant
RH	Relative Humidity
SAS	Statistical Analysis System
SHDDP	Southern Highlands Dairy Development Project
TLY	Total Lactation Yield
Temp	Temperature

CHAPTER ONE

INTRODUCTION

Tanzania's livestock industry is founded on the traditional sector which owns over 97% of the national herd of 17.7 million local cattle, 500 000 dairy cattle and produces over 73% of the milk (Msangi, 2006). The low production coefficients of cattle under traditional production systems are partly responsible for the growing gap between demand and supply of milk and other dairy products (Balikowa, 1997).

The average milk yield per lactating cow in the traditional sector was estimated at 100 litres per year while the equivalent from the improved dairy cattle was estimated at 1597 litres per year (Msangi, 2006). Improved and exotic dairy cattle which constitute only 1.4% of the national herd are also poorly distributed, with over 64% being in Kilimanjaro and Arusha regions where they are mainly found on commercial farms and on small holdings near urban centers (Shekimweri, 1982).

Crossbreeding with European dairy breeds has been widely used to improve milk production potential of the indigenous Tanzania Short horn zebu (TSZ) in many parts of Tanzania. Although the F_1 offsprings have consistently performed better than their indigenous parents, real success in the crossbreeding program has been hampered by lack of appropriate guidelines for producing future generations beyond the F_1 (Mchau, 1991). It has been reported that upgrading beyond 50% *Bos taurus* inheritance does not lead to appreciable improvement in the performance of high-grades (Pongpiachan *et al.*, 2003). Beyond 75% *Bos taurus* blood, management becomes a limiting factor leading to deterioration in performance of the animals (Liu *et al.*, 2003). Loss of adaptation was also thought to exert an increasing influence on the grades. Balikowa (1997) reported that, in order to maintain the exotic germ-plasm in the crossbreeds at intermediate levels, F_1 bulls were supplied to small holder farmers in Iringa and Mbeya regions for the purpose of breeding the F_1 cows. Although inter se mating of F_1 animals to get F_2 is a segregating population which has poorer performance than F_1.

In Tanzania, indigenous cattle produce very little milk compared to exotic ones. In most cases an indigenous cow produces just enough milk to nurse her calf. When indigenous breeds are cross-bred with exotic ones, they produce considerably more milk. In agriculturally advanced countries, herds with an average of over 4 500 kg of milk a year are found. As the people of Tanzania advance in literacy and health education, milk consumption is increasing. None of African countries report surplus in milk and milk products, however, very few can export a little amount. Only Kenya in this part of Africa has an established pattern for the export of dairy produce. It follows therefore that the dairy industry must aim at increased production and productivity (Nangwala, 1996).

Kilolo district has a total of about 39 579 cattle whereby among them 35 086 (88.6%) are indigenous breeds and 4 493 (11.3%) are dairy cattle involving pure dairy breeds and crosses. The district is divided into three divisions, 12 wards, 83 villages, 415 hamlets with a human population of 224 739. The population comprises of 114 617 females and 110 122 males of whom 44 947 are children under 5 years and 8 990 are children above 5 years. The district has 46 022 households with an average size of 5 people (DED, 2007).

The dairy cow is the most efficient machine, which turns pastures, minerals and water into milk and beef, two very prized human foods. There is a dairy processing factory in Iringa known as ASAS, which is undersupplied with locally produced milk. The factory can process 30 000 litres per day but receives only 1 500 litres from smallholder dairy farmers and receives 7 500 litres of milk from large farms. This is a ready market for Kilolo farmers, which needs to be exploited through improving productivity. Since there is little information about dairy cattle productivity in Kilolo district, therefore this research was designed to generate new information about dairy cattle productivity and to evaluate the performance of dairy cattle managed under different production systems of smallholder dairy cattle keepers. With this regard, this study was done to meet the following objectives:

1. To study dairy cattle husbandry practices under smallholder farmers in Kilolo district.
2. To assess the reproductive performance (age at first calving and calving interval) and lactation performance (milk yield, lactation length and dry period) of the various genotypes of dairy cattle on smallholder farms in Kilolo district.
3. To study environmental and genetic sources of variation influencing dairy performance traits.

CHAPTER TWO

LITERATURE REVIEW

2.1 Characteristics of Smallholder Dairy Cattle Production Systems

Smallholder dairy farming is an important part of farming throughout the developing countries. Smallholder dairy farmers follow three main feeding systems for cattle rearing which are zero grazing (intensive), partial grazing (semi-intensive) and free range (extensive) (Msuya, 2002). Zero grazing system has been widely adopted by smallholder in dairy farming due to shortage of land (3.2 hectares/family on average), and relatively sufficient availability of labour (Kitalyi and Massawe, 2000).

Furthermore, zero grazing is also used as a means to control communicable diseases by isolating crossbred and exotic cattle from the indigenous cattle (Reis and Combs, 2000). However zero grazing can contribute to poor animal productivity due to a number of factors: failure to feed cattle during the night is often encountered in zero grazed animals, which is undesirable since stall-fed milking cows need night feeding like grazing animals (Phiri, 2001).

Kitalyi and Massawe (2000) proposed use of improved technologies, such as introduction of forage legumes and intensive use of multipurpose trees in the banana/coffee based farming system to reduce nutrient mining in the highlands. An additional shortfall of the system is due to inferior nutritive value when cut pasture is offered compared to that received by grazing animals. Grazing animals are able to choose their own forages and tend to produce more milk and obtain better reproductive performance than stall-fed cows (Msangi *et al.*, 2001).

Smallholder farmers have the common characteristics of limited resources and income, their farming systems and culture differ widely from place to place. The smallholder dairy herd in Tanzania is made up of about 450,000 crossbred cattle managed on small holdings of about one hectare of land. Farmers own mostly between one and five zero grazed dairy cattle (Kurwijila and Boki, 2003). Among the smallholder farmers, milk has always been an important product or by-product of the enterprise (Bebe *et al.*, 2003).

Smallholder dairying is an important avenue for developing countries through its contribution to increased livestock and farm productivity, income generation from sales of milk and dairy products, provision of jobs, transfer of money from urban to peri-urban and rural areas. Farming households integrate dairy with crop enterprises to maximize the returns from limited land and capital, with dairy production as a means to achieve multiple objectives; to improve food security, support crop production, build capital assets and generate cash income (Paris, 2000 ; Kristensen *et al*., 2004).

Smallholder dairy farmers in Tanzania have been facing a number of constraints which include poor quality natural pastures and unavailability and prohibitive prices of hominy meal, oil seed cakes and commercial minerals for supplementation (Safari *et al*., 2000; Stephen *et al*., 2002).

Introduction of specialized dairy breeds and increased level of inputs and the requirements for good market linkages for milk sales and inputs supply are bound to be high. Consequently, the existing smallholder dairy production system offers a good base for further research aimed at developing and promoting appropriate technologies for sustainable support the improvement of dairy industry in Tanzania (Shem and Mdoe, 2002).

Introduction of the improved dairy cattle in Kilolo district took place since 1980's as a result of activities of Southern Highlands Dairy Development Project (SHDDP). The project introduced in-calf heifers and breeding bulls. The introduced breeds were Friesian and Ayrshire. Great emphasis was to maintain 50%, 62.5% and 75% exotic blood for milk production (DED, 2007). SHDDP has been working in Tanzania since 1979 to strengthen the private dairy sector with the specific goal of contributing to the family income to dairy farmers and the nutritional status amongst their communities. In the latest phase of the project (1996 - 1999) SHDDP has moved away from supporting dairy production towards a more holistic dairy sector support approach, with a focus on working in a participatory manner throughout all its activities (DED, 2007).

2.2 Factors Affecting Dairy Cattle Production in Tropical Countries

In the tropics, forages and other feed resources differ greatly both in quality and quantity. In order to improve productivity of smallholder dairying in the tropics it is therefore necessary to improve quality of natural forages by incorporating legumes in the pastures or by supplementing dairy cattle with balanced concentrates and minerals (Brumby, 1974). Boitumelo (1993) observed that supplementing dairy cattle with improved forages, crop residues and milling by-products was a beneficial strategic feeding technique for increased milk yield. Similar benefits of supplementary feeding of cows have been reported by Mc Dowel *et al.* (1984). Cows that were supplemented with minerals produced heavier calves, had lower abortions (0.75 Vs 9.3%) hence higher calving rates than unsupplemented ones. Also mortality rates of calves from birth to weaning were lower (10.5%) in supplemented cows while they were higher (22.6%) in unsupplemented cows.

Clearly, the highest milk production in the tropics comes from intensive feeding and management of high producing dairy cows of European breeding (e.g. Holstein) and higher production may be possible if high quality pastures and forages are utilized particularly where night grazing is carried out. But supplementation of energy in particular is necessary to maximize milk production (Gimbi, 2006).

Problems facing milk production and the livestock sector in Tanzania include; inadequate feeding especially during the dry season, diseases, low genetic potential of indigenous animals and problems related to management (Biwi and Shamhuna, 1986). Massawe *et al*. (1997) observed that milk production in Tanzania was constrained by inadequate nutrition. This can be aggravated by infestation with external and internal parasites, clinical and sub clinical diseases, diets comprising of poor quality roughages and generally low levels of livestock management (Shekimweri, 1982).

The feeding of dairy cattle in the Southern highlands particularly in Iringa and Mbeya regions is influenced by several important limiting factors; feed availability which depends on climatic environment, poor availability of supplementary feeds and forage composition, system of production practiced also diseases and parasites. On the overall, these factors are influenced by socio-economic conditions and in particular the prevailing marketing conditions. However, the various systems of milk production range from high input- high output to low input- low output systems and it is suggested that the systems approach be used to improve the efficiency of these milk production systems for the tropics by optimizing the use of resources (Nkala, 1992).

Kayunze *et al*. (2001) reported that, the main constraints of dairy farming in Chunya District were poor availability of inputs, shortage of capital and livestock diseases. In order to improve food status and income, major factors affecting production should be tackled. Those included input supply, shortage of capital, livestock diseases, markets and transport.

2.3 Characteristics of Tropical Forages Used by Dairy Cattle

The humid or high rainfall tropics are potentially high producing zones for milk production but this potential has not been fully realized because environmental conditions found in the tropics exert both direct and indirect effects on the productivity, thrift, efficiency and health of dairy livestock through climatic stress, increased incidence of parasitism and diseases also rapid deterioration in the quality of pasture and forages with maturity. However, the high rainfall experienced in the tropics, stimulates high annual dry matter production from pastures and fodder crops as well as from intensive cultivation of arable crops which produce a wide range of agro-industrial by-products that are potential sources of supplementary feeds for ruminant livestock (Mchau, 1991).

Feed stuffs for dairy cows have traditionally been divided into roughages and concentrates. Concentrates include cereals, oil cakes and milling by-products rich in cellular contents, with low fibre content and a high content of digestible energy per unit weight or volume (Van-Soest, 1982). Roughages on the other hand are characterized as bulkier, higher fiber (cell walls) feed stuffs. Their contents of digestible energy vary tremendously. Typical roughages are forage products, whole grain crop silages and straws (Mwakilembe, 2004).

The efficiency of conversion of tropical pastures to animal product is lower than that of most improved temperate pastures (Humphreys, 1987). This makes high individual animal performance harder to attain in the tropics than in temperate countries. In the tropics pastures grow rapidly causing the herbages to mature rapidly with high contents of fibres due to increased cell walls which are made to support the stems and branches. These lead to decrease in the quality although they are abundant (Kusekwa and Kidunda, 1988).

Increased human population in Tanzania has resulted into more land being devoted to food crop cultivation, especially in the areas with high agricultural potential. As a consequence, there has been a continuous decrease in grazing land, so that smallholder dairy farmers have reduced their stock numbers and opted for stall feeding system (Massawe *et al.*, 1996). Land as a constraint to smallholder dairy farmers has also been reported in Kenya by Kanyongo (1991). Due to the constraint of grazing land in the urban and peri-urban areas, the majority of dairy cattle owners have decided to zero graze their animals. They hire labour for cutting forages from roadsides and purchase concentrates. Cutting of forages from roadsides and open spaces is a labour intensive exercise and experience every where in Tanzania has shown that cut and carry system is also expensive (Sichale, 1996).

2.4 Grazing Regimes with Supplementation in the Southern Highlands

High milk production from dairy cows in the Southern highlands undoubtedly is obtained when supplements are fed (principally of cotton seed cake and maize bran) to grazing animals under improved pastures and forages and milked twice daily gave milk yields around 2 400 kg/ cow/ year, as compared with about 1 700 kg/ cow/ year on a once a day milking regime with restricted suckling by the calf (Gimbi, 2006).

Urassa (1999) reported that, supplementary feeding supplies the animals with the required nutrients for maintenance and the desirable level for production especially when the animals were fed poor quality forages and crop residues. According to Milang'ha (2002), supplementation can be done in the following ways; by incorporating legumes in pastures or by supplementation with balanced concentrates and minerals.

Laisser (1997) reported that, in southern highlands, smallholder dairy keepers owned on average one hectare of improved pastures for their dairy animals. This was a positive impact of the project as each farmer was required to have one hectare of pasture before receiving an animal. But when the herd grew there was no attempt made to increase the pasture areas.

Kidunda (1993) observed that, the increase in number of animals without an attempt to increase pasture areas resulted in the use of natural pastures of low quality, that need supplementation of concentrates though many farmers were unable to purchase concentrate feeds in sufficient quantities due to their unavailability and when available prices were high.

In the tropics forages and other feed resources vary greatly both in quality and quantity. In order to improve productivity of smallholder dairying in the tropics it is therefore necessary to improve quality of natural forages (Mtui, 2004).

2.5 Reproductive Performance Traits in Dairy Cattle

Reproduction is one of the important factors determining dairy production. Dairy cows should show regular cyclic breeding activity and become pregnant at the appropriate time and produce a healthy calf each year. Pryce *et al.* (2000) reported that age at first calving and calving interval play a significant role in measuring reproduction performance of dairy cattle and have a very high correlation with life time performance traits.

Pongpiachan *et al*. (2003) reported that high yielding dairy animals had poor reproductive performance and the extent of such an adverse effect of lactation appeared more eminently in the purebred than the crossbred animals because of the greater amount of milk produced by the former.

Reproductive performance in many dairy herds is low because many cows are not detected in heat or do not conceive at first service. Peters (1984) used a closed circuit television system and noted that all cows had shown oestrous by 60 days post calving, but the herdsman detected only 64% of those cows. Holness *et al.* (1980) observed that 90% of the cows reported as anestrous had ovaries typical of cycling cows. Other data reported by these workers indicated that 43% of cows showed anestrous with 13% failing to show oestrous prior to breeding and 31% failing to return to oestrous following breeding even though they were not pregnant. Developing a reliable method of detecting oestrous in dairy cows would appear to be important if reproductive programs are to be successful.

Generally, factors constraining performance of dairy industry include; inadequate feeding of dairy cattle for high production, inadequate control of epidemic diseases, unreliable supply of inputs and shortage of skilled labour for good management. Also environmental stress (high temperatures and humidity), high ambient temperature, often combined with high humidity and/or intense solar radiation, lead to heat stress, discomfort and reduced feed intake hence those factors depressed production (Msechu *et al*., 1995). Mwatawala *et al.* (2003) suggested that problems of long calving interval (CI), short lactation length (LL) and long dry period (DP) could be reduced through improvement in management than manipulation of genetic constitution of the animals.

2.5.1 Age at first calving

Age at first calving is defined as the time period from birth date to first calving date (Kasonta and Rushalaza, 1993) and it is influenced by both genetic and non-genetic factors. First calving marks the beginning of a cow's productive life. Age at first calving is closely related to generation interval and, therefore, influences response to selection. Early age at first calving is an important desirable economic character of dairy cows as it increases the margin of profit by increasing life time production and reducing generation interval.

Breed differences were reported by Mchau (1991) to account for about 1 to 8% of total variation in AFC. The average age at first calving in *Bos indicus* cattle was about 44 months, compared with about 34 months in *Bos taurus* and *Bos indicus* x *Bos taurus* crosses in the tropics (Mchau, 1991)). To calculate age at first calving, animals must be recorded at birth and at first parturition. Under controlled breeding, heifers are usually mated when they are mature enough to withstand the stress of parturition and lactation. This increases the likelihood of early conception after parturition. In traditional production systems, however, breeding is often uncontrolled and heifers are bred at the first opportunity. This frequently results in longer subsequent calving intervals. In general, *Bos indicus* breeds are reported to take longer to mature than *Bos taurus* breeds (Msuya, 2002).

Further findings by Hayatnegakar (1991) revealed significant differences in age at first calving between crossbred cattle with varying levels of *Bos taurus* inheritance. Jersey x zebu crosses with 50 and 75% exotic inheritance were younger at first calving by 25.1 and 40.1 days compared to respective Friesian x Zebu crosses (i.e 1110.5 and 1123.8 vs 1135.7 and 1164.9 days). It was further observed that within Jersey and Friesian crosses, animals with 50% exotic inheritance had shorter age at first calving than those with 75%.

Other factors which influence age at first calving include season of birth. Ageeb and Hillers (1991) observed that crosses of Friesian with local Sudanese cattle born in dry summer season tended to calve for the first time later than those born in the wet summer season due to differences in availability of forages between seasons.

Mwatawala (2006) reported that heifers born in the light wet season calved for the first time 1.5 months earlier than those born during the early dry season. The significant influence of season was associated with the quality and quantity of forage available to heifers when they were born, which in turn affected their growth performance. Contrary to the reported seasonal effect, Thorpe and Trail (1990) and Kifaro (1995) reported non-significant effect of season on age at first calving.

Oliveira (1974) observed that Nellore cows in Brazil that calved for the first time in the dry season were younger than those that calved first in the rainy season. Miranda *et al*. (1982) found that age at first calving in Brazilian Nellore heifers was significantly affected by year and month of birth. Calves born from January to May tended to be younger at first calving than those born between June and December. However, Sabino *et al*. (1981) found that season of birth had no significant influence on age at first calving in locations with bimodal rainfall.

Msuya (2002) reported that geographical location contributed to variation in age at first calving. Animals reared under better management usually tend to have lower age at first calving, which indicates that the trait can be improved to a certain extent by better feeding and management. Payne (1990) reported that location was one of the non-genetic factors affected age at first calving. The large differences in climate between locations were associated with fluctuations of the following: Livestock feeds, incidence of diseases and parasites, storage and handling of animal products. Heritabilities of age at puberty, at first conception and at first calving were low, indicating that those traits were highly influenced by environmental factors. All these affected age at first calving directly or indirectly. Hayatnegarkar (1991) reported that age at first calving ranged from 1079.8 to 1185.7 days in village dairy cattle. The observed differences were attributed to different management practices by farmers between locations.

Nkala (1992) reported that under nutrition increases the time taken to reach puberty and hence increase age at first calving. For normal functions, the animal requires protein, energy, vitamins, fat and water. In the tropics the most limiting nutrients for animal production are protein, energy and minerals (Crowder and Chheda, 1982). However the amount of nutrients required by animals varies with age, sex, weight and physiological status of the animal (McDonald *et al.*, 1990). The nutritional adequacy of dairy herd diets is reflected in milk yield and in live weight change (Teendwa, 2005). A deficiency of any nutrient may decrease microbial protein synthesis in the rumen, passage of amino acids to the small intestine and in milk production by dairy cows, but the two nutrition factors that are most limiting are energy and protein (Davies, 1992).

Kifaro (1995) reported that period of birth of heifers had a significant ($P < 0.001$) influence on age at first calving at Kitulo, Uyole and Ihimbu farms. The influence of environmental factors on age at first calving has been reported by several workers, that they change with time in years. Balikowa (1997) found that the year of birth significantly ($P < 0.001$) affected age at first calving (AFC). Mwatawala (2006) reported that years of birth had no specific trend in age at first calving. However, on regressing AFC on year, there was significant relationship between year and AFC which clearly indicated that AFC was declining by 0.42 months per year. AFC was high (46.4 months) during 1979 and low (32.8 months) during 1996. The variation in age at first calving between years could be attributed to effects of climate and changes in animal management among the different years (Lee and Choundhary, 2006).

2.5.2 Calving interval

Calving interval (CI) is defined as the period between consecutive calvings, and can be expressed in days or months. CI is the function of the two major components namely; service period or days open and gestation length. Service period is the period from calving to next conception while gestation length is the period between conception and next calving. The service period depends on the interval between calving and new heat and on the number of services per conception. Thus service period has a significant contribution to the differences in the length of CI in dairy cattle (Pryce *et al*., 2000). Logically, cows with CI between 15 and 24 months would be dry for longer periods. Such cattle could tax farmers through treatments and feeding them without returns from milk and calf crop. Under such a situation, keeping cattle for milk production as the major target would not be economical (Mulangila *et al*., 2003).

Calving interval can be divided into three periods: gestation, postpartum anoestrus (from calving to first oestrus) and the service period (first postpartum oestrus to conception). The "days open" period should not exceed 80-85 days if a calving interval of 12 months is to be achieved (Kanuya and Greve, 2000). This requires re-establishment of ovarian activity soon after calving and high conception rates. The duration of this period is influenced by nutrition, season, milk yield, parity (Meikle *et al.*, 2004), suckling and uterine involution. At any time, the effects of one or more of these factors may be confounded.

Calving interval has been extensively analysed and reported. It is probably the best index of a cattle herd's reproductive efficiency. Resumption of ovarian activity in the postpartum period does not necessarily lead to conception and methods of stimulating oestrus must be considered in relation to their effect on conception (Pryce *et al.*, 2000) and, indirectly, calving intervals.

Calving interval is only available after a cow has calved for a second time, which makes it of limited use in progeny testing schemes in which information is required from either the early part of lactation or preferably from juveniles. Furthermore, calving interval data are more highly selected for the trait of interest, namely fertility, because the least fertile cows will not calve for a second time (Pryce *et al*., 2000).

The length of calving interval, in tropical dairy cattle has been reported to be influenced by genetic and non-genetic factors. Thus the inherent genetic composition of breeds is one of the genetic factors that are responsible for differences for calving interval between cows of different genotypes. An extensive study by Donald (1985) on small holder dairy farms in Arusha, Arumeru, Moshi, Rombo, Rungwe, Kinondoni and Lushoto districts in Tanzania, revealed the mean calving interval to be 534 days. Udo (1993) reported significant differences in calving intervals among crossbred cows in central Tanzania. Friesian x Mpwapwa had longer calving interval by 13.5 and 36.3 days compared to Ayrshire x Mpwapwa and their back crosses (438.7 ± 9.3 vs 425.2 ± 7 and 402.4 ± 5.5 days).

Lovince (2004) reported a significantly long mean calving interval (480.4 ± 2.4 days) in dual purposes cross bred cattle of Turiani division and Bukoba district. She noted that longer calving intervals were attributed to inability of farmers to detect heat, early embryonic mortality and failure to obtain a bull in time when cows were on heat. Safari *et al.* (2000) reported scarcity of bulls to be evident in Turiani division and contributed to long calving intervals which ranged from 12 months to more than 24 months. Udo (1993) reported significant differences in calving interval among crossbred cows in central Tanzania. Significant differences in calving interval of *Bos taurus* x *Bos indicus* cows with increasing taurus blood from 0 to 100% was also reported by Dalah *et al*. (1990) and Syrstad (1995). As the proportion of exotic blood increased from 50% to 100%, calving interval decreased by 31 days.

Borsotti *et al.* (1976) observed that genotype had a significant effect on the calving intervals of Brahman cows in Venezuela. In Mexico, Valesio (1983) found calving intervals of 18.1 months for Gir and InduBrazil cattle, 18.8 months for Brown Swiss x zebu crosses and 20.3 months for pure Brown Swiss cattle. The long mean calving interval of the Brown Swiss probably reflects lack of adaptation to the humid environment. Nodot *et al.* (1981) reported that calving interval was affected by maternal grand sire. However, Duarte *et al.* (1983) found no significant effect of genetic grouping (proportion of zebu blood) among cows in Brazil.

Kifaro (1984, 1995) and Nkala (1992) reported that longer lengths of calving interval in first parity than subsequent ones can be attributed to higher calving stress among heifers compared to older heifers. During early lactation, first calvers experience physiological stress. This is associated with more pronounced partitioning of nutrients for milk production, growth and reproduction function in heifers than in older cows. As a result days open is extended hence longer calving intervals after first calving compared to subsequent parities.

High level of feeding after calving tends to shorten the interval from first breeding to conception and thus reduce calving interval. In zebu cattle, Mukasa-Mugerwa *et al.* (1989) found a calving interval of 780 days (26 months) in traditionally raised Ethiopian highland zebus. This may be the average period required to gain sufficient bodyweight and condition to start cycling and conceive again, given the limited nutritional resources of the traditional system. Calving intervals also tend to be shorter in animals that are more productive in other respects. This may be a reflection of the effect of nutrition, since more productive animals are usually fed better than unproductive animals (Luna-Dominguez *et al.*, 2000).

Kifaro (1995) reported that year accounted for 3 – 31% of total sum of squares and significantly ($P < 0.001$) influenced calving intervals of dairy cattle in four farms while calving intervals of the fifth farm were not significantly influenced by year effects. Year effects on calving intervals in the tropics have been reported to be indirect due to dynamic climatic changes which are frequently associated with fluctuation in forage availability and changes in management by farmers. Jointly or separately the above components of year effect can influence performance of dairy cattle that are managed under diverse agro-ecological conditions in the tropics (Meikle *et al.*, 2004).

2.6 Lactation Performance Traits in Dairy Cattle

2.6.1 Total lactation yield

The daily yield and composition of milk are affected by physiological and environmental factors. The physiological factors are governed in part by the inheritance of the animal and in part by such non-hereditary factors like age, number of previous lactations and pregnancy (Mwatawala, 2006). Dairy production among the smallholder farmers has contributed significantly to poverty alleviation and reduction of malnutrition particularly in rural areas (Kayunze *et al*., 2001; Kurwijila *et al*., 2002). However, the productivity of dairy cattle in Tanzania is rather low, producing on average of 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 yield of the cow is dependent on her body condition at calving, her inherited potential, her freedom from metabolic and infectious diseases and the feeding regime after calving. A good body condition at calving and an adequate feeding program after calving tends to increase peak of milk production. Peak of milk production plays an important role in determining lactation milk production, since there is a high correlation between these two factors (Mayeres *et al.*, 2004). Freedom from metabolic diseases, particularly milk fever and ketosis allows the cow to attain high milk production. The rate of decline in yield after calving is called persistency. Cows must have high persistency as well as high peak of milk production for high lactation milk yield (Milang'ha, 2002).

Abdallah and McDaniel (2000) reported that marked drop in milk production occurs towards the end of pregnancy which is caused by an increase in the level of nutrient required for fetal development; however this appears to be only 1 to 2% of the dairy requirements of the cow. Another reason is the change in hormone production, whereby large amounts of oestrogen and progesterone flow into the blood stream, which occur at this time and may be detrimental to milk production.

Mwatawala (2006) observed that the yield was maintained longer at the maximum and falls more slowly when the cow was empty than when she was pregnant. Also efficiency and frequency of milking have effects on the milk yield where by the more frequently a cow was milked the larger was the yield. The improvement in milk yield traits lead to decrease in the fertility of cows, because high yielding dairy animals had poor reproductive performance (Abdallah and McDaniel, 2000).

Dairy development in the tropics is generally directed towards the smallholder sector in which lack of fund is the major constraint in the production (Walshe, 1993). Rakotoirainy (1993) reported constraints to dairy development in the highlands of Madagasca to include: poor roads in rural areas making farm input prices to be excessively high in comparison to milk prices, thus making milk collection to be difficult particularly in the wet season and large quantities of milk powder received by dairy factories, there by causing milk prices to stagnate. Mtui (2004) has also reported scarce and poor quality food resources to limit dairy production in the tropics.

The level of milk production is determined by genotype of the cow, environment and interaction between the two (Kifaro, 1995). It has also been reported by Mulindwa (2005) that the type of breed crosses used by smallholder dairy farmers may cause variation in single lactation records. Genotype has also been reported by Guo-li *et al.* (2006) to significantly affect lactation yields and lengths.

Cross breeding tropical cattle with European dairy breeds for milk production has been a method widely used and accepted for increased productivity. The level of milk production has been reported to vary with *Bos taurus* inheritance in the crossbred cattle. The general agreement is that milk yield increases as the level of *Bos taurus* blood increases from zero to 50% (Msanga and Bee, 2003).

Mchau (1991) reported the significant effect of breed and breed levels on total lactation yield of dairy cattle with varying levels of *taurus* inheritance in tropical environments. Similarly large differences in total lactation yield due to varying levels of *taurus* inheritance have been reported by Balikowa (1997). High grades lack heat tolerance and disease resistance due to reduced heterozygosity hence heterosis. This set back has always led to recommendations of 50% proportion of *Bos taurus* genes to be optimum for milk production in the tropics. The conclusion is based on good performance of F1 and the decline in viability, fertility and some times milk yield in higher grade cattle (Mchau, 1991). Most of the variation in production level among herds is environmental, although genetic differences could also exist within the same breed (Gimbi, 2006). Syrstad (1995) reported that milk yield per lactation increased by increasing the proportion of *Bos taurus* inheritance in the crosses, but the increase beyond 50% level was only slight. He observed that when the foundation stock was the improved *Bos indicus*, no improvement beyond 50% *taurus* level occurred but the milk yield continued to rise if the foundation stock was non-improved *Bos indicus.*

Normally a cow gives a comparatively small yield of milk in the lactation that follows the birth of her first calf and her maximum yield in the lactations following her fourth to sixth calf (Mwatawala, 2006). Mulindwa (2005) reported parity to be one of the major sources of variation in milk yield. In his study the highest extracted lactation milk yield was observed in cows in fourth parity followed by those in lactation numbers three, two, and one, in that order.

Effects of year on total lactation yield have been reported by Udo (1993) to have big influence on the trait. It was observed that the proportion of components of variance of lactation traits attributable to year of calving were larger than components of variance attributable to breed and season of calving. This was linked to larger variability from year to year of climatic conditions mainly rainfall. Rainfall indirectly affects milk production through fluctuation of feed availability in the tropics. According to Kusekwa and Kidunda (1988) rainfall and soil moisture are major determinants of pasture growth. They also affect indirectly the nutrients availability of forages to ruminants through seasonal variability of grazing resources.

The season of calving has been reported by Thorpe and Trail (1990) to have a significant effect on milk yield. During dry seasons, most tropical grasses are highly resistant to digestion by ruminants which depend on forages. According to Mwakilembe (2004), lower digestibility of tropical grasses is due to the fact that during the dry season grasses become more lignified with high crude fibre and low crude protein. Therefore, seasonal fluctuation with regards to availability of forages is the major component of season which influences dairy cattle production.

The effects of season of calving and year of calving particularly for grazing cattle are mainly through their influence on supply of feed. In regions with unimodal distribution of rainfall, lactation yield has been reported to be influenced by season of calving (Msanga and Bee, 2003). In regions with bimodal type of rainfall distribution, the effects of season on performance have been found to be non-significant (Mwatawala, 2006).

2.6.2 Lactation length

Lactation length refers to the time of period from when a cow starts to secrete milk after parturition to the time of drying off. A lactation period of 305 days is recommended to take advantage of 60 days dry period and a yearly calving interval (Schmidt and Van Vleck, 1974).

Syrstad (1995) reported significant increase of lactation length with increasing proportion of exotic blood in dairy cattle in the tropics. The lactation lengths of zebu cattle were normally shorter than those of crossbreds between Zebu and Taurus which ranged from 244 to 324 days. That information suggested that longer lactation lengths were a consequence of high milk yield. Therefore breeds with long lactation length were expected to have higher total lactation yield than those with short lactation length.

Kifaro (1984) revealed positive relationship between total lactation yield and persistency which was consequently associated with longer lactation length. In other studies, longer lactation lengths have been associated with lowered conception rate and longer calving interval (Vargas *et al.,* 2000). Therefore cows which normally experience longer lactation lengths of up to 400 days or above are likely to have poor reproductive performance although they can produce more milk per lactation.

Lactation performance traits are indirectly affected by year of calving through variability in climatic conditions, fluctuations in forage resources, disease occurrence and changes in management related to feeding and breeding (Mchau, 1991).

Msanga and Bee (2003) observed that in most cases differences in lactation performance of dairy cattle in the tropics were attributed to the following: dynamic changes in climate, management policies by farmers, fluctuations in forage availability and interaction of disease occurrence and socio-economic constrains. This implies that seasonal variability of the above factors form the major proportion of indirect seasonal effects on traits of economic importance (including lactation length) in dairy cattle. The average lactation length reported in Malawi (Agyemang and Nkhonjera, 1986) was 454 days for cows that calved between January and May. For cows, that calved between June and December had a mean lactation length of 402 days.

2.6.3 Dry period

Dry period refers to the time when the cow does not produce milk. This takes eight weeks before the next parturition or two months before next lactation. The purpose of drying off cows is to give a rest before the next lactation. The epithelial cells within the mammary gland need to rest and regenerate before the next lactation. The rest period also allows the cow to replenish some of her body supplies. The drying-off process should be done as rapidly as possible without injuring the udder. Drying-off is accomplished by allowing the udder pressure to reach the point at which milk secretion is stopped, eventually the milk remaining in the udder is absorbed by the blood (Balikowa, 1997).

Nangwala (1996) cautioned that, in practice, drying-off may give rise to mastitis, especially in the case of high yielding cows which may experience difficulty at this stage. The process can operate in two very different ways; the first one is sudden drying-off by the American method. The animals are put on a very severe diet and milking is simply stopped from one day to the next. This method can only be used for cows giving less than 5 litres of milk per day, in which case lactation ceases completely within 48 hours. The second way is gradual drying-off, milking being carried out once daily for eight days, then once every second day for the subsequent eight days, when it stops.

Diggins and Bundy (1969) reported three methods of drying off cows named as intermittent milking, incomplete milking and abrupt cessation of milking. Intermittent milking where by the cow that was to be dried off was milked once a day for a while, then once every other day and finally milking will be stopped altogether. Dairy men who practiced incomplete milking system started by not extracting all the milk from the udder at milking time for the first few days later they milked the cow intermittently but never completely. After the production of milk decreased to only few litres daily, all milking was stopped entirely. The experiments proved that abrupt cessation of milking was the best when the udder was sound and had no mastitis infection. All concentrates were removed from the ration three days before dry-off date. Also the hay was reduced to about one-half to two-thirds of the normal ration.

The reduction in feed reduced milk flow and he recommended that after the last milking the teats should be washed and dipped in collodion, which sealed the ends and prevented infectious organisms from entering the udder.

The dry cow does not present many management problems. She should be guarded against possible injuries that may cause abortion, such as falling from hills, slippery alleyways, or other obstructions that may cause injury. She needs comfortable quarters and moderate amount of exercise (Schmidt and Van Vleck, 1974).

Balikowa (1997) reported that, parity had no significant effect on dry period. Findings reported by Kifaro (1995) found the effect of parity to be significant in only three out of five institutional farms in Tanzania. The effect of parity has been reported to have somewhat minor influence on lengths of dry period. For instance dry period lengths reported by Nkala (1992) in Tanzania between parity 1 and subsequent parities, ranged between 138 and 162 days.

In a study by Nkala (1992) dry period lengths were significantly ($P < 0.001$) different between cows of two farms which can be equated to locations and management. The farms were less than 10 kilometres apart. More over, cows at those farms were of similar genetic composition and originated from a former common farm (Livestock Breeding Station). In addition, the distance between the farms is not tremendously big. Basing on the above information, it can be generalized that differences in dry period lengths of populations with similar genetic constitution in different locations, are attributable to effects of management practices especially breeding, feeding and disease control.

Crossing native cattle with European breeds has resulted in longer lactation lengths and shorter dry periods (Mchau, 1991). Vargas (2000) analysed the dry periods for effect of breed and lactation number. Only parity was a significant source of variation showing a clear trend of dry periods to decrease during the first three lactations.

Balikowa (1995) reported the average dry period of 128 days which was slightly higher than 100 days reported by Mchau (1991) in Mbeya region. Payne (1990) recommended that heifers should be milked for about 260 to 270 days and allowed a dry period of 90 to 100 days as they are likely to continue to grow throughout the first lactation.

CHAPTER THREE

MATERIALS AND METHODS

Description of the Study Area

Kilolo district is administratively among the seven districts of Iringa region. The district covers a total of 9075 km^2 of land. The district lies between 7°00" and 8°30" latitudes south and 34° – 37° longitudes East. Kilolo district forms borders with Iringa district to the north, Morogoro region (Kilosa and Kilombero districts) to the east and Mufindi district to the south.

Geographically, Kilolo district is characterized by three distinctive landscape forms of highlands, midlands and lowlands. The highland zone occupies Kilolo division and lies at an attitude between 1300 and 2800 meters above sea level. It is characterized by mountains and undulating topography. This zone has annual rainfall between 700 – 1500 mm with a mean annual temperature of about 11°C. The total zone area is 1669 km^2. The midland zone lies in the north of the district and constitutes Mazombe division and Udekwa ward in Mahenge division. The midland zone has an area of 1587 km^2 and lies at an attitude of 800 to 1300 meters above sea level. This zone has annual rainfall between 600 – 900 mm with a mean annual temperature of about 18°C. The lowland zone occupies Mahenge division and lies at an attitudes between 400 to 600 meters above sea level. This has a total area of 5819 km^2. The zone experiences a moderate annual rainfall ranging from 500 mm to 600 mm and the mean annual temperature is about 25°C.

A Survey on Production Environment of Dairy Cattle

The survey

A cross section study was carried out between October 2008 and January 2009. A questionnaire was used to get information from livestock keepers on major management aspects like feeding system, breeding and disease control (Appendix 1). The owner of the farm or someone who was familiar with management of dairy cattle in the farm was interviewed.

Sampling procedures

The population of the study consisted of smallholder dairy farmers in Kilolo and Mazombe divisions of Kilolo district. In Mazombe division two wards were involved and these were Ilula and Ilole, while in Kilolo division; four wards were sampled namely Dabaga, Bomalang'ombe, Ukumbi and Mtitu. The villages selected in Kilolo division were; Bomalang'ombe, Masisiwe and Mbawi in Bomalang'ombe ward, Kidabaga, Ng'ang'ange and Magome in Dabaga ward, Luganga, Ihimbo and Lulanzi in Mtitu ward. Other villages were Mawambala, Lukani and Masege in Ukumbi ward. In Mazombe division the villages sampled were; Ilole, Kitumbuka and Ibofwe in Ilole ward additional villages were Mlafu, Itunda and Masukanzi in Ilula ward. Sampling frame of all farmers was prepared at the office of district livestock officer and number of farmers to be involved in each division was determined. The farmers interviewed were picked from the list made for each ward by taking an n^{th} person on the list after choosing a starting point basing on number of farmers earmarked for each ward. A total of 176 respondents who were keeping crossbred dairy cattle were sampled. The number of respondents per division was 115 and 61 from Kilolo and Mazombe divisions, respectively.

Data handling and analyses

Survey data obtained from the questionnaire were summarized under the following major parameters: Demographic characteristics (family size, age groups and sex), land holding characteristics (total area, area for fodder and crop production) and general management (herd composition, feeding, breeding and diseases control). Proportions in percent were computed for the parameters above and presented in the text. In addition descriptive statistics (means, standard deviations) were computed.

Collection and Processing of Performance Secondary Data

Reproductive and lactation performance traits

Monthly reports from all wards in the Kilolo district were used to get data on performance of dairy cattle. The data were collected on reproductive performance and health of dairy cattle. The period from birth of the female cattle to her first calving date was considered as age at first calving (AFC) while the period between two consecutive calving dates was considered as calving interval (CI). Data collected on lactation performance included: Total lactation yield (TLY) which was the sum of daily milk yields of a cow recorded over the period from calving date to dry off date; lactation length (LL) which was the length from calving date to dry off date and dry period (DP) was the period from dry off date to next calving date. Lactation lengths and dry periods were expressed in days while total lactation yield was expressed in litres.

Coding of class variables

The months of the year were classified into three seasons and coded as follows; 1= January to April which is normally a rain season. 2= May to August which is very cold but dry. 3= September to December which is medium cold and dry season. The 10 years from 1999 to 2008 represented the study period and were coded 1 to 10 in ascending order. The two divisions involved in the study were coded as 1= Kilolo, and 2= Mazombe. Only two divisions were involved in the study these are; Kilolo division in highland zone and Mazombe division in midland zone.

The dairy cattle project in Kilolo was introduced by Southern Highlands Dairy Development Project (SHDDP) in year1981. The animals introduced were crosses between Friesian x Tanzania short horn zebu or Friesian x Boran and Ayrshire x Tanzania short horn zebu or Ayrshire x Boran. The dairy cattle involved in the study were Friesian crosses and Ayrshire crosses. The coding of the major groups were 1=50% Friesian 2=62.5% Friesian 3= 75% Friesian and 1=50% Ayrshire 2=62.5% Ayrshire 3 = 75% Ayrshire. The cow parities were coded as 1, 2, 3 and 4 for the first to fourth parity, respectively.

Data handling and analyses

Data on reproductive and lactation performance were subjected to least squares analysis of variance using General Linear Models (GLM) procedure of Statistical Analysis System (SAS, 2000) package.

In the first analysis, the interest was to compare the two breeds namely Friesian and Ayrshire. In the second round of analysis, the aim was to compare genetic levels (50, 62.5 and 75% exotic blood) within breeds. So data was analysed for fixed effects of breed, breed level, year of birth/calving, parity, division and season of birth/calving. For age at first calving (AFC) the following model (Model 1) was used for first analysis:

Model 1

$Y_{ijklmn} = \mu + A_i + C_k + D_l + E_m + e_{ijklmn}$

Where:

Y_{ijklmn} = a single record of AFC

μ = overall mean

A_i = effect of the i^{th} breed

C_k = effect of the k^{th} year of birth

D_l = effect of the l^{th} season of birth

E_m = effect of the m^{th} division

E_{ijklmn} = a random element N $(0, I\sigma_e^2)$

In the second analysis breed genetic levels were nested within breed. Analyses of CI, TLY, LL and DO involved two models. The first one was similar to the one used for AFC but parity was also fitted in the model as a fixed effect. In the second analyses, breed levels were nested within breed as shown in model 2.

Model 2

$Y_{ijklmnp} = \mu + A_i + B_j(A_i) + C_k + D_l + E_m + F_n + e_{ijklmnp}$

Where:

$Y_{ijklmnp}$ = a single record of TLY, CI, LL or DP

μ = overall mean

A_i = effect of the i^{th} breed

$B_j(A_i)$ = effect of j^{th} breed level nested within the i^{th} breed

C_k = effect of the k^{th} parity

D_l = effect of the l^{th} year of calving

E_m = effect of the m^{th} season of calving

F_n = effect of the n^{th} division

$e_{ijklmnp}$ = a random element $N(0, I\sigma_e^2)$

CHAPTER FOUR

RESULTS

4.1 Demographic Features of Farms Surveyed

Mean ages of dairy cattle keepers were 44.2 ± 7.41 years in Mazombe division and 45.3 ± 5.81 years in Kilolo division (Table 4.1). The smallholder dairying in Kilolo district was dominated by men who comprised of 65.9% of farmers interviewed. The mean numbers of cattle owned per household were 3.1 ± 1.07 in Kilolo division and 2.6 ± 0.97 cattle per household in Mazombe division. There was slight difference in acreage owned by farmers with average of 7.2 ± 2.70 ha in Kilolo division and 5.7 ± 2.51 ha in Mazombe division. The number of people per household in Kilolo district was 8.5 ± 3.65 (Table 4.1). The marital status of dairy cattle keepers in Kilolo district was 84.6%, 11.4%, 2.3% and 1.7% for married, widowed, divorced and single farmers respectively (Table 4.2).

Table 0.1 Household characteristics of sampled dairy cattle keepers

	Division		
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
Farmers			
Male farmers	116 (65.9%)	77 (67%)	39 (63.9%)
Female farmers	60 (34.1%)	38 (33%)	22 (36%)
Mean age in years	44.9 ± 6.41	45.3 ± 5.81	44.2 ± 7.41
Division means for			
Cattle owned	2.9 ± 1.05	3.1± 1.07	2.6 ± 0.97
Acreage owned (ha)	6.7 ± 2.75	7.2 ± 2.70	5.7 ± 2.51
People/Household	8.5 ± 3.65	8.7 ± 3.83	7.9 ± 3.25

Table 0.2: Marital status and areas cultivated by dairy cattle keepers

	Division		
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
% Marital status			
Single farmers	1.7	0.9	3.3
Married farmers	84.6	88.7	77.1

Widowed farmers	11.4	8.7	16.4
Divorced	2.3	1.6	3.3
Cultivated area			
Hectare of fodder	0.5 ± 0.09	0.6 ± 0.12	0.4 ± 0.06
Hectare of other crops	6.7 ± 2.75	7.2 ± 2.7	5.3 ± 2.51

4.2 Management Aspects of Smallholder Dairy Cattle in Kilolo District

Most of the farmers (72.2%) milked their cows twice per day and 27.8% of the farmers milked their cows once per day in the morning. This was done to allow the cow to suckle her calf for the whole day till evening. The average amount of milk/day/cow was 8.7 ± 2.79 litres in Kilolo district (Table 4.3). The average amount of milk sold and consumed/day/household was 13.7 ± 4.61 kg and 0.9 ± 0.65 kg respectively. More than half of the farmers (58.3%) prefer Ayrshire breed while 41.5% like Friesian crosses. All farmers preferred to breed their animals by use of bulls rather than by artificial insemination (AI) (Table 4.4). The results show that most of the management activities like milking, feeding and manure handling were done by family members indicating that most of smallholder dairy cattle keepers in Kilolo district depend on family labour (Table 4.4).

Table 0.3: Frequency of milking and amount of milk/day/cow

		Division	
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
Frequency of milking/day (%)			
Once	27.8	22.6	37.7
Twice	72.2	77.4	62.3
Amount of milk/day/cow (litres)	8.7 ± 2.79	8.8 ± 2.74	8.6 ± 2.91
Amount of milk sold/day/household (litres)	13.7 ± 4.61	14.0 ± 4.28	12.9 ± 5.16
Amount of milk consumed/day/household	0.9 ± 0.65	0.9 ± 3.1	0.8 ± 0.67

Table 0.4: Characteristics of breeding and labour use for milking, feeding and manure handling

	Division		
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
Breeding method and Preferences (%)			
Use of A.I	0	0	0
Use of Bulls	100	100	100
Cost of mating (Tshs):	7221.69 ± 39.42	7565.22 ± 39.12	6573.71 ± 16.31
Distance to breeding bull (km)	1.57 ± 0.04	2.63 ± 0.68	1.06 ± 0.17
Preference to Ayrshire crosses	58.5	59.8	55.7
Preference to Friesian crosses	41.5	40.2	44.3
Labour use/Activity (%)			
Family labour on milking	88.1	90.4	83.6
Hired labour on milking	11.9	9.6	16.4
Family labour on feeding	76.1	78.3	72.1
Hired labour on feeding	23.9	21.7	27.9
Family labour on manure handling	75.6	79.1	68.9
Hired labour on manure handling	24.4	20.9	31.2

Table 0.5: Characteristics of smallholder feeding systems and record keeping as management parameters

		Division	
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
% Feeding systems			
Zero grazing	13.9	4.7	23.1
Partial grazing	35.8	31.2	31.1
Full grazing	50.3	64.1	36.5
% Supplementing calves			
Supplemented	14.2	13.1	16.3
Unsupplemented	85.8	86.9	83.6
% Supplementing lactating cows			
Supplemented	53.4	55.7	49.2
Unsupplemented	46.6	44.3	50.8
Records kept (%)			
Birth records	72.8	69.5	76.3
Milk records	69.6	18.3	24.6
Health records	54.7	78.2	60.7
Sire records	21.4	63.5	45.9

A half (50.3%) of the farmers practiced full grazing of their animals and only a few (13.9%) who were zero grazing. Lactating cows were supplemented with concentrates by many farmers (53.4%) but very few of them (14.2%) supplemented concentrates to suckling calves (Table 4.5). In Kilolo division the majority of respondents (73.1%) weaned their calves above five months of age while in Mazombe division only 57.4% weaned their calves at that age and the rest weaned their calves at the age below four months. The major causes of disposals of dairy cattle in Kilolo district were deaths due to diseases (50.6%), sales (39.8%) and only 9.6% were disposed by slaughter (Table 4.6).

Table 0.6: Dairy cattle categorization, weaning and disposal characteristics

		Division	
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
% weaning ≤ 4 months	32.4	26.9	42.6
% weaning ≥ 5 months	67.6	73.1	57.4
% Disposals			
Death	50.6	32.5	18.1
Slaughter	9.6	6.0	3.6
Sales	39.8	25.3	14.5
Cattle No by sex /Age			
Group category			
Male calves 0 - 6 months	1.1 ± 0.2	1.0 ± 0.17	1.2 ± 0.12
Male calves 7 - 12 months	1.1 ± 0.32	1.1± 0.32	1.1 ± 0.33
Female calves 0 - 6 months	1.2 ± 0.41	1.3 ± 0.45	1.1 ± 0.32
Female calves 7 - 12 months	1.3 ± 0.46	1.4 ± 0.48	1.2 ± 0.43
Heifers or cows > 12 months	2.7 ± 0.98	2.7 ± 0.82	2.6 ± 1.19

The main constraints of dairy farming in Kilolo district were livestock diseases (63.6%), lack of dip tanks (51.7%) and feeding costs (44.3%). The most prevailing diseases were ECF (63.1%), diarrhoea (59.7%), pneumonia (26.3%) and heart water (22.1%) (Table 4.7).

Table 0.7: Factors affecting dairy cattle production

	Division		
Parameter	Overall	Kilolo	Mazombe
Farmers surveyed	176	115	61
Management problems (%)			
Lack of dip tanks	51.7	48.6	57.4
Feeding cost	44.3	45.2	42.6
Diseases	63.6	66.1	59.2
Major diseases (%)			
ECF	63.1	64.3	60.7
Heart water	22.1	22.6	21.3
Diarrhoea	59.7	62.6	54.1
Pneumonia	26.3	25.2	27.9

Most of the smallholder dairy cattle keepers (92.1%) in Kilolo district kept chicken as their best alternative of other animal species followed by goats (35.5%) and pigs (34.7%) (Table 4.8).

Table 0.8: Other livestock species kept in Kilolo district (%)

	Division		
Parameter	Overall	Kilolo	Mazombe
Goats	35.5	34.7	37.7
Sheep	13.2	19.1	7.9
Pigs	34.7	36.5	31.1
Chicken	92.1	89.6	96.7
Rabbit	11.4	15.6	3.2
Dogs	19.8	18.3	22.9
Guinea pigs	4.5	6.1	1.6

4.3 Reproductive Performance Traits

4.3.1 Age at first calving

The effects of breed, division, year (all at $P < 0.01$) and season of birth ($P < 0.05$) significantly influenced age at first calving (Appendix 2). The overall mean of age at first calving was 1004.4 ± 13.15 days or about 33 months.

Friesian crosses were significantly older at first calving by 21 days compared to Ayrshire crosses (Table 4.9). AFC within Ayrshire and Friesian crosses differed significantly ($P < 0.05$) and it was revealed that Friesians with 50% exotic inheritance were significantly older at first calving by 42 days compared with 62.5% Friesian. It was revealed that dairy cattle crosses in Mazombe division had older (1038.7 ± 27.06) age at first calving than those kept at Kilolo division (982.5 ± 23.62).

Within Ayrshire crosses (Table 4.10) heifers with 62.5% were significantly younger at first calving by 54 days compared to Ayrshire crosses with 75% exotic blood. Small differences in AFC (Table 4.11) were observed in dairy heifers born in different years and seasons. For example heifers born during 2005 were younger at first calving by 120 and 109 days compared to those that were born in 2000 and 1999 respectively, while those heifers which were born in 2001, 2002, 2003 and 2004 their mean ages at first calving were not significantly different. With regard to seasons, heifers born during January and April were significantly older at first calving by 62 days compared to heifers born between September and December (Table 4.11).

4.3.2 Calving interval

A comparison of calving intervals between breeds and genetic groups within breeds was established by two analyses of variances (Tables 4.9 and 4.10). Breed of cows and year of calving significantly ($P<0.01$) influenced calving intervals. When levels of exotic blood within breed were included in the model, the ANOVA (Appendix 3) revealed that calving intervals were significantly ($P<0.001$) influenced by year of calving and breed of cows.

Least squares means (Table 4.9) show that, the overall mean of calving intervals of cows under dairy cattle keepers in Kilolo district was 482.2 ± 2.41 days. Calving intervals in Friesian crosses had significantly ($P<0.001$) longer calving intervals by 68 days over Ayrshire crosses. Year of calving had a significant effect ($P < 0.001$) on calving intervals. Cows that calved in 2005 had longest mean calving intervals (598.3 ± 48.62 days) while cows that calved in 2000 had shortest mean calving interval (440.7 ± 11.24 days). Season of calving did not significantly influence lengths of calving intervals.

Table 0.9: Least squares means of age at first calving (AFC) and calving interval estimated for effects of breed, parity and division

	Variable [1,]			
Factor	n	AFC	n	CI
Overall mean	255	1004.4 ± 13.15	409	482.2 ± 2.41
Division				
Kilolo	174	982.5 ± 23.62[b]	284	497.2 ± 8.56[b]
Mazombe	81	1038.7 ± 27.06[a]	125	490.2 ± 9.84[b]
Breed				
Ayrshire crosses	139	1000.5 ± 24.45[b]	219	459.8 ± 8.89[c]
Friesian crosses	116	1020.7 ± 25.75[a]	190	527.6 ± 9.37[a]
Parity				
Parity 1	_	_	255	499.6 ± 8.73
Parity 2	_	_	154	487.9 ± 9.51

[1] = within columns and effect means with the same letter do not differ significantly (P > 0.05).

Table 0.10: Comparison of least squares means of age at first calving (AFC) and calving interval (CI) within breeds

	Variable [1]			
Factor	n	AFC	n	CI
Ayrshire crosses				
50%	54	1008.4 ± 28.59[a]	91	473.9 ± 10.48[a]
62.5%	43	969.6 ± 29.48[b]	75	447.8 ± 10.55[b]
75%	42	1023.4 ± 32.51[a]	53	457.9 ± 12.24[b]
Friesian crosses				
50%	48	1036.8 ± 30.47[a]	82	537.5 ± 11.08[a]

62.5%	36	994.5 ± 33.11^{b}	67	527.3 ± 11.76^{a}
75%	32	1030.8 ± 34.26^{a}	41	517.9 ± 13.42^{a}

[1] = within columns, means with the same letter don't differ significantly ($P > 0.05$).

Table 0.11: Least squares means estimated for age at first calving (AFC) and calving interval (CI) for effects of year and season

	Variable [1]			
Factor	n	AFC	n	CI
Year of calving				
1999	18	1075.4 ± 35.63[a]	34	509.8 ± 12.41[a]
2000	28	1074.2 ± 27.07[a]	48	440.7 ± 11.24[c]
2001	109	1019.7 ± 14.71[b]	190	488.5 ± 5.40[b]
2002	61	997.8 ± 18.26[b]	85	483.7 ± 7.58[b]
2003	31	931.1 ± 27.41[b]	41	449.1 ± 11.22[c]
2004	7	973.8 ± 53.09[b]	9	485.1 ± 22.69[b]
2005	1	1001.9 ± 141.84[b]	2	598.3 ± 48.62[a]
Season of calving				
Jan - April	86	1037.9 ± 27.38[a]	156	488.9 ± 9.58
May - August	98	1018.1 ± 27.31[b]	134	502.7 ± 9.87
Sep - Dec.	71	975.8 ± 25.92[c]	119	489.5 ± 9.64

[1] = within columns and factor, means with the same letter do not differ significantly (P > 0.05).

4.4 Lactation Performance Traits

4.4.1 Total lactation yield

The results of ANOVA (Appendix 4) show that division, breed, parity and year of calving significantly affected total lactation yield. Further, when breed levels within breed were included in the model (Appendix 5), ANOVA revealed significant influence of parity, breed level, division, year and season of calving on total lactation yield. Also the milk yield produced by Friesian crosses (1730 kg) out yielded Ayrshire crosses (1654 kg) by 76 kg. Cows in Mazombe division produced significantly much more milk (1819.5 kg) compared to cows in Kilolo division

(1564.9 kg). In both breed crosses, cows in parity one produced less total milk yield compared to parity two and parity three. The total lactation yield increased with the increase in parity (Table 4.12). There has been a tendency for TLY to increase as years went by. Year 2002 had least TLY (1393.8 kg) while year 2007 had the highest (1946.3 kg). Cows that calved in the wet season (January - April) produced more milk than those that calved in other seasons (Table 4.14).

4.4.2 Lactation length

The effects of breed, parity and year of calving significantly ($P<0.001$) influenced lactation lengths (Appendix 4). The overall mean of lactation lengths was 359.9 ± 3.61 days or about one year. Least squares means (Table 4.12) show that Friesian crosses had longer (by 67 days) lactation length compared to Ayrshire crosses. Within breeds, there was no significant difference between Friesian breed levels but 50% Ayrshire had significantly ($P<0.05$) shorter LL compared to higher breed levels (Table 4.13). The lactation lengths increased with increase in parity. Season of calving had no significant ($P > 0.05$) influence on lactation lengths.

4.4.3 Dry period

Lengths of dry period (DP) were significantly affected by year of calving ($P<0.01$), season of calving ($P<0.001$), parity ($P<0.05$) and breed level ($P<0.05$) (Appendix 4 and 5). Least squares means (Table 4.12) show that dry periods for cows in parity two were longer than those in parity one. The results show that 62.5% crosses of both breeds had least dry periods (118.9 days) (Table 4.13). In Friesian crosses, the lengths of dry period for cows with 50% exotic blood were prominently longer than other breed levels within breed. Division had a significant influence on the lengths of dry periods ($P < 0.05$) with Kilolo cows having 12 days longer of dry period compared to Mazombe cows. The breed had no significant influence on dry period lengths. Seasonal variations in length of dry periods were large. Cows that calved in the early dry season (May - August) had longest (140.2 days) mean dry period compared to cows that calved in other seasons.

Table 0.12: Least squares means of total lactation yield (TLY), lactation length (LL) and dry period (DP) estimated for effect of division, breed and parity

	Variable[1]		
Factor	TLY	LL	DP
Overall mean	1612.9 ± 13.26 (660)	359.9 ± 3.61 (660)	129.5 ± 5.13 (409)
Division			
Kilolo	1564.9 ± 34.58[b] (454)	375.2 ± 3.68[a] (454)	133.7 ± 4.35[a] (284)
Mazombe	1819.5± 47.69[a] (206)	365.1 ± 5.07[b] (206)	121.6 ± 5.58[b] (125)
Breed			
Ayrshire crosses	1654.4 ± 40.91[b] (354)	335.2 ± 4.34[b] (354)	131.1 ± 4.91 (318)
Friesian crosses	1729.9 ± 40.86[a] (306)	402.1 ± 4.35[a] (306)	124.2 ± 4.92 (91)
Parity			
Parity 1	1414.5 ± 38.70[c] (258)	312.6 ± 4.13[b] (258)	135.8 ± 3.93[a] (217)
Parity 2	1748.9± 48.34[b] (245)	378.4 ± 5.15[a] (245)	119.6 ± 6.30[b] (192)
Parity 3	1913.2 ± 68.03[a] (157)	419.3 ± 7.24[a] (157)	-

1 = in parenthesis are numbers of observations and within columns means with the same letter don’t differ significantly (P > 0.05).

Table 0.13: Comparison of least squares means of total lactation yield (TLY), lactation length (LL) and dry period (DP) within breeds

	Variable[1]		
Factor	TLY	LL	DP
Ayrshire crosses			
50%	1381.7 ± 48.32[c] (134)	322.5 ± 5.15[c] (131)	141.2 ± 5.82[a] (87)
62.5%	1833.2 ± 56.32[a] (128)	344.1 ± 6.01[b] (131)	118.9 ± 6.63[b] (75)
75%	1748.3 ± 69.07[a] (93)	338.9 ± 7.26[b] (93)	133.2 ± 8.28[a] (53)
Friesian crosses			
50%	1531.1 ± 48.43[b] (130)	399.8 ± 5.14 (130)	132.8 ± 5.89[a] (82)
62.5%	1820.2 ± 57.14[a] (103)	407.4 ± 6.18 (103)	118.9 ± 6.89[b] (67)
75%	1838.9 ± 75.94[a] (72)	408.1 ± 8.11 (72)	120.8 ± 9.09[b] (45)

[1] = in parenthesis are numbers of observations and within columns, means with the same letter don't differ significantly (P > 0.05).

Table 0.14: Least squares means of total lactation yield (TLY), lactation length (LL) and dry period (DP) estimated for effects of year and season

	Variable[1]		
Factor	TLY	LL	DP
Year			
2002	1393.8 ± 122.32^{bc} (26)	395.1± 12.87^{a} (26)	146.2± 11.18^{a} (26)
2003	1556.7 ± 100.43^{c} (45)	377.2± 10.73^{a} (45)	149.9 ± 9.31^{a} (43)
2004	1622.4 ± 61.39^{b} (128)	373.1 ± 6.48^{a} (128)	120.7 ± 5.36^{b} (132)
2005	1745.2 ± 40.94^{a} (220)	377.4 ± 4.34^{a} (220)	121.1 ± 3.90^{b} (117)
2006	1589.6 ± 52.98^{b} (111)	309.8 ± 5.76^{b} (111)	100.4 ± 11.26^{b} (91)
2007	1946.3 ± 59.98^{a} (130)	388.3 ± 6.39^{a} (130)	-
Season			
Jan – Apr.	1765.2 ± 51.31^{a} (266)	378.4 ± 5.44 (266)	117.3 ± 5.87^{b} (154)
May – Aug.	1537.6 ± 46.23^{c} (214)	318.1 ± 4.92 (214)	140.2 ± 5.49^{a} (135)
Sep – Dec.	1699.8 ± 47.72^{b} (180)	362.8 ± 5.06 (180)	125.4 ± 5.69^{b} (120).

[1] = in parenthesis are numbers of observations and within columns, means with the same letter don't differ significantly (P > 0.05).

CHAPTER FIVE

DISCUSSION

5.1 Characteristics of Smallholder Dairy Cattle Management

In this study it was observed that many households keeping dairy cattle were male headed similar to the survey findings reported by Gimbi (2006) in Rungwe district. Results also show that the majority of the respondents were married couples with an average age of 44.9 years. This implies that a great proportion of the respondents were mature (adult) people who have influence on production aspects. This agrees with the views by Lovince (2004) who found that marriage has an effect on the production process as it increases labour availability in the households.

Results show that almost all farmers depended entirely on natural mating, although the majority of them did not have their own bulls. They got bulls from their neighbours who were far away from their farms hence the delay in getting a bull on time, resulting in long calving intervals. The consequence of insufficient number of bulls automatically causes poor reproductive performance. Kasonta and Rushalaza (1993) attributed longer calving intervals to failure of farmers to detect heat and/or to obtain a breeding bull on time.

Many farmers in the study claimed to breed their animals after observing signs of heat but the majority of them mated their animals in less than 12 hours after observing heat signs. According to Luoga (2005), the optimum mating time ranges from 12 to 24 hours after observing heat. This could be the reason why most of the cows did not conceive at the first service thus resulting in too long service period.

Many farmers in Kilolo and Mazombe divisions had problems in detecting heat signs due to involvement in other farm activities hence don’t spend time to observe heat signs and this has resulted in long calving intervals. Pryce *et al*. (2000) contended that oestrus aids and education to livestock attendants on signs of heat is important for increased reproductive efficiency. However both of these are lacking for most Tanzanian farmers. Detection of heat is of great importance in getting cows pregnant at the desired time.

Most smallholder dairy cattle farmers in Kilolo district practiced full grazing, this was so because there were large areas with tree plantations, particularly in Kilolo division where under cropping was not practiced therefore those tree plots were covered with grasses, bearing in mind that, there is no weeding at all for the plots with big trees. Lactating cows in Kilolo were supplemented with concentrates by many farmers but very few of them supplemented concentrates to suckling calves. Supplementation to lactating cows is aimed at getting more milk through provision of concentrates which contained nutrients required for milk synthesis and to stimulate milk let down.

In the current survey, smallholder dairy farmers owned land at an average of 6.66 hectares per household which were higher than 3.2 hectares reported by Gimbi (2006) for smallholder dairy cattle farmers in Rungwe district. A large portion of the land owned by farmers in Kilolo district is used for tree plantation and food crop production compared to the land used for pasture establishment.

On average smallholder dairy farmers in Kilolo district reared 2.93 dairy cattle per household similar to findings reported by Urassa (1999) in Tanga region and falls within the range of two and three heads of cattle per household reported for smallholder dairy farms in Tanzania (Kurwijila and Boki, 2003). The number of dairy cattle reared could partly be a result of land limitations often reported in areas with good potential for dairy cattle production (Mtui, 2004).

Ayrshire crosses were dominant in population over Friesian crosses by 16.05%. Farmers in Kilolo district preferred Ayrshire crosses due to their belief that Ayrshire crosses are more resistant to diseases than Friesian crosses despite of fact that Friesian crosses produced much more milk per lactation than Ayrshire crosses. Lovince (2004) obtained different results in Turiani division and Bukoba district that Friesian crosses were dominant in population over other crosses in her study areas because those were the animals distributed by the projects found in those areas.

5.2 Reproductive Performance Traits

5.2.1 Age at first calving

The overall mean of age at first calving was 1004.4 ± 13.15 days or about 33 months. The genetic factor that influenced the trait was the effect of breed ($P < 0.001$) but breed level was not significant. Similar breed effects on age at first calving were observed and reported by Udo (1993) in crossbreds of central Tanzania. The present AFC is very close to the mean of 34 months reported by Mchau (1991) for southern highlands of Tanzania. It was revealed that Friesians with 50% exotic blood inheritance were significantly older at first calving by 42 days compared with 62.5%

Friesian. Their difference could be caused by the breed level as reported by Msuya (2002) that *Bos indicus* breeds take a longer time to mature than *Bos taurus* breeds. Therefore those animals with high *Bos taurus* blood matured early and hence their age at first calving was slightly low.

The significant differences in age at first calving between divisions might have been due to differences in the management levels and climatic conditions between them, which influenced growth rate and hence age at maturity. The difference in climate between locations was associated with fluctuations of the following: livestock feeds, incidences of diseases and parasites, storage and handling of livestock feeds hence influenced indirectly the age at first calving. The effect of location in this study on age at first calving is similar to the previous study by Msuya (2002). Animals reared under better management usually tend to have lower age at first calving which indicates that, the trait can be improved to a certain extent by better feeding and management. Indeed Gimbi *et al.* (2003) attributed the significant effect of location on age at first calving to feed availability and that under nutrition increases the time taken to reach puberty and hence increase age at first calving.

Year of birth of the heifers had higher significant effect on age at first calving than their season of birth. Similar higher influence of year than of season on age at first calving was reported by Mchau (1991) in crossbred dairy heifers in southern highlands. This was attributed by greater effects of climatic and management changes by farmers between years rather than between seasons.

Season of birth of heifers had a significant effect ($P < 0.05$) on age at first calving. Heifers born during January and April were significantly older at first calving compared to heifers born between September and December. This was caused by forage availability between seasons as those born between September and December received more delicious forages at their early stages of postnatal life as the rain season which starts in December enhances green forages. Heifers born between January and April were affected by next prolonged dry and cold season which started in May to November hence the heifers were growing slowly leading to late puberty and older age at first calving. Also heifers born during early rain and late dry seasons entered breeding activities during the heavy rain and early dry seasons which are better months in terms of quality and quantity of pastures hence they had good chances of showing signs of oestrus and thus conceiving faster than other seasons. In this study, heifers born in the late dry season had the lowest age at first calving (Table 4.13); similar observations were reported by Miranda *et al*. (1982). Such heifers were probably weaned in the rainy season and therefore experienced less post-weaning nutritional stress. It should be noted, however, that heifers born in the early dry season and late rainy season had the highest mean age at first calving. In both cases, such heifers would be expected to be introduced to pastures and/or weaned in the dry season when the availability and quality of pastures is poor.

Similar effects of season on age at first calving (AFC) have been reported by Mwatawala (2006) that heifers born in the light wet season calved for the first time 1.5 months earlier than those born during the early dry season. The significant influence of season was associated with the quality and quantity of forage available to heifers when they were born, which in turn affected their growth performance.

5.2.2 Calving interval

In this study breed and year of calving significantly influenced calving interval. Calving intervals in Friesian crosses were inferior compared to calving intervals in Ayrshire crosses. Therefore Friesian crosses had significantly longer calving intervals by 68 days over Ayrshire crosses. The mean of calving interval of smallholder dairy cattle in Kilolo district is not different from that reported by Lovince (2004) which was 480.4 days.

The long calving intervals observed in Kilolo district could be contributed by inability of farmers to detect heat, early embryonic mortalities and failure to obtain a bull on time when cows were on heat, as most of the smallholder dairy farmers in Kilolo district depended on natural mating and most of them did not have their own bulls. Another reason could be lack of consciousness on the cost of keeping an empty cow and its economical implication is not yet well understood by both farmers and extension officers. Based on the survey done by Donald (1985) in selected districts in Tanzania, farmers were not concerned with long calving intervals and this could be the problem of access to bulls and poor management. Nutritional problems especially low phosphorus level in the natural pastures contributed to the long calving interval in this study.

Parity did not show significant influence on calving interval in this study, although calving intervals decreased as the number of parities increased. The decrease in calving interval with advancement of age indicates that physiological maturity is attained with concomitant increase in production and efficiency in reproduction. It should be noted that first calving heifers often delay to conceive after calving, resulting into longer calving intervals. A longer calving interval in heifers has been reported to be physiologically necessary because heifers at the beginning of lactation have high nutrition demands for growth, milk production and reproduction, hence days open are increased. This would permit them to put on weight prior to next calving (Mwatawala, 2006). Similarly Kifaro (1984, 1995) and Nkala (1992) reported that longer lengths of calving interval in first parity than subsequent ones can be attributed to higher calving stress among heifers compared to older cows. During early lactation, first calvers experience physiological stress. This is associated with more pronounced partitioning of nutrients for milk production, growth and reproduction function in heifers than in older cows. As a result days open get extended hence longer calving intervals after first calving compared to subsequent parities.

Season of calving had non-significant effects ($P > 0.05$) on the calving interval although cows that calved during the rain season had shorter calving intervals. Management practices like providing shelter against extreme weather conditions and feeding practices like supplementing the animals during the dry season could have helped to overcome the season effect. Similar findings have been reported in other studies (Kifaro, 1995; Balikowa, 1997). The significant effect of season of calving could probably be attributed to good feeding regime and management of cows during the breeding season. In other words the animals were not in negative energy balance which could have interfered with their post-partum reproductive cycles, thus resulting in long calving intervals. Nkala (1992) argued that the significant effect of season on calving interval depends more on other factors such as breeding efficiency and policy than on climate or weather conditions. Oyedipe *et al.* (1982), working with White Fulani heifers, found calving intervals of 15.3 and 18 months for the dry and wet seasons, respectively. The authors suggested that the difference was due to the fact that cows calving in the dry season could take advantage of improved nutritional conditions during the subsequent rainy season to meet their total requirements for maintenance, growth and lactation. In addition, a larger proportion of dry-season calves die due to inadequate nutrition. Both factors lead to earlier re-establishment of oestrus in cows that calve in the dry season.

In this study, year of calving had a significant influence on calving interval ($P < 0.001$). Year effects on calving intervals in the tropics have been reported to be indirect due to dynamic climatic changes which are frequently associated with forage availability and changes in management by farmers. Jointly or separately the above components of year effect can influence performance of dairy cattle that are managed under diverse agro-ecological conditions in the tropics. Similar effects by these components of year on calving interval have been reported by Balikowa (1997).

5.3 Lactation Performance Traits

5.3.1 Total lactation yield

The results of this study showed that Friesian crossbred cows were superior over Ayrshire crossbred cows in terms of total lactation yield indicating that Friesian crossbred cows are favoured by environmental conditions than Ayrshire crossbred cows in Kilolo district. Year differences were, however, very significant (see table 4.18). It is also known that Friesians have higher milk production potential than Ayrshires. Year to year changes in management and climatic factors appear to have played a big role in milk production. Similarly Balikowa (1997) reported a significant effect of year of calving on milk yield.

In this study a common characteristic between total lactation yield and lactation length was that, cows with higher total lactation yield, between and within breeds had longer corresponding lactation length. This feature concurs with reported findings by Kifaro (1984) on positive relationship between total lactation yield and lactation length. Total lactation yield is somewhat lower for Friesian and Ayrshire crosses compared to those reported by Udo (1993) in cows with similar exotic blood. The major reason could be the genetic differences between the crosses since Mpwapwa cattle (in Udo’s 1993 study) was an improved zebu while in Kilolo the *Bos indicus* breed was either Boran or Tanzania short horn zebu.

Further evidence in this study have indicated that genotype with 50% *taurus* inheritance in all breed groups had lowest total lactation yield compared to those with 62.5 and 75% exotic inheritance. These findings are in agreement with those reported in the literature by Syrstad (1995). In this study crossbred cows with 62.5% *Bos taurus* blood appeared to be the best milk producers and could therefore be recommended as the genetic group of choice for Kilolo production system.

In the literature Agryemang and Nkhonjera (1986) and Udo (1993) have reported greater effects of year of calving on lactation performance than effects of season of calving. In this study total lactation yield ranged from 1393.8 to 1946.3 litres between 2002 and 2007 while they ranged from 1537.6 and 1765.2 litres across seasons of the year (January-December). A big range of total lactation yield between years of calving (552.5 litres) is an indication that year effects had stronger influence than season (range of 227.6 litres). Year effects were probably associated with availability of forages as a result of the amount of rainfall precipitated in each year.

In this study differences in lactation traits due to effects of season were detected. It can therefore be argued that there were no huge differences in management of dairy cattle between seasons in Kilolo district. In a study by Kifaro (1995) significantly higher milk yields were observed in cows that calved in the late dry season and early rainy season compared to other seasons. An explanation to this was that when these cows reached peak production there were already abundant forages and hence the required nutrients as a result of adequate rain. Calvers in these seasons had higher total lactation yield and most of their lactations coincided with the rainy season (January-April). It can be argued that persistence of lactation can be improved significantly in late dry season calvers and in early wet season calvers. This is because these cows will have the greater parts of their lactations coinciding with wet season and abundant pastures hence availability of most required nutrients.

The mean lactation yield was higher in Mazombe than in Kilolo division. The differences of 254.9 litres could be due to the management systems between divisions within the district, especially in the feeding of concentrates, improved fodder and crop residues. The use of zero grazing sheds could be partly responsible for the significant differences in management systems between divisions that are attributed to the availability of arable land, differences in soil fertility and climatic factors and therefore fodder production potential.

Parity was the most important non-genetic factor influencing TLY. The least squares means show that, total lactation yield increased with increase in parity from parity one to three. Similarly Mwatawala (2006) reported significant effect of parity on the milk yield. Also Mulindwa (2005) reported parity to be one of the major sources of variation in milk yield. In this study the highest extracted lactation milk yield was observed in cows in third parity followed by those in parturition number two and one in that order. The increase in milk yield with increase in parity is due to the fact that mature cows do not need nutrients for growth instead nutrients are used for milk production. Also the udder possesses more secretory cells for synthesis of larger quantities of milk.

5.3.2 Lactation length

The overall mean lactation length was 359 ± 3.61 days. This mean is relatively higher than the average lactation length for *Bos taurus* and cross bred cattle in most parts of the tropics which range between 244 and 324 days (Syrstad, 1995). The higher lactation length was due to long calving intervals in cows in Kilolo district hence cows lactate for a longer period. Balikowa (1997) and Msuya (2002) also reported equally higher mean lactation lengths for cross bred cattle in Tanzania.

Year of calving significantly ($P<0.001$) influenced lactation length (Table 4.14). The highest lactation length was 395.1 ± 12.87 days in 2002 and the lowest lactation length was 309.8 ± 5.76 days in 2006. The trend was decreasing from 2002 to 2006. The decrease in lactation length was caused by improvement of breeding systems and the decrease in calving intervals. Mchau (1991) reported lactation performance traits were indirectly affected by year of calving through variability in climatic conditions, fluctuations in forage resources, disease occurrence and change in management related to feeding and breeding.

The effect of season of calving on lactation length was significant, contrary to report by Agyemang and Nkhonjera (1986) in Malawi which was 405 days for cows that calved between January and May. For cows that calved between June and December they had a mean lactation length of 420 days. The seasonal fluctuations in forage availability and interaction of disease occurrence and socio-economic constraints formed the major proportion of effects on lactation length.

The lactation lengths increased with the increase in parity from parity one, two and parity three. This does not conform to the findings by Kifaro (1995) who observed that lactation number had no significant effect on the duration of lactations.

Breed of cows significantly ($P<0.001$) affected the lactation length. The mean lactation length of Friesian crosses was higher than that of Ayrshire crosses. In this study breed level had significant influence ($P<0.05$) on lactation length. Syrstad (1995) reported significant increase of lactation length with increasing proportion of exotic blood in dairy cattle in the tropics. Lactation lengths of Zebu cattle were normally shorter than those of cross-breds between Zebu and Taurus which ranged from 244 to 324 days. That information suggested that longer lactation lengths were a consequence of higher milk yield.

5.3.3 Dry period

The overall mean dry period was 129.5 ± 5.13 days (Table 4.16). The average dry period reported in this study is similar to that reported by Balikowa (1997) and Mwatawala (2006) who reported an average dry period of 128.8 ± 1.4 days. Msuya (2002) reported a lower mean dry period of 106 days.

The longest dry period among the genetic groups was observed in parity one (135.8 ± 3.93 days). The average dry period in this study was slightly higer than what was reported by Mchau (1991) (100 days) in Mbeya region of Tanzania but similar to the mean dry period of 132 days reported by Agyemang and Nkhonjera (1986) in Malawi. Shekimweri (1982) reported a lower mean (97 days) for the second lactation than the means for the corresponding lactation in this study. The effect of parity on dry period had a significant influence (P<0.05). Kifaro (1995) found the effect of parity to be significant in only three out of five institutional farms in Tanzania.

In the literature Nkala (1992) reported location to have a significant influence (P<0.001) on dry period. Similarly this study has revealed a significant influence (P<0.05) of division on the lengths of dry periods. It can be generalized that differences in dry period lengths of populations with similar genetic constitution in different locations are attributable to effects of management practices especially breeding, feeding and disease control. The length of dry period depends also on milk production potential of cows and length of calving interval. Poor milk producers coupled with long calving interval would have long dry periods. Vargas *et al.* (2000) analysed dry the periods for effects of breed and lactation number. Only parity was a significant source of variation showing a clear trend for dry periods to decrease during the first three lactations.

Season of calving had a significant influence (P<0.001) on the lengths of dry periods. In this study cows that gave birth during early dry season (May-August) had a prolonged dry period compared to those calved during rainy season which was January to April. On the contrary Balikowa (1997) reported season to have no significant influence on length of dry periods.

Differences between years were quite significant (P<0.001). The dry periods were longest in 2003. Year effects were also reported to be significant by Mwatawala

(2006) and Kifaro (1995). Year to year variations in dry period could be attributed more to changes in climatic factors than the changes in management levels. Significant year effects were also reported by Balikowa (1997).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

In this study almost all farmers depended entirely on natural mating, although the majority of them did not have their own bulls. Most smallholder dairy cattle farmers in Kilolo district practiced full grazing and supplemented their lactating cows with concentrates but very few of them supplemented concentrates to suckling calves. Ayrshire crosses were dominant in population over Friesian crosses, despite of the fact that Friesian crosses produced much more milk per lactation than Ayrshire crosses.

The average age at first calving was quite high for all the two genotypes. The average calving intervals (CI) were quite high for both Friesian and Ayrshire crossbred cattle. This meant heavy losses in terms of life-time milk yield and calf crop.

Considering the overall performance of the two genotypes, it is evident that cows in Mazombe division had consistently performed better. They had higher average milk yields, shorter dry periods and shorter calving intervals than those in Kilolo division.

Breed, division, parity, season and year of calving had a significant effect on milk yield and lactation length. Also breed and year of calving affected both age at first calving (AFC) and calving interval (CI). Location (division) and season of calving had no significant influence on calving interval.

6.2 Recommendations

The following recommendations are made in order to reduce the severity/magnitude of the factors influencing the reproduction and production efficiency on dairy farms:

- To increase the number of training courses to farmers in order to equip them with proper package of dairy cattle management skills and training them on appropriate reproductive management practices particularly detection of heat signs.

- Farmers should supplement animals especially during the dry season when forages have low nutritive value. This will avoid weight losses thus ensure early start of oestrus, timely service and consequently reduce calving intervals. Farmers need to conserve feeds during the rain seasons so as to feed their animals during the dry season to counteract the negative effects for low nutritive value of pasture during that season.

- Farmers should be sensitised to keep bulls in groups so as to minimize distance to track cows looking for bulls and this will increase efficiency and timely mating.

REFERENCES

Abdallah, J.M. and McDaniel, B.T. (2000). Genetic change in milk, fat, days open and body weight after calving based on three methods of sire selection. *Journal of Dairy Science* 83 (6): 1359 – 1369.

Aggeb, A.G. and Hillers, J.K. (1991). Effect of crossing local Sudanese cattle with British Friesian on performance traits. Bulletin of Animal Health and Production in Africa 39 (1): 69 – 76.

Agyemang, K. and Nkhonjera, L.P. (1986). Evaluation of the productivity of crossbred dairy cattle on small holder and Government Farms in the Republic of Malawi. ILCA *Research report* No 12. 39 pp.

Balikowa, D. (1997). Reproductive and lactation performance of dairy cattle on smallholder farms in Iringa and Mbeya Regions. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 177 pp.

Bebe, B.O., Udo, H.M.J., Rowlands, G.J. and Thorpe, W. (2003). Smallholder dairy systems in the Kenyan highlands: breed preferences and breeding practices. *Livestock Production Science* 82: 117 – 127.

Biwi, K.M. and Shamhuna, A.J. (1986). Constraints to livestock productivity in Zanzibar. In: *Proceedings of the 12th Scientific Conference of the Tanzania Society of Animal Production* (TSAP) (Edited by Kurwijila, R.L. *et al.*) November 1986, Arusha, Tanzania. 13: 92 - 106.

Borsotti, N.P., Verde, O. and Plasse, D. (1976). Repeatability of calving interval in Brahman cows. *Memoria, Asociacion Latinoamericana de Produccion Animal* 11: 26 (*Animal Breeding Abstracts* 46: 1259).

Boitumelo, W.S. (1993). Peri-urban small-scale dairy research programme in Botswana. In: *Proceedings of Future of livestock industries in East and Southern Africa.* (Edited by Kategile, J. A. and Mubi, S.), 20 – 23 July 1992, Addis Ababa, Ethiopia. 50-58 pp.

Brumby, P.J. (1974). Tropical pasture improvement and livestock production. *Animal Review* 9:13-15.

Crowder, L.V. and Chheda, H.R.(1982). Tropical grassland Husbandry. Longman, London. 229 pp.

Dalah, D. S., Arora K. C. and Rath, S. (1990). Factors affecting herd life production and first lactation traits in crossbred dairy cattle. *International Journal of Tropical Agriculture* 8 (1): 89-92.

Davies, O.C. (1992). The effects of protein and energy and energy content of compound supplements offered at low levels to October-calving dairy cows given grass silage adlibitum. *Animal Production* 55 (2): 169-175.

DED-District Executive Director. (2007). Livestock and Agriculture reports in Kilolo District. Unpublished. 126 pp.

Diggins, V.R. and Bundy, C.E. (1969). Dairy production. Prentice-hall, Inc, Englewood Cliffs, New Jersey. 176 pp.

Donald, R. (1986). Smallholder dairy survey in selected districts in Tanzania. In: *Proceedings of the 12th Conference of the Tanzania Society of Animal Production* (TSAP). (Edited by Mgheni, M.), 24 - 27 September 1985, Arusha, Tanzania. 12: 98 -105.

Duarte, F.A.M., Valle, A., Lobo, R.B. and Bezerra, L.(1983). Phenotypic and genetic study in reproductive and production characters in the Pitanguieras breed. 2. Calving interval. *Agronomia Tropical (Maracay, Venezuela)* 30: 325-334 (*Animal Breeding Abstracts* 53: 1281).

Gimbi, A.A. (2006). Assessment of reproductive performance of smallholder dairy cattle in Rungwe district, Tanzania and possible interventions. Thesis for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 270 pp.

Gimbi, A.A., Kimambo, A.E., Kanuya, N.L., Mtenga, L.A., Laswai, G.H. and Madsen, J. (2003). Seasonal variations on reproductive performance, mineral and body condition status of smallholder dairy cattle in Rungwe district Tanzania. In: *Proceedings of the 30th Scientific Conference* of TSAP. (Edited by Mnembuka, B.V.), 28 - 30 October, 2003, Tanga, Tanzania. 30: 333 – 336.

Guo-li, Z., Qi, Z., Hai-guo, F. and Shan-li, G. (2006). Genetic variation of growth hormone gene and its relationship with milk production traits in Chinese Holstein cows. *Asian-Australasian Journal of Animal Sciences* 19: 315 – 317.

Hayatnegarkar, S. (1991). Factors affecting age at first calving in village crossbreds in India. *Indian Journal of Dairy Science* 35 (12): 213 – 215.

Holness, D.H., Hale, D.H. and Hopley, J.D.H. (1980). Ovarian activity and conception during the post-partum period in Afrikander and Mashona cows. *Theriogenology* 14: 375-381.

Humphreys, L.R. (1987). Tropical Pastures and Fodder crops. Longman Scientific Technical, Singapore. 155 pp.

Kanuya, N.L. and Greve, T. (2000). Effect of parity, season and FSH treatment on the calving interval of Ayrshire cows in the Tropics. *Tropical Animal Health and Production* 32: 197 – 204.

Kanyongo, S.B. (1991). Sustainable fodder production and utilization under small holder dairying in Kenya. In: *Proceedings of 18th Scientific Conference of Tanzania Society of Animal Production* (TSAP). (Edited by Kurwijila, R.L. and Kifaro, G.C.), 24 - 26 September, 1991, Arusha, Tanzania. 18: 132-140.

Kasonta, J. S. and Rushalaza, V. G. (1993). Dual purpose cattle in Central Tanzania. In: *Proceedings of Future of livestock industries in East and Southern Africa.* (Edited by Kategile, J. A. and Mubi, S.), 20 – 23 July 1992, Addis Ababa, Ethiopia. 71-88pp.

Kayunze, K.A., Urasa, J.K. and Mwakalobo, A.B.S. (2001). Food status and income levels among dairy and non-dairy farmers in Chunya District, Tanzania. In: *Proceedings of Tanzania Society of Animal Production (TSAP)* (Edited by Mbaga, S.H. *et al*), 3 - 5 2001, Arusha, Tanzania. 28: 11 - 27.

Kidunda, R.S. (1993). Temporal selection of spatially separated patches by cattle. Thesis for Award of PhD Degree at Colorado State University. 49 pp.

Kifaro, G.C. (1984). Production efficiency of *Bos taurus* cattle in Mbeya Region. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 128 pp.

Kifaro, G.C. (1995). Perfomence of exotic dairy cattle in the Southern Highlands of Tanzania and prospects for genetic improvement. Thesis for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania,. 291 pp.

Kitalyi, A. and Massawe, N.F. (2000). Livestock feeding management systems and impact on environment: The case of the Eastern Africa. In: Proceedings of the 27th *Scientific Conference of the Tanzania Society of Animal Production.* (Edited by Mbaga, S.H. *et al.*), 3 - 5 August, 2000, Dar es Salaam, Tanzania. 27: 105 – 114.

Kristensen, E., Larsen, C.E.S., Kyvsgaard, N.C. Madsen, J. and Henriksen, J. (2004). Livestock production – The twenty first century's food revolution. *Livestock Research for Rural Development.* 16: 1- 3.

Kurwijila, L. R., Minga, U. and Kyomo, M.L. (2002). The challenges of research in improving the livestock productivity in Tanzania. Poverty Eradication and Sustainable Development. In: Proceedings of the 2nd University-Wide-Scientific Conference pp 29 – 63.

Kurwijila, L.R. and Boki, K.J. (2003). A review of the small scale dairy sector- Tanzania. Milk and dairy products, Post-harvest losses and food safety in Sub-Saharan Africa and the near East. *FAO prevention of Food Losses Programme*. 38 pp.

Kusekwa, M.L. and Kidunda, R.S. (1988). Increasing livestock production through better pastures: Potentials and limitations. In: *Proceedings of 15th Scientific Conference of Tanzania Society of Animal Production.* (Edited by Kurwijila, R.L.), 27 - 30 September, 1988, Arusha, Tanzania. 15: 11-29.

Laisser, E.L.K. (1997). Record keeping among smallholder dairy producers in the Southern highlands of Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 135 pp.

Lee, D. H. and Choundhary, V. (2006). A study on milkability traits in Holstein cows. *Asian-Australasian Journal of Animal Sciences* 19:310 – 314.

Liu, Z., Reents, R., Reinhardt, F. and Kuwan, K. (2003). Approaches to estimating daily yield from single milk testing schemes and use of A.M – P.M. Records in test-day model genetic evaluation in dairy cattle. *Journal of Dairy Science* 83: 2676 – 2682.

Lovince, A. (2004). Factors influencing breeding and reproductive efficiency in smallholder dairy cattle in Tanzania: A case study of Turiani division and Bukoba district. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 132 pp.

Luna-Dominguiz, J.E., Enns, R.M. Armstrong, D.V., and Ax, R.L. (2000). Reproductive performance of Holstein cows receiving somatropin. *Journal of Dairy Science* 83 (7): 1439 – 1454.

Luoga, P.W. (2005). Effect of market access on dairy performance and market orientation of smallholder farmers in Rungwe district, Mbeya. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 136 pp.

Massawe, N.F., Owen, E., Mtenga, L.A., Romney, D.L. and Holden, S. (1996). Developing suitable forage utilization to increase milk production on smallholder farms in Tanzania. In: *Proceedings of 23rd Scientific Conference of Tanzania Society of Animal Production.*(Edited by Kurwijila, R.L. *et al.*), 20 - 22 August 1996, Arusha, Tanzania. 23: 23-31.

Massawe, N.F., Owen, E., Mtenga, L.A., Ashley, S.D., Holden, S.J. and Romney, D.L. (1997). Forage feedstuff resources and economic constraints on Crop/Livestock Smallholding producing milk from cows and goats in three locations in Tanzania. In: *Proceedings of 24th Scientific Conference of Tanzania Society of Animal Production*. (Edited by Kurwijila, R.L. *et al.*), 5 - 7 August 1997, Arusha, Tanzania. 24: 115-123.

Mayeres, P., Stool, J., Bormann, J., Reents, R. and Gengler, N. (2004). Prediction of milk, fat, and protein production by a random regression test-day model. *Journal of Dairy Science* 87:1985 – 1993.

McDonald, P., Edwards, R.A. Greenhalgh, J.F.D. and Morgan, C.A. (1990). Animal Nutrition. 5th Ed Longman Scientific and Technical Singapore. 539 pp.

McDowel, R. E.; Ellis, G.L. and Conrad, H.J. (1984). Mineral supplementation for grazing cattle in tropical regions. *World Animal Review* 52: 2-12.

Mchau, K. W. (1991). The impact of upgrading the Tanzania shorthorn Zebu on small holder dairy production in Mbeya region. Thesis for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 199 pp.

Meikle, A., Kulcsar, M., Chilliard, Y., Febel, H., Delavaud, C., Cavestany, D. and Chilibroste, P. (2004). Effects of parity and body condition at parturition on endocrine and reproductive parameters of the cow. *Reproduction* 127: 727 – 737.

Milang'ha, R.C.T. (2002). The effect of supplementing *Moringa oleifera* on perfomernce of dairy cattle. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 67 pp.

Miranda, J.J.F., de Garneiro, G.G., Penna, V.M. and Fonseca C.G. (1982). A study of environmental factors affecting age at first calving of Nellore heifers. *Arquivos da Escola de Veterinaria, Universidade Federal de Minas Gerais* 34: 374-380 (*Animal Breeding Abstracts* 51: 183).

Msanga, Y.N. and Bee, J.K.A. (2003). Comparative performance in growth and lactation of crossbred dairy cattle in the Northern Coast of Tanzania. In: Proceedings of the 30th Scientific Conference of TSAP (Edited by Mnembuka, B.V), 28 - 30 October, 2003, Tanga, Tanzania. 30: 39 – 49.

Msangi, B.S.J. (Ed.) (2006). Prospects for growth and contribution of the Dairy Industry to poverty alleviation in Tanzania. *Proceedings of the 6th National Dairy Development Conference held during the "Milk promotion week"*. Morogoro Tanzania, 2 June, 2006. 128pp.

Msangi, B.S.J., Msanga, Y.N., Brayant, M.J. and Nkya, R. (2001). Performance at pasture and zero grazed crossbred dairy cows in the Sub-humid Coast of Tanzania. In: *Proceedings of the 28th Scientific Conference of the Tanzania Society of Animal Production.* (Edited by Mbaga, S.H. *et al.*), 3 -5 December 2001 Arusha, Tanzania. 28: 148 – 154.

Msangi, B.S.J. and Kavana, P.Y. (2002). Survey and evaluation of grasses and legumes for feeding dairy cattle in Morogoro and Kibaha districts. In Proceedings of the 1st collabolative research workshop on food security (Edited by Batamuzi, E.K. and Tarimo, A.J.P.) 28 – 30 May 2002. TARP II – SUA Project. pp 196 – 200.

Msechu, J.K.K., Syrstad,O. and Mgheni, M. (1995). Contribution of climatic factors to variation in milk yield in Mpwapwa cattle and their crosses. In: *Proceedings of the 22nd Scientific conference of the Tanzania Society of Animal Production*. (Edited by Kurwijila, R.L. and Muhikambele, V.R.), 15 - 17 August 1995, Arusha, Tanzania. 22: 24 – 34.

Msuya, R.S. (2002). Evaluation of dairy cattle performance under smallholder production systems in Kagera region. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 125 pp.

Mtui, D.J. (2004). Available feed resources and seasonal variation under smallholder dairy production in Turian division, Morogoro, Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 111 pp.

Mulindwa, H.E. (2005). Growth, extracted milk yield and reproductive performance of Teso cattle and their crosses with Sahiwal and Boran at Serere, Uganda. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 107 pp.

Mukasa-Mugerwa, E., Ephraim, B. and Taddese, T. (1989). Type and productivity of indigenous cattle in Central Ethiopia. *Tropical Animal Health and Production* 29: 303–308.

Mulangila, R.C.T., Tulingwa, A.P., Salum, M.R., Mwamuhehe, H., Massangya G., and Mleche, W. (2003). A study of current smallholder cattle status in Southern zone: its constraints and opportunities for improvement. In: *Proceedings of the 30th Scientific Conference of TSAP* (Edited by Mnembuka, B.V), 28 - 30 October, 2003, Tanga, Tanzania. 30: 278 -287.

Mwakilembe, P.A.A. (2004). Evaluation of *Leucaena diversifolia* as dry season feed supplement for lactating cattle. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 190 pp.

Mwatawala, H.W. (2006). Evaluation of performance of Kagera region herds of cattle. Thesis for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 207 pp.

Mwatawala, H.W., Kifaro G.C., and Peternsen, P.H. (2003). Phenetypic and genetic parameters for reproduction and lactation traits of Friesian x Boran crosses in Tanzania. In: *Proceedings of the 30th Scientific Conference of TSAP* (Edited by Mnembuka, B.V), 28 - 30 October, 2003, Tanga, Tanzania. 30: 108 - 119.

Nangwala, S.W. (1996). Effect of mastitis on quarter milk yield response to improved feeding. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 123 pp.

Nkala, P. V. (1992). Growth and milk production of dairy cattle in the coastal zone of Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 138pp.

Nodot, P., Olson,T., Koger, M. and Hargove, D. (1981). Reproductive performance of IndoBrazilian cows in Mexico. *Memoria, Asociacion Latinoamericana de Produccion Animal* 16: 145-146 (*Animal Breeding Abstracts* 52: 6520).

Oliveira, F.E.B. (1974). Age at first calving, service period and calving interval in a Nellore herd. Thesis, Universidade Federal de Minas Gerais, Brazil. 80 pp. (*Animal Breeding Abstracts* 43: 5799).

Oyedipe, E.O., Osori, D.I.K., Akerejola, O. and Saror, D.(1982). Effect of level of nutrition on onset of puberty and conception rates of zebu heifers. *Theriogenology* 18: 525 - 539.

Paris, T.R. (2000). Crop-animal systems in Asia: Socio-economic benefits and impacts in rural livelihoods. *Agricultural Systems* 71: 147 – 168.

Payne, W.J.A. (1990). An Introduction to Animal Husbandry in the Tropics. Fourth edition. John Wiley and Sons, Inc., New York. 881 pp.

Peters, A.R. (1984). Reproductive activity of the cow in the postpartum period. 1. Factors affecting the length of the postpartum acyclic period. *British Veterinary Journal* 140: 76-83.

Phiri, E.C.H. (2001). Performance of grazing crossbred cattle supplemented with minerals: Calcium. Phosphorus and Zinc. Dissertation for Award of PhD Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 129 pp.

Pongpiachan, P., Rodtian, P. and Ōta, K. (2003). Effects of tropical climate on reproduction of crossbred and purebred Friesian cattle in Northern Thailand. *Asian-Australasian Journal of Animal Sciences* 16: 954 – 960.

Pryce, J.E., Coffey, M.P. and Brotherstone, S. (2000). The genetic relationship between calving interval, body condition score and linear type and management traits in registered Holsteins. *Journal of Dairy Science* 83 (11): 2666 – 2670.

Rakotoirainy, H.J. (Ed.)(1993). Milk production in Highland of Madagascar with emphasis on the Vakinankaraira Area. *In seminar Proceedings: Dairy development policy and implementation, Harare Zimbabwe*. 12-16 July, 1993. pp. 114 - 127.

Reis, R.B. and Combs, D.K. (2000). Effects of increasing levels of grain supplementation on rumen environment and lactation performance of dairy cows grazing grass-legume pasture. *Journal of Dairy Science* 83: 2888 – 2898.

Sabino, L., Montoni, D., Manrique., U. Batistini, J. and Garcia, E. (1981). Reproductive performance in a herd of Gir and zebu cows in Venezuela. II. Age at first calving. *Memoria, Asociacion Latinoamericana de Produccion Animal* 16: 117 - 123.

Safari, J., Lekule F.P., Sarwatt, S.V., Mollel, E.L and Manki, A.F. (2000). A study of some aspects of dairy management practices of farmers in Morogoro rural district: A case study of SURUDE and HIP beneficiaries in Turiani division. In: *Proceedings of 27th Scientific Conference of Tanzania Society of Animal Production*. (Edited by Mbaga, S.H. *et al.*), 3 - 5 August 2000, Dar es Salaam, Tanzania 27: 20 – 25.

SAS (2000).Statistical Users guide, Statistical Analysis System. 9th edition. SAS Institute Inc. Carry, USA 1024 pp.

Schmidt, G. H. and Van Vleck, P.A. (1974). Principles of dairy science. Arya offset press. Daya Bast Delh. 558 pp.

Shekimweri, T. (1982). A comparative study of dairy cattle crosses in the humid coastal belt of Tanzania. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 80 pp.

Shem, M.N. and Mdoe, N.S.Y. (2002). Dairy production and poverty alleviation in Tanzania: A history perspective. In: *Proceedings of the Joint 17th Scientific Conference of the Tanzania Society of Animal Production and the 20th Scientific Conference of the Tanzania Veterinary Association.* (Edited by Kazwala, R.R. *et al.*) 3 – 5 December 2002, Arusha, Tanzania. 20: 112 – 127pp.

Stephen, J., Sokombi, E. and Bitanyi, S. (2002). Poverty alleviation through smallholder dairying: Experiences of Magabiri Farm Extension Centre, Tanzania. In: *Proceedings of the Joint 17th Scientific Conference of the Tanzania Society of Animal Production and the 20th Scientific Conference of the Tanzania Veterinary Association.* (Edited by Kazwala, R.R. *et al.*) 3 – 5 December 2002, Arusha, Tanzania. 20: 81 – 86.

Sichale, G.M.N. (1996). Formulation of total mixed ration for urban dairy cows in Tanga. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 98 pp.

Syrstad, O. (1995). Dairy cattle cross breeding in the Tropics. *Choice of cross breeding strategy*. Edited by NORAGRIC working papers. Agricultural University of Norway No 5 pp 7.

Teendwa, A.A.P. (2005). Assessment of dairy production in Tanga region: Farmers' awareness and adaptation of the available technologies for improving feed quality. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 168 pp.

Thorpe, W. and Trail, J. C. M. (1990). Evaluation of dairy cattle genotypes for small holder production in Sub-humid Coastal Kenya. In: *International Livestock Centre for Africa (ILCA) annual report* 1989. Addis Ababa, Ethiopia. pp 144 – 145.

Udo, M.G. (1993). Comparative study on growth and lactation performance of different crosses in Mpwapwa cattle herd. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 147 pp.

Urassa, J.K. (1999). A study of the factors influencing milk output of dairy cattle under small holder farms in Tanga Region. Dissertation for Award of MSc Degree at Sokoine University of Agriculture, Morogoro, Tanzania, 131pp.

Valesio, C.R.L. (1983). Reproductive characters in zebu and Brown Swiss cows at four farms in South-eastern Veracruz state. *Veterinaria (Mexico City)* 14: 198 (*Animal Breeding Abstracts* 53: 2100).

Van-Soest, P.J. (1982). Nutrition Ecology of the Ruminant. O and B. Books, Inc. 374 pp.

Vargas, B., Koops, W.J., Herrero, M. and Van-Anendonk, J.A.M. (2000). Modeling of extended lactations of dairy cows. *Journal of Dairy Science* 83 (6): 1374 – 1377.

Walshe, M.J. (Ed.) (1993). Dairy development issues and options (with special reference to sub-Saharan Africa). *In seminar Proceedings*: *Dairy Development policy and Implementation*, *Harare Zimbabwe* 12 - 16 July, 1993. 155 - 171 pp.

APPENDICES

Appendix 1: Questionnaire on dairy cattle management in Kilolo district

1. Farmer’s name……………………., Sex………, Age……., Married/single/ widowed/divorced……………………., Division………………, Ward………………….., Village………………..
2. Total family members…………...., under 10….., 11 – 20 ….., > 20…….
3. Total acreage……, under fodder……, under crops………..
4. List of cash and food crops produced
5. Fertilizer use: manure/commercial fertilizer…………, proportional………., crop fertilized (list)
6. List of animal species kept
7. Herd composition;

Age class	**Male**	**Female**
0 – 6 months		
7 – 12 months		
1–2 years		
> 2 years		

8. Records: Any record on milk/health/feeding/others (If YES list them)
9. Frequency of milking…………, yield/cow/day…………..., sold……………..., home consumption……....................................
10. Breeding: by bull/AI, breed preference …..…………. Reasons………………
    (i). Cost of AI ……………………………………….
    (ii). Who owns the bull……………………………….
    (iii). Distance to the bull………………………………
    (iv). Cost of mating……………………………………

11. Disposals for 2007 and 2008

	BREED	SEX	AGE	DATE	REASON
DEATH					
SLAUGTHER					
SALES					

12. Routine disease control measures ……….

13. (i). Major diseases……………….

 (ii). Who treats your animals………….

14. Feeding systems: zero grazing, partial grazing, and full grazing. List of feeds used

15. Supplementations to calves and lactating cows

Animal group	Supplements	Amount / Animal
Suckling calves		
Weaned calves		
Lactating cows		

16. Age at weaning calves …..…..

17. Labour requirements: milking, family/hired……………., feeding, family/hired………………..., manure removal, family/hired………………

18. Major problems in management of dairy cattle…. ……………….

Appendix 2: Analyses of variance of age at first calving (AFC) and calving interval (CI)

Variable	AFC	CI

Source	df	Ms x 10^4	df	Ms x 10^3
Division	1	18.7**	1	1.5^{NS}
Breed	1	2.4***	1	440.8**
Year	6	5.8**	6	26.7***
Season	2	5.7*	2	6.3^{NS}
Parity	-	-	1	11.1^{NS}
Breed x Year	5	1.9^{NS}	5	16.2**
Division x Breed	1	1.4^{NS}	-	-
Division x Year	5	3.5*	-	-
Residual	244	1.9	397	5.6

NS = Not significant, * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$

Appendix 3: Analyses of variance of age at first calving (AFC) and calving interval (CI) when breed levels were included in the model

Variable		AFC[1]	CI
Source	df	Ms x 10^4	Ms x 10^3
Division	1	15.8**	3.9^{NS}
Breed	1	2.4^{NS}	420.9***
Breed level	5	9.5^{*}	8.5^{NS}
Year	6	28.9*	28.6***
Season	2	13.5*	8.1^{NS}
Parity	1	_	12.5^{NS}
Residual		(240) 1.9	(393) 4.5

NS = Not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001

[1] = in parenthesis are residual degrees of freedom for AFC and CI.

Appendix 4: Analyses of variance of total lactation yield (TLY), lactation length (LL) and dry period (DP)

Variable		TLY	LL	DP
Source	df	Ms x 10^5	Ms x 10^3	Ms x 10^3
Division	1	51***	22.3**	12.1*
Breed	1	12.1*	805.9***	4.5 NS
Parity	2	38.6***	272.5***	6.7*
Season	2	7.3 *	9.2 NS	16.1***
Year	5	25.7***	83.0***	8.4**
Div x Parity	2	6.5 NS	695.6 NS	3.1 NS
Div x Breed	1	6.9 NS	655.9 NS	-
Div x Year	5	7.5*	753.8*	2.5 NS
Parity x Year	5	3.8 NS	387.4 NS	2.5 NS
Season x Year	7	-	-	7.6**
Residual[1]		(648) 3.1	(648) 3.2	(399) 2.4

-

NS = Not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001,

[1] = in parenthesis are residual degrees of freedom for TLY, LL and DP.

Div = division

Appendix 5: Analyses of variance of total lactation yield (TLY), lactation length (LL) and dry period (DP) when breed levels were included in the model

Variable		TLY	LL	DP
Source	df	Ms x 10^5	Ms x 10^3	Ms x 10^3
Division	1	87.7***	1.4*	12.1*
Breed	1	8.8NS	754.3*	4.5NS
Breed level	4	47.8***	8.6*	6.7*

Parity	2	57.8***	249.2*	15.9*
Season	2	10.9*	8.8^{NS}	16.1**
Year	5	15.0***	81.7**	8.4**
Residual1		(644) 2.7	(644) 3.1	(395) 2.4

NS = Not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001,

[1] = in parenthesis are residual degrees of freedom.