ASSESSMENT OF FEEDING PRACTICES AND PERFORMANCE OF DAIRY CATTLE IN KIBAHA DISTRICT, TANZANIA

BY

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ABSTRACT

Two studies were carried out in Kibaha District to investigate feeding practices and performance of dairy cattle kept by smallholder farmers. In experiment 1, formal survey which aimed at assessing the existing feeding practices, performance and constraints, involved 30 dairy farmers from 3 wards. In experiment 2, twenty four (24) lactating cows from two wards, that is 12 cows from each ward, were monitored for one month where intakes and milk yield were measured. In experiment 1; the performance in terms of reproduction and milk yield of cows under both zero and full grazing, was low during wet and dry seasons. Major constraints identified were nutritional related causes by the existing feeding practices. In experiment 2, the overall percentages of crude protein (CP), *in vitro* dry matter digestibility (IVDMD), neutral detergent fibre (NDF), calcium (Ca), Phosphorus (P) and overall means of Metabolizable energy (ME MJ) contents of mixed forages under full grazing were 6.18, 48.01, 73.58, 0.25, 0.16 and 6.88, while those under zero grazing were 6.09, 49.08, 74.2, 0.24, 0.18 and 7.02, respectively. The overall daily nutrient intakes (g/ kg$W^{0.75}$) of zero grazed cows were 120, 7.48, 0.26, 0.21 and 0.86 MJ for DM, CP, Ca, P and ME respectively. The daily milk yield of lactating cows under full grazing and zero grazing systems measured during monitoring experiment were 5.45 and 6.59 l/cow, respectively. Production performance of dairy cattle observed during wet season was suboptimal, probably due to underfeeding attributed by lack of adequate supplementation. It is, therefore proposed to supplement the animals with concentrate that will supply 41.6 MJ, 1012g CP, 38g Ca, and 22g P per cow/ day for optimal milk production.

DECLARATION

I, DARLINGTON DAWSON NKENWA, do hereby declare to the Senate of Sokoine University of Agriculture that, this dissertation is of my own original work and have neither been submitted nor concurrently being submitted for a higher degree award in any other University.

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LIST OF ABBREVIATIONS

%	percent
^{O}C	Degree Celsius
AFC	Age at First Calving
AI	Artificial Insemination
Ca	Calcium
CI	Calving Interval
CP	Crude Protein
CRBD	Completely Randomized Block Design
DM	Dry Matter
DMI	Dry Matter Intake
DOMD	Digestible Organic Matter in Dry Matter
FAO	Food and Agriculture Organization of the United Nations
g	Gram
HPI	Heifer Project International
IVDMD	*In vitro* Dry Matter digestibility
kg	Kilogram
l	Litre
m	metre
ME	Metabolisable Energy
MJ	Mega Joules
N	Nitrogen
NDF	Neutral Detergent Fibre
NGOs	Non Governmental Organizations
P	Phosphorus

pH	Potential Hydrogen
RDP	Rumen Degradable Protein
No.	Number
SE	Standard Error
SUA	Sokoine University of Agriculture
Tshs	Tanzania shillings
WSC	Water Soluble Carbohydrates

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Dairy cattle farming in the smallholder sector in Tanzania is one of the important livestock production enterprises. The sector is predominantly run by smallholder rural farmers who are generally resource poor. They own over 500 000 dairy cattle, producing approximately 2000 liters of milk per lactation per animal, and contributing approximately 25% of the total milk production in Tanzania (MLD, 2006). Farmers under this sector keep pure breed and cross bred cattle. The sector is comprised of three production practices. These include zero grazing, semi-zero grazing and full grazing practices.

Zero grazing practice is also called cut and carry system. It involves total confinement of animals in the barn or shed and feeds are brought to the animal. The system is highly practiced in densely populated areas, where there is shortage of grazing land and relatively sufficient availability of labour (Aminah and Chen, 1989). Semi-zero grazing practice is called semi-intensive sytem where cattle graze on natural pasture for about 6 hours after which they are confined in a barn or shed and supplemented with pasture during the night (Aminah and Chen, 1989). Animals under this practice have wide range of selecting forages of higher quality than those under zero grazing. Full grazing practice also called free range, is mainly practiced by pastoralists who keep local cattle and to a small extent by smallholder dairy farmers. Dairy cattle under this practice graze freely in the rangeland for 9 to 12 hours (Sarwatt and Njau, 1990) and then they are confined into night bomas.

Feeding practices have influence on the performance of dairy cattle in terms of reproductive efficiency and milk yield (Gimbi, 2006). The average milk yield of cows raised in all feeding practices in Tanzania ranges from 5-15 l/day (MLD, 2006) and the mean values of age at first calving (AFC) and calving interval (CI) are 36 and 15-18 months, respectively (MWLD, 2004). However, these figures are low compared to the recommended milk yield of 15 l/cow day (Falvey and Chantalakhana, 1999) and AFC of 24 months and CI of 360 days for a well managed herd (Quigley *et al.*, 1996). Dairy cow production performance is, however, constrained by a number of factors with feeding being the major factor. Feeding practices of most smallholder dairy farmers are based on forage diets with or without concentrate supplementation (Mlay, 2001). In most cases, feed supplied to dairy cattle does not supply sufficient nutrients to meet their requirements for maintenance, production and reproduction (Urassa, 1999). This could be attributed by inadequate quality and quantity of forages fed to these animals, arising from feeding one type of forage and minimal feeding frequencies. Low amount of concentrate supplementation and poor concentrate formulation are other factors contributing to poor performance of these animals (Urassa, 1999).

Appropriate feeding strategies could improve the performance of dairy cattle kept under smallholder sector. Concentrate supplementation to dairy cattle improves the intakes of low quality forages as well as improving milk yield. Bwire and Wiktorsson (2003) reported higher yield of 6.2 kg vs 5.0 kg per day of saleable milk from Mpwapwa breed cows that were fed 6.8 kg/day of hay and supplemented with high level of concentrates (4 kg DM/day) than those supplemented with low level of concentrates (2 kg DM/day).

Mineral deficiencies in tropical forages particulary Calcium (Ca) and Phosphorus (P) contributed to poor performance of dairy cows kept by smallholder farmers in Rungwe district in Tanzania. However, cows supplemented with essential minerals such as Calcium and Phosphorus improved milk yield. Gimbi *et al.* (2004) reported high milk yield of 10.13 l by dairy cows in Rungwe district, due to high P in concentrates supplemented cows compared to 7.63l for the unsupplemented cows.

1.2 Problem Statement and Justification

Smallholder dairy farmers in Kibaha District practice a mixture of zero and full grazing based on the available natural feed resources (Maluila, 2004). The availability of feed resources in Kibaha District varies with seasons. There is enough green forage during rainy season while there is shortage of the same during dry season. However, crop residues, specifically rice straws are abundant in the latter though are of poor quality. Despite the abundance of green forages during rainy season and crop residues (rice straws) during dry season, dairy cattle performance in Kibaha district is still low. The average milk yield was 5l/cow/day (Maluila, 2004). The low performance could probably be due to poor feeding practices, which lead to underfeeding. Therefore, a thorough assessment of feeding practices in Kibaha district could provide an insight on the feeding problems facing dairy cattle production in the area.

1.3 Objectives of the Study

1.3.1 Major objectives

To investigate feeding practices and performance of dairy cattle kept by smallholder farmers in Kibaha district.

1.3.2 Specific Objectives

To assess and monitor the performance of lactating dairy cows in Kibaha district under different feeding practices and propose appropriate feeding strategies through efficient utilization of the available feed resources.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

Feeding practices have great influence on the performance of dairy cattle. High performance of dairy cattle under smallholder sector has not been realized due to several factors, one of them being poor feeding practices. Most of the feeds supplied to dairy cows by smallholder farmers are forage based with or without concentrate supplementation. Generally, animals do not access adequate feeds necessary to meet their nutritional requirements for maintenance, production and reproduction. This results into low milk yield, delayed age at first calving and long calving intervals. This chapter is centered on three main topics. The first topic gives detailed information on how feeding practices influence dairy cattle performance in terms of reproduction and milk yield. It highlights on the influence of zero and full grazing practices on dairy cattle performance. The second topic gives detailed information on various feeding strategies under different feeding practices that could be utilized in order to improve dairy cattle performance. The third topic focuses on nutritive values of forages fed to dairy cattle in terms of chemical composition, digestibility and intake. It illustrates further the relationship between nutritive value of feedstuffs and performance of dairy cattle. These topics are useful for critical analysis of the current status of dairy cattle production and reproduction in the study area.

2.2 Feeding Practices and Performance of Dairy Cattle

A feeding practice which leads to underfeeding of dairy cattle usually results into low performance, which eventually culminates into economic losses to smallholder farmers. This part of review is limited to two main feeding practices namely zero grazing and full grazing (free range). Detailed information on the characteristics of the feeding practices, performance of dairy cattle under these feeding practices, their limitations and improvements are highlighted.

2.2.1 Zero grazing practice

Zero grazing is an intensive milk production practice in which herbage is cut in the field and carried to housed animals. This is commonly practiced by smallholder farmers in the humid highlands and low lands, urban and peri- urban areas, though it is now extending to semi-arid areas of Tanzania (Mlay, 2001). Few animals (1-10 cows per household) are kept due to smallholding and high labour demand with increased number of animals (Mlay, 2001). Zero grazing practice evolved from traditional sector in which farmers were practicing both mixed crop and livestock farming and land was not a limiting factor (Kitalyi and Massawe, 2000). As human population increased, land for grazing was devoted for food crop cultivation, especially in the area of high potential for agriculture (Massawe *et al.,* 1996). As a result, there has been a continuous decrease in grazing lands, which forced smallholder farmers to reduce the number of their livestock and opt to zero grazing practice (Massawe *et al.,* 1996).

Zero grazing practice in Tanzania involves improved grade dairy cattle, mainly crosses between exotic breeds (Fresian and Ayrshire) with either Boran or Zebu cattle (Mlay, 2001). Under good management these improved dairy cattle have a potential of producing 13 to 15 l /cow/day of milk (Falvey and Chantalakhana, 1999) where as local cattle can produce 1-2 l /cow/day. Extensive work has been done to assess performance of dairy cattle under this feeding practice. In Tanzania, Gimbi (2006) reported milk yield of 7.9 l /cow/day in Rungwe district. Urassa (1999) reported average milk yield of 9.3 l/cow/day in Tanga district. Increase in feed intake could improve the milk yield of dairy cow kept by smallholders. Jatinder *et al.* (2003) reported an increase in daily DM intake and milk yields when crossbred cows consumed higher quantity of concentrate mixture, green fodder and wheat straw, during both pre- and post-partum periods, as compared to those in the control group. In Japan, Yoshiaki *et al.* (2006) reported low milk yield of 6.2 l/Cow/day in village one and high milk yield of 8.1 l/cow/day in village two due to variation in CP concentration of feeds, where by village one had lower CP concentration in the diet than village two. Poor supplementation of minerals such as Phosphorus resulted into reduction in appetite, less efficiency in feed utilization and decreased milk production (Phiri, 2001; Gimbi, 2006).

The reproductive performance of cows under zero grazing practice in terms of age at first calving (AFC) and calving interval (CI) differ from one household to another due to managerial factors, such as feeding and heat detection. In Tanzania, Lovince (2004) reported higher AFC (35.1 vs 24) months and long CI (480.4 vs 360) days in zero grazed dairy cows in Bukoba district compared with cows kept under good management (MWLD, 2004). This poor performance was attributed to poor feeding. Similarly, Swai *et al.* (2007) reported long CI of 476±14 days of crossbred cows raised on smallholder farms in Eastern Usambara Mountains, Tanzania. The long CI reported from this study was due to managerial factors such as under nutrition, caused by unskillful feeding, failure or inaccuracy of owners or attendants to detect heat or late reporting. Also, Hiroshi Uchida *et al. (*2002) reported high mean CI of 390 days, respectively of Japanese black cows. This was also due to managerial factors, such as under nutrition and poor heat detection. In Tunisia, Ben Salem (2006) reported long CI of 407 days of Holstein-Fresian cows due to poor feeding management. Other workers (Lucy, 2003; Gimbi, 2006) have reported poor heat detection of dairy cows under zero grazing to be among the factors contributing to poor reproductive performance. This is because confinement and isolation of animals contributed to decrease in oestrus expression resulting in untimely and unsuccessful mating.

Zero grazing practice has been faced by many shortfalls. Farmers practicing zero grazing do not feed their animals during night (Gimbi, 2006). This reduces total DMI hence, leading to poor performance. This is often aggravated by lack of enough labour for collecting feeds and poor supervision leading to underfeeding of the animals (Teendwa, 2005; Okwir, 1998). Furthermore, cows under this feeding practice consume whatever is offered to them, as they have limited chances of feed selection (Msangi *et al.,* 2001). Despite the shortfalls of zero grazing practice, various strategies such as supplementation with concentrates (Mtui, 2004; Mlay *et al.,* 2005) and feeding of legumes (Sarwatt *et al*., 2004; Msangi, 2005) have been reported to improve performance of dairy cattle raised under zero grazing practice. Thus, good performance of cows under zero grazing practice can only be achieved through better feeding and good management.

2.2.2 Full grazing practice

Full grazing is also called free range or extensive system. Animals under this system depend largely on forages found in the communal grazing land and no supplements are offered to them (Olson, 2005). Traditional or continuous grazing, favours production per head during the season of plant growth because of more selective grazing. Animals under this system select nutritious plants and consequently better milk yield and reproductive performance are realized (Msangi *et al.,* 2001). High performance is realized during rainy season, especially under good grazing management. During the dry season, when forages are mature and scarce, chances for selection decrease. Instead, the animals consume what is available, which in most cases does not meet their nutrient requirements. This eventually, results into low milk yield and poor reproductive performance (Msangi *et al*., 2001).

Smallholder farmers practicing full grazing do not take into consideration the stocking rate in relation to amount of forages available and the number of animals (Fike *et al.,* 2003). This is because no body takes care of the improvement of pastures; as a result animals are forced to eat any pastures which mostly are of poor quality (Mestawet *et al*., 2003). Feeding on poor quality pastures has effect on reproductive performance. In Tanzania, Msangi *et al*. (2001) reported long CI of 480 days for pasture grazed cows in subhumid coast of Tanzania due to low nutritive value of grazing pastures. On the other hand, factors such as walking long distance, pasture distribution; sward quality, sward allowance and stocking rate have influence on performance of dairy cattle.

Distance covered by dairy cattle during grazing has influence on their performance. A dairy cow walking a long distance during grazing, spend a lot of energy, which in turn lowers its performance as compared to confined cows (Fike *et al.,* 1997).

Sward distribution has influence on milk yield. Good swards, with grasses and legumes, result into high performance when grazed by dairy cattle. Cows grazed on grass- legume mixture had increased milk yield by 2.5 kg/cow/day than those grazed on grasses only (Ribeiro *et al*., 2004). High stocking rates, have contributed to low milk yield since dairy cows have low chances of selecting nutritious species in the mixed sward to specific part of the plant (Msangi *et al.,* 2001). However, various workers have reported low milk yield due to cows grazing on low quality swards which leads into low nutrient intake by dairy cows during grazing in the range land. The study done in Morogoro by Sarwatt and Njau (1990) reported milk yield of 6.6 l/d for cows under full grazing. Also Urassa (1999) reported milk yield of 7.3 l/day of cows under full grazing in Tanga district. The reported low milk yield was contributed by underfeeding where cows were grazed on low quality and inadequate forages. Lack of supplementation to grazing dairy cows has been reported to contribute to low milk yield. Fike *et al.* (2003) reported milk yield of 17.3 kg/day for cows grazed on Bermuda grass and supplemented with concentrates than the cows grazed on rhizome peanuts (15.0 kg/day). Jakob *et al.* (2003) reported higher milk yield of 17.0 kg/day of supplemented grazed cow as compared to 12.1 kg/day of unsupplemented grazing cows. Thus, good feeding practice can improve milk yield to grazed dairy cows.

2.3 Feeding Practices under Smallholder Dairy Farmers in Kibaha District

Dairy cattle production in Kibaha district is under zero grazing and full grazing practices (Maluila, 2004). Dairy cattle under these practices depend on natural pasture as their main basal diet. However, pasture availability depends on seasons. There are adequate pastures during the wet season and less during the dry season.

Maluila (2004) reported the main sources of feed especially during dry season to be natural pastures and crop residues. These feeds are of poor quality and quantity which do not meet the daily nutrients requirements for maintenance and production. Feeding crop residues is one of the feeding practices done by smallholder dairy farmers in Kibaha District, especially during the dry season. However, the extent of use of these crop residues varies from one ward to another and is largely influenced by distance between homesteads where animals are kept and the fields where crops are cultivated. Maize stover and rice straws are the main sources of crop residues available during the dry season (Maluila, 2004).

Most farmers do not supplement their cows with concentrates due to perceived high cost. In most cases smallholder dairy farmers supplement maize bran singly. Concentrate supplementation could improve milk yield of 5 l/cow/day in the study area (Maluila, 2004). Therefore, a thorough assessment of existing feeding practices could provide insight on the problems hindering productivity of dairy cattle in Kibaha district.

2.4 Feeding Strategies for Dairy Cattle

Smallholder dairy farmers in Tanzania practice mainly zero grazing and full grazing (Urassa, 1999). In both feeding practices, there is low performance of the dairy cattle. However, feeding strategies can be employed to improve performance of dairy cattle under smallholder farmers. Alot of work has been done to improve milk yield. Few studies have been reported on the improvement of reproductive parameters, such as AFC and CI of dairy cattle. This could probably be due to long time requirement to improve those traits of dairy cattle. Strategies for improving milk yield by dairy cattle can be viewed in two categories; strategies employed by farmers practicing zero grazing and strategies employed by farmers practicing full grazing.

2.4.1 Feeding Strategies for Zero Grazed Cows

One of the problems hampering animal production in the tropics is the seasonal unavailability of roughage. During the dry season, smallholder dairy farmers increasingly face difficulties in finding sufficient feed for the animals, not only for maintainance but also for survival (Falvey and Chantalakhana, 1999). The deficit of feeds during the dry season has also resulted into low milk yield. However, strategies such as use of crop residues, treatment of low quality forages, use of supplements, forage conservation and use of multipurpose trees has been widely used to improve milk production from smallholder farmers.

Crop residues are important sources of feed during the dry season. Crop residues are fibrous remains from crop harvest whose quality is highly variable depending on the species, growing conditions and post-harvest processing or treatment (Tesfaye and Chairatanayuth, 2007). Most crop residues are deficient in protein, energy, vitamins and minerals. In order to be used as dry season feeds, their quality should be improved. Feeding practice and physical treatment, chemical and biological treatment and supplementation are important for maximum crop residue utilization.

Feeding practice and physical processing is one of the ways used to improve utilization of crop residues (Mlay, 2001). The more the feed is consumed, the more nutrients will be available to the microbes and the host animal. One way of stimulating intakes is to offer large amounts of feeds so as to allow animals to select the best nutritious parts of the feed. Chopping and grinding reduce particle size and improve ingestibility and mastication (Osafo *et al.*, 1997) as well as the overall intakes of stover by 60-80% (Chenost and Kayouli, 1997). However, chopping or grinding reduce the chances for selection and therefore lower the quality of the overall feed consumed. Feeding small amounts of green forage with poor quality forage improves the utilization of the poor quality forage as the green forage acts as rapid bacterial growth media and protein source that seeds the rest of the digesta (Leng, 1990).

Chemical treatment has a great influence on the improvement of utilization of crop residues. Treatment with alkali has been reported to have high potential of increasing digestibility and intakes of crop residues in ruminants (Jackson, 1977). Urea treatment is the most practical significance in the tropics, acting both as an alkali and a source of supplementary nitrogen (N) to materials which are low in crude protein (Kimambo *et al*., 2002). The nutritive value of cereal residues can therefore be improved through urea treatment. Mtamakaya (2002) reported an increase in CP from 6.0 to 7.0% and decrease of NDF from 60.96 to 56.97 % in urea treated rice straws. Urea treatment causes partial solubilization of lignin and hemicellulose fractions, with resultant increase in digestibility. The study by Wanapat *et al.* (2000) reported that combination of urea-treated rice straw and whole sugar cane crop as roughage sources for dairy cattle during the dry season improved the feeding values of these forages and increased dry matter intake (7.6 kg/day) and milk yield (4.47 l/day) of lactating cows in Thailand. In Tanzania, Kimambo *et al.* (2002) reported an increase of ME intakes from 54.92 to 60.78 MJ/day and DOM intakes from 2.34 to 2.53 kg from urea treated rice straws fed to steers. In Zimbabwe lactating dairy cows fed urea treated maize stover yielded higher milk (10.1 kg/ day) than those fed untreated maize stover (9.5 kg) (Masimbiti, 2001). In Ethiopia, Mesfin (2001) reported that feeding urea treated straws increased milk production by 0.5 to 2 l/day and improved body condition of crossbred dairy cows. Urea treatment is relatively easy to apply. However, its uptake by smallholder farmers has been slow due to high cost of urea (Mtamakaya, 2002). Feeding of ammoniated rice straws to dairy heifers in China improved DMI to 7.45 kg/day as compared to DMI of 6.58 kg/day of untreated rice straws. Also, feeding dairy heifers ammoniated rice straws increased body weight gain from 324 g/day to 613 g/day (Meng *et al.,* 2007).

Sodium hydroxide (NaOH) is among the common alkalis used to treat straws (Homb *et al*., 1976). It has high potential of improving the nutritive value of straws. The work done by

Kimambo *et al. (*2002) showed an improvement in dry matter digestibility by 64.6%, 33.9%, 63.5% and 59% for maize stem, leaf sheath, ear bract and rice straw, respectively. In addition, Jackson (1977) reported significant increase in daily milk production from 17.6 kg to 19 kg per day following treatment of barley straw with sodium hydroxide. However, the use of NaOH for treating straws is harzardous and not economically feasible in developing countries due to high cost incurred in buying the chemical. Environmental pollution also inhibit the use of the chemicals.

Magadi (Sodium carbonate) is another alkali used to improve quality of roughages. The study by Mlay (2001) showed an improvement of NDF digestibility and increase in microbial protein synthesis in hay treated with magadi compared to hay supplemented with maize bran alone. However, its utilization is still low due to bulkness and is only available in some parts of Tanzania such as Kilimanjaro and Arusha regions.

Wood ash is also one of the chemicals that can be used for treatment of rice straws and stover. It is cheaply available and produced locally in different households where fire woods and charcoal are used for cooking (Nkenwa, 2001). Treatment of straws and stover using wood ash have been reported to increase rumen dry matter and organic matter digestibility and decreased NDF of rice straws (Nkenwa, 2001; Mtamakaya, 2002; Kimambo *et al.,* 2002; Kimario, 2003). This is due to decrease of bond between lignin, cellulose and hemicellulose, which eventually makes them susceptible to microbial attack in the rumen.

Forage conservation is another strategy that can be used for improving dairy cattle productivity by smallholder farmers. Forage and by-products are usually consumed fresh by domestic animals. However, it is possible to conserve them for use during future periods of feed shortages. These feeds could be conserved in form of hay and silage (Sarwatt, 1995). Conservation can be achieved by sun drying (hay) and fermentation (silage) (Mannetje, 2000). Hay is a feed resulting from dehydration of green forage to allow moisture content of about 15-20%. Hay can be stored and fed to livestock during times of scarcity and periods of lush pasture to provide energy. It is a cheap method of conservation by small scale farmers since it requires simple equipment (Muyekho, 1999). Good quality hay can be made from grass, fodder crops and grasses mixed with forage legumes. Grasses used for hay making should be cut just before flowering when they contain optimum dry matter (DM) and crude protein (CP). Grass harvested before flowering is usually of high quality having CP content ranging from 9-12 % (Muyekho, 1999). Quality of hay may be improved through mixing grasses with legumes. Factors such as curing and storage can affect the quality of hay. Curing starts in the field after cutting and leaving the material to wilt. The materials wilted under the sun shine for 2-3 days with moisture content of 15-20 % usually produce good quality hay. Appropriate storage of hay in sheds like hay barn with a good air circulation reduces wastage of hay and hence maintains its quality. However, hay making is difficult to smallholder dairy farmers because at the time when forage is of acceptable quality for conservation (early in the wet season), weather is likely to be too unreliable for sun drying (Mannetje, 2000).

Silage is a forage or agricultural and industrial-by products preserved by acid, either added or produced by natural fermentation. Silage making has several advantages as compared to hay making. It is less dependent on weather conditions; it offers one option to secure feeds during season of high production for conservation and storage, for later use in the periods of relatively shortage. Silage can be kept for months or even years and can be used at any time and when required, especially during periods of drought. Fodder crops such as maize and sorghum have been used extensively for making excellent silage (Sarwatt *et al.*, 2001) due to high dry matter (DM) content and water soluble carbohydrates (WSC) available for fermentation. Silage making has been reported to be of high economic importance to dairy farmers of North Pakistan. These milk producers made little bags of silage from green paddy straw, and found their traditional buffalo could eat one bag of silage a day in addition to their normal ration of straw and bran. As a result, milk yield increased by fifty percent, from 2 to 3 litres per day (Muyekho, 1999).

Supplementation is also a good feeding strategy for improving reproductive and productive performance of dairy cattle. Supplementation with 0.8 kg/cow/day of concentrate comprising of maize bran (70%), cotton seed cake (28%) and minerals (2%) during dry season improved milk yield by 34% and reduced postpartum anoestrus period from 86.3±6.6 to 71.2±5.3 days and calving to conception from 102.4±5.1 to 80.4±4.7 days (Nkya and Swai,1999). Dry season supplementation with urea molasses mineral blocks for 49 days, to on-station cows receiving *ad libitum* grass hay and 6 kg/day of maize bran, increased milk production from 6.7 to 11.2 l/day and DMI from 10.1 kg/day to 12.0 kg/day while supplementation with molasses urea mix increased daily milk yield from 6.7 to 8.8 l/day in Morogoro (Nkya *et al.,* 1999). On-farm supplementation with urea molasses mineral blocks for 53 days increased milk yield by 1.7 l/day in dry season (Nkya *et al*., 1999). Concentrate supplementation improve intakes of low quality forage as well as milk yield of dairy cows. Bwire and Wiktorsson (2003), reported higher saleable milk of 6.2 kg per day from Mpwapwa breed cows fed 6.8 kg/day of hay and supplemented with high level of concentrates (4 kg DM/day) compared with 5.0 kg from those supplemented with low level of concentrates (2 kg DM/day). Bwire (2002) reported more milk yield of 5.3

kg/cow/day from dual- purpose cattle when fed two grass species and supplemented with 3.1 kg DM of concentrate per day compared to milk yield of 4.8 kg/cow/day of cows fed combinations of forage species. Supplementation of cows with 4 kg of concentrates per cow per day (68% maize bran, 31% sunflower meal and 1% super Macklic ®) showed average improvement in live body weight (52 kg), body condition score and milk yield (1.5 l/cow/day) during 12 weeks of treatment in peri-urban and urban areas of Morogoro (Mlay *et al.*, 2005).

The use of multipurpose trees has been reported to improve dairy cattle performance. The study by Kakengi *et al.* (1999) found that 2.6 kg DM of Leucaena leaf meal (LLM) can substitute 1.8 kg DM of cotton seed cake (CSC) without affecting cattle performance. Cows supplemented with LLM gained more weight and had higher milk yield than those under control (supplemented with CSC and maize bran only at a rate of 1.8 kg/DM). *Moringa oleifera* was used to replace conventional protein source such as sunflower seed cake by 50 % and obtained high dry matter intake and metabolisable energy intakes (Sarwatt *et al*., 2000). In another study, Sarwatt *et al*. (2004) reported an increase in milk yield from 7.8 to 9.2 kg/day for cross bred cows when cotton seed cake was substituted with *Moringa oleifera* in Napier grass (*Pennisetum purpureum*) based diet.

Supplementation of essential minerals, such as calcium and phosphorus has influence on milk yield. Gimbi *et al*. (2004) reported high milk yield of 10.13 1/cow/d, due to high P concentration from animals supplemented with concentrates than unsupplemented ones (7.63 l/cow/d).

2.4.2 Feeding strategies for full grazed cows

Feeding strategies employed by farmers practicing full grazing include; grazing on crop residues, rotational grazing and supplementation. Range management, such as stocking rates and oversowing, can improve dairy cattle performance (Mestawet *et al.*, 2003; Fike *et al.,* 2003). Heavy stocking rates have resulted into deterioration of forages in terms of quality and quantity, leading to low performance of dairy cattle (Fike *et al.*, 2003; Olson, 2005). Grazing on appropriate stocking rates can increase cow's ability to select forages and the more nutritious parts of the forage, resulting in increased dairy cattle performance (Fike *et al*., 2003). Smallholder farmers that graze dairy cattle in rangeland composed of poor forages usually experience low performance by their animals (Mestawet *et al.,* 2003). Oversown pastures with legume species improve the botanical composition as well as nutritive values of forages than that of grass species alone (Mestawet *et al.,* 2003). An animal grazing on oversown pastures usually perform better than that under grasses alone (Fike *et al*., 2003). Including legume in the grass swards generally increases nutrient intake and performance of grazing cattle. Ribeiro *et al. (*2003) reported higher herbage allowance and herbage intakes of grazing dairy cows ranging from 1.6-2.0 kg DM on mixed than on pure grass swards.Variation on sward type or herbage allowance in grazing cows increased average milk yield by 11g per kg DM intake (Ribeiro *et al*., 2004).

Feeding of crop residues to grazing dairy cattle is another feeding strategy used by smallholder farmers to improve dairy cattle performance during dry season (Ocen, 1992). However, most common crop residues (ie straws and stuble) have low crude protein content in the range 2-5% on DM basis. They are generally low in fermentable energy as reflected by their relatively low organic matter digestibility and also the limited availability of minerals (Meng *et al.,* 2007). Crop residues can be piled around the homestead and fed to dairy cattle either in the morning before grazing or during evening after grazing. On the other hand, crop residues can be grazed directly in the field (Ocen, 1992).

In Ethiopia, cows grazed on natural pasture are supplemented with crop residues so that they can obtain enough nutrients for supporting production. Crop residues supplementation increased milk yield from 1.3 to 3.4 litres per day for cows grazing natural pastures in Ethiopia (Yilma, 1999). Since crop residues are of poor quality, improvement of their nutritional value will increase its utilization and hence increase dairy cattle performance. Increasing offer rates of crop residues (excess feeding) to promote selective feeding to grazing animals have shown to be an effective strategy of improving utilization of crop residues (Methu *et al.,* 2001). Provision of *ad libitum* amount of maize stover offered to grazing dairy cattle in Central Kenya High lands, allowed selectivity by cows and increased milk yield from 10 to 12.2 kg/cow/day (Methu *et al.,* 2001).

Intensive rotational grazing is another strategy which can be used for improving dairy cattle performance. It is characterized by frequent movement or rotation of milking herd among pasture units or paddocks (Weigel *et al.,* 1999). It extends to benefits in maximizing the pasture growth rates over the farm and maximising the intake of animals when the pasture growth rates are less than the potential intake rates (Woodward *et al*., 1994).

Animals on full grazing, normally feed on low quality forages especially during dry season, resulting in low performance. Supplementing low quality forages with concentrates could be one of the strategies to improve performance of grazed dairy cattle. Increased supplementation rate had a greater positive impact on reproductive performance and milk yield of grazing cows. Jakob *et al. (*2003) reported low calving interval (CI) of 370±14 days of dairy cows supplemented with concentrates in Denmark as compared to unsupplemented ones (415±14 days). Increased amount of supplementation (0.8kg of supplement) had a greater positive impact on milk production of cows grazing Bermuda grass compared to rhizome peanut (21.9 vs.10.6% increase) due to lower substitution of grain for forage intake (Fike *et al.*, 2003). The positive response (11.3 %) in milk production to additional supplement when cows grazed bermudagrass indicate the value of providing substantial amounts of supplement to cows grazing this moderate quality forage and stand in contrast to the limited production response to supplement when cows grazed rhizome peanut (Fike *et al.,* 2003). Thus, good feeding strategy such as supplementing cows grazing on low quality forages with concentrates can be a useful tool for improving dairy cattle performance in Kibaha District.

2.5 Nutritive Value of Tropical Forages

Nutritive value of tropical forage refers to its chemical composition, digestibility and nature of digested products. However, the amount of forage consumed by the animal is very important, as it affects total nutrient intake and therefore the animal performance (Crowder and Chheda, 1982).

2.5.1 Chemical composition of tropical forages

Dairy cattle farming under smallholder sector in the tropics depends largely on forages found in the range land as their basal diet. However, their chemical composition in terms of crude protein (CP), minerals and cell wall content (NDF), vary from one species to another (McDonald *et al.,* 2002). Forages are variable in protein content, depending on forage type. Legumes may contain 15 to 23 % CP, whereas grasses typically contain 8 to

18 % CP. Crop residues such as straws may have 2 to 6 % CP (Doto *et al*., 2004). These forages contain high fibre and low energy (Doto *et al*., 2004). Usually forages contain more than 30 % NDF (McDonald *et al.*, 2002). In general the higher the fibre the lower the energy content of the forage. Generally forages contain Ca content ranging from 0.3-0.6 % and P content ranging from 0.1-0.3 % (Phiri, 2001; Doto *et al*., 2004 and Gimbi, 2006). Chemical composition of forages is influenced by factors such as stage of growth of forage, seasonal variation, plant species, sampling and processing.

At early stages of growth, forages contain high nutrient content including energy, protein and minerals and low cell wall contents (McDonald *et al.*, 2002). Nutrient contents of forages decrease with advancing maturity due to the decreased proportion of leaves and the corresponding decrease in protein (McDonald *et al.,* 2002). In addition, there is increased proportion of stem leading to high fibre and hence increased lignification and reduced energy value.

Chemical composition of forage varies with seasons, particulary in the tropics (Crowder and Chheda, 1982). During wet season, two months after the onset of the rainy season, the CP content of forage grass is well above 7 %. As grasses advance in maturity, CP contents drops to values of 4 to 6 % after 3 to 5 months, while NDF increases. During the dry season, CP content often drops below 4% (Crowder and Chheda, 1982). Temi (1999) reported protein contents of forages (grasses) to be 8.4 % and 6.2 % CP during wet and dry seasons respectively. The study by Mtui (2004) and Temi (1999) in Turiani ward reported an increase in CP and ash content of both grasses and legumes during wet season and a decline in the dry season. In contrast, CF increased during dry season.

Oversown natural pasture with legume forages can improve the nutritive values of the pastures. The study by Mwita (2003) in Bukoba district showed higher CP contents of 11.28 %, 9.6 %, 9.43 %, and 9.3 % in natural pastures oversown with C. *pubescens*, C. *ternatea*, P. *phaseoloides*, M. *atropurpureum* and D. *intortum* respectively compared to 4.62 % CP of natural pastures which were not oversown. In Uganda, Kabirizi *et al*. (2003) reported higher overall mean CP content of 10.0±0.15 % in grown elephant grass mixed with legumes than elephant grass alone (7.4±0.01 %). Other workers (Aregheore, 2002; Lemma and Smit, 2004) reported factors such as plant age, grazing pressure, and toxic substances to cause variation in nutritive value of forages.

In many traditional grazing practices, animals are kept on the same area of pasture throughout the year (continuous grazing). In such systems the ideal stocking rate is one that maintains a perfect balance between growth of new herbage and harvesting by animals (Givens *et al*., 2002). If the rate of growth exceeds the rate of harvesting, herbage accumulates and matures, and thus reducing the nutritive value of forages. Selective grazing compensates to some extent for general fall in nutritive value by selecting plant parts that are higher in nutritive value than the rest (McDonald *et al.,* 2002). If the rate of harvesting exceeds the rate of growth of the pasture, the grazing pressure on the sward increases. Under high grazing pressure, selection by animals is reduced and the forage plants may be denuded of foliage that their root reserves are depleted and they fail to regrow (McDonald *et al*., 2002). Over-grazing of pasture may change botanical composition and therefore the nutrive value of herbage (Givens *et al*., 2002).

Knowledge on chemical composition of the feed alone is of little interest unless the intake and digestibility by the animals and expected response are also known (Mlay, 2001).

Intake and digestibility are good indicators of the quality of the forage and have great influence on dairy cattle performance (McDonald *et al.,* 2002).

2.5.2 Feed intake

The diet consumed by animals is a source of energy, protein, minerals and vitamins that are required for the metabolic functions of the animal (McDonald *et al.,* 2002). Daily dry matter intakes (DMI) have strong implication on animal productive and reproductive functions. In fact, DMI of a given feed has stronger impact on animal performance than digestibility of a diet (Forbes, 1995). Maximum DMI is even more necessary for ruminants maintained on high roughage diets, whose energy density is low and filling capacity is high. In general the amount of forage consumed is related to the body weight of the animal. Under average condition cows consume approximately 3% of their body weight (Schmidt, 1973). Feed intake in ruminants fed on high roughages is most of the time limited by the rumen capacity, due to their bulky nature of the material consumed. In order to consume more feed, fill of the feed already in the rumen must be reduced by particle breakdown and digestive process which facilitate passage out of the rumen (Van Soest, 1994; Allen, 1996). Therefore maintaining dairy animals solely on roughages should be discouraged because animals can not consume enough to meet the maintenance, production and reproduction requirements.

Feed intake can be influenced by factors related to feed, animal and environment. Factors that influence and therefore play role in the regulation of feed intake in ruminants have been extensively studied (Poppi *et al*., 2000). However, this review is limited to feed related factors that influence the intake of poor quality roughages that are the basal feed for ruminants in the tropics for a big part of the year.

Performance of animals in terms of production and reproduction depends on the amount of feeds consumed (Dulphy and Van os, 1996; Givens *et al*., 2002). However, factors such as energy density of diet and the extent of digestibility, types of feeds, availability of water, feed processing, chemical composition of feeds, botanical compositions, chemical treatment, sward structure and time spent on grazing affect the total daily feed intake of animals.

Animals can only use the energy in the feed efficiently if there is enough protein, minerals and vitamin. If CP content becomes less than 7% DM, then the intake of feed will be less than the potential intake when fed to animals (Doto *et al.,* 2004). Poorly digestible feeds may not only cause greater rumen fill due to their longer stay in the rumen, but also may fail to provide the necessary nutrients for the rumen microbes and host animal.

Types of feeds have influence on intakes by animals (McDonald *et al*., 2002). Manninen *et al.* (2005) reported variation on DM intakes of 9.2, 10.5 and 10.3 kg and ME intakes of 102, 109 and 97 MJ ME/day in grass silage, whole-crop barley silage and whole crop oat silage, respectively fed to suckler Hereford cows. However, large differences existed in the composition and feeding value of whole crop cereal silages mainly due to differences in proportion of grain and straw between crops. Including silage in the diet can improve the intake as well as the nutritive value of the diet. Browne *et al*. (2004) reported that inclusion of maize silage in diet fed to Holstein steers had positive linear effect on forage and total DM intake and apparent dry matter and organic matter digestibility.

The availability of water can affect feed intake. When water is deprived, intake falls due to slowed digestion and movement of materials from the rumen. Also the intra-ruminal conditions become abnormal (pH falls and ionic concentration rises) when normal supply of water is not provided. However, the water content of feed is negatively correlated to intake due to the water contributing to the fill volume (Forbes, 1995).

Reduction in particle size of forage has been associated with increased DMI. An increased intake, make more DM or nutrients to be availed to rumen flora and fauna and subsequently the animal. Schroeder *et al.* (2003) fed short, medium and long particle size to Holstein cows and reported higher DMI to cows fed medium particle size than the cows fed short and long particle size. In contrast, too much reduction in particle size decreases intake, since feeds become dusty hence less preferred (McDonald *et al*., 2002).

The CP content of a feed is positively correlated to intake while cell wall contents (NDF) are negatively correlated to intake (Mgheni, 2000). The critical level of NDF in grass based diet is 75%. Higher concentrations above this level reduce intake and animal productivity (Bwire and Wiktorson, 2003). Poor quality roughages fed to animals during the dry season are high in NDF and lignin and low in protein contents. These leads to slow digestion of forage and require more resident time in the rumen that limits further intakes (Reed *et al*., 2000). Within certain limits, an increase in digestibility leads to an increase in feed intake to a level that metabolic control starts to cause a fall in intake at higher digestibility (Dado and Allen, 1995). With poor to medium quality forages, energy availability is directly related to DMI but with high quality forages, energy density above 10 KJ/g is inversely related to DMI (Waldo, 1986).

Including legume in the grass swards generally increased nutrient intake and performance of grazing cattle (Ribeiro *et al.*, 2003). Variation on sward type or herbage allowance in grazing cows increased average milk yield by 11g per kg DM intake (Ribeiro Filho *et al.*, 2004).

Chemical treatment improves the intake of crop residues. The study by Mtamakaya (2002), showed an increase of ME intakes from 54.92 to 60.78 MJ/day and DOM intakes from 2.34 to 2.53 kg from urea treated rice straws fed to steers.

In grazing animals, the structure of the sward can restrict intake not only in terms of the space taken up in the gut, but also by limiting the amount of herbage which the animal can actually harvest within a 24h period (Givens *et al*., 2002). Characteristics of the grazed sward, such as plant density and height can influence intake through their effect on ease of apprehension and thus bite size, which has been shown to be a major factor influencing daily herbage intake (Hodgson *et al*., 1991). Cushnahan *et al. (*1998) cited by Givens *et al*. (2002) conducted a study on lactating cows fasted for 5h to enable measurement of potential intake and observed that pre-grazing sward height was the major factor influencing bite depth and bite volume, but bulk density determined the weight of herbage per bite.

Time spent on grazing has influence on feed intake. Where sward structure limits bite mass and therefore intake rate, grazing time can be altered to compensate for decreased bite size (Weston 1996). However, there appears to be an upper limit to the amount of time a ruminant can spend grazing. Weston (1996) observed grazing times of 13 and 15h for sheep and cattle, whereas, Forbes (1995) suggests that ruminants are unwilling to eat for more than 12 h per day. Therefore, if a bite size fall below a certain limit, animals will not be able to achieve maximum intake capacity. This occurs as a result of the upper limit to oral processing time, which encompases prehension, mastication and rumination (Illius, 1998). It can conclusively be stated that, assessment of existing feeding practice and how it affects feed intake by animals offer good base for developing appropriate feeding strategies, which can help to improve dairy cattle performance in Tanzania.

2.5.3 Digestibility of forage

Digestibility is an important measure of the nutritive value of forages and can be defined as the difference in value between the feed consumed and the materials voided by animals and which is assumed to be absorbed by the animal (McDonald *et al.,* 2002). The difference is expressed as percentage of the feed consumed. However, digestibility is affected by many factors, such as stage of growth of forage, climate, chemical composition and plant fraction.

Stage of growth has influence on the digestibility of forages. Forages are highly digestible at young and immature stages. At this stage of growth, *in vitro* digestibility values range from 75 to 85% (McDonald *et al*., 2002). Digestibility declines with advanced maturity. As forages mature digestibility decline up to 0.1 to 0.2 % daily (Van soest, 1994). The decline in digestibility is not only because of change in chemical composition but also because of decline of digestibility of chemical component (Crowder and Chheda, 1982).

Climatic variation, particularly temperature changes during growing season, can cause differences in the digestibility of forages. Tropical forages have lower digestibility as compared to temperate forages (Van soest, 1994). Dry matter digestibility of tropical forages was reported to range from 30 to 75 % by Doto *et al.* (2004). This was attributed mainly to high temperature which resulted into increased lignification of plant cell wall (Van soest, 1994).

Crude protein content in forages can have a significant effect on digestibility. When it exceeds 7 % in the herbage, digestibility does not appear to be affected but when it is less than 7 % digestibility declines and this depresses microbial activities in the rumen due to lack of nitrogen (Doto *et al.,* 2004). This causes incomplete utilization of structural carbohydrates in the ingested forages and a slow rate of passage of digesta. Therefore, forage digestibility and voluntary intake are significantly reduced (Crowder and Chheda, 1982).

Forage mineral contents have influence on the digestibility of forages. Digestibility is adversely affected when mineral contents of plants drop below the level required for animal growth (Fonseca *et al.,* 1998). Thornton and Minson (1973b) cited by Mwita (2003) reported that DM digestibility of Pangola grass- legume pasture fed to sheep increased from 41.6 % to 44.9 % when P concentration increased from 0.11 to 0.15 percent. Also Rees and Minson (1979) cited by Mwita (2003) showed that DM digestibility of pen-fed sheep increased by 1.2 % when Ca concentration of forage was increased from 0.22 to 0.38 %.

Digestibility of forages is also influenced by leaf/stem ratio. In very young forage the stem is more digestible than the leaf, whereas with advancing maturity digestibility of the leaf fraction decreases very slowly while that of stem fraction falls rapidly (McDonald *et al.,* 2002). As plants mature, the stem comprises an increasing proportion of total herbage thus more influence on the digestibility of the whole plant than the leaf (McDonald *et al.*, 2002).

2.6 Influence of Tropical Forages on Animal Performance

Dairy cattle production in the tropics depends largely on forages as the main basal diet. These forages are characterized by fast growth and early maturity followed by rapid decline in nutritive value in the dry season (Mcdonald *et al.*, 2002). Poor and fluctuation of nutrient levels results into both milk yield and reproductive inefficiencies in dairy cattle (Aminah and Chen, 1989). A number of studies have been documented on the influence of tropical forages on dairy cattle performance. In Tanzania, Gimbi (2006) reported shorter CI of 454.8 days for cows grazing on forages in rainy season and longer CI of 516.6 days for cows grazing in the dry season in Rungwe District. The longer CI observed during dry season was due to underfeeding of cows attributed to low quality and quantity offered to them. Yilma (1999) reported longer CI of 512 days and lower milk yield of 4.5 litres per day for crossbred cows kept in Ethiopia. The performance of these cows were due to factors such as short grazing time especially 3h per day, shortage of forages during dry season due to overgrazing and shortage of water. In Kenya, Lanyasunya *et al*. (2006) reported longer CI of 468 days of cows kept by smallholder farms in Bahati Division, Nakuru District. The longer CI was mainly attributed by imbalances in their nutrients intakes which did not meet animal requirements for high performance. Thus, good feeding strategy can improve dairy cattle performance in the tropics.

2.7 Chapter Summary

It has been revealed from the review that poor feeding practices such as feeding of grass alone, poor mixing of concentrates and type of concentrates supplemented, are the major constraints to production as reflected in low milk production, long calving interval and older age at first calving. From this review, it has been shown that adoption of different feeding strategies such as feeding of treated crop residues, conserved forages, tree legumes and use of supplements has been low. The use of these strategies could improve dairy cattle productivity. Kibaha district in the Coast Region of Tanzania, is one of the areas which dairy farming is increasingly becoming one of the major sources of income due to growing milk market in Dar es Salaam. Limited information is documented on the existing feeding practices and performance of dairy cattle in the district. Thorough assessment of existing feeding practices and performance of dairy cattle could assist in the formulation of feeding strategies for improving dairy cattle productivity in Kibaha District.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Overview

Two studies were carried out to assess the feeding practices and performance of dairy cattle in Kibaha District, Coast Region. Study 1, involved baseline survey which was undertaken in August 2006, during the dry season, to collect baseline information on the existing feeding practices and their suitability for optimal dairy cattle performance. It included farmers practicing zero and full grazing in the three wards, that is Mlandizi, Kongowe and Soga. Likewise, study 2 involved monitoring experiment which was undertaken in January 2007 at the end of the short rains when the area was full of green forage at different stages of development. Two wards, that is Mlandizi and Kongowe were involved.

3.2 Study 1- Baseline Survey

3.2.1 Description of the study area

Kibaha District is located about 40 km West of Dar es Salaam. The district has five wards namely Soga, Mlandizi, Ruvu, Kongowe and Magindu. There are 25 registered villages and 71 sub villages. The area is located at an altitude of about 50 m above sea level and has an average annual rainfall of 1000 mm. There are two rainy seasons, long rains from March to June and short rains from October to January. The area has an average temperature of 29.7^0 C. The population of the area is about 132 045 (District Annual Report, 2006) out of whom 66 296 are females and 65 754 are males. The district has a total arable land of 76 554 ha of which 26 794 ha of the area is cultivated with different types of crops. Food crops grown include cassava, paddy, maize, sorghum, cow peas, tomatoes, okra, cashew nut and sweet potatoes (District Annual Report, 2006). The area is endowed with sandy loamy soils of high permeability with the exception of clay loamy soils along the river basin. Kibaha District is also involved in livestock production, which is predominantly on a small scale and contribute about 30% of total income of the household. The livestock kept in the district includes, zebu cows (34,830), dairy cattle (1 835), local goats (6 816), dairy goats (38), sheep (3 014), local chicken (182 502), layers (93 718), broilers (408 000), pigs (6 430), donkeys (105), ducks (6 530) and dogs (1 560) (District Annual Report, 2006).

3.2.2 Sampling procedure

Purposive sampling was used to select wards based on accessibility and availability of dairy cattle. Thus, Mlandizi, Kongowe and Soga were selected, because they had more dairy cattle compared to other wards. They had 38, 25 and 19 dairy farmers, respectively.Within wards, respondents practicing zero and full grazing were selected randomly from a list of dairy farmers in the ward provided by extension workers. However, the study did not involve farmers practicing semi-zero grazing since were few and concentrated only in Mlandizi ward. A total of 30 farmers that is 14 from Mlandizi, eight from Kongowe and eight from Soga, were sampled for study1.

3.2.3 Questionnaire design and pre-testing

Structured questionnaire was formulated in English (Appendix 1) but administered in Kiswahili, a language commonly spoken by all respondents. The questionnaire was pre-tested using nine farmers to make them more relevant in obtaining the intended information.

3.2.4 Primary data collection

Primary data was collected using the structured questionnaire and personal observations. The structured questionnaire was used to collect information on individual household's characteristics (e.g. age, gender, education and family size). Other information collected included food and cash crop production, livestock herd structure, livestock production practices, husbandry activities, reproductive performance, livestock feeds and feeding practices, sources of feeds, major feeding constraints and milk yield were also recorded.

3.2.5 Secondary data collection

Secondary data such as Demographic, climate and feeding constraints, were collected using reports from wards, district and Heifer Project International (HPI), which is a non governmental organization. The collected secondary data provided additional information to enrich the understanding of dairy cattle performance in the study area.

3.2.6 Data analysis

Statistical Package for Social Science (SPSS, 2003) was used to analyse the data obtained from baseline survey. Descriptive statistics analysis for percentages, means, ranges, cross tabulation were employed to assess household characteristics, livestock production practices, productive and reproductive performances, feeding and feeding practices, feeding constraints and milk yield.

3.3 Study 2- Field Monitoring Experiment

3.3.1 Experimental design and treatments

Complete randomized block design (CRBD) was used during monitoring, whereby wards were blocks and feeding practices were treatments. Monitoring experiment involved two wards, that is Mlandizi and Kongowe. These wards were selected because farmers practiced both zero and full grazing, whereas those in Soga ward practiced zero grazing only. In each of the two wards, twelve lactating cows, six under zero grazing and six under full grazing were monitored. Thus, 24 farmers were visited during monitoring exercise. Only one cow was selected from each farmer. Selected experimental cows by feeding practice are summarized in Fig 1.

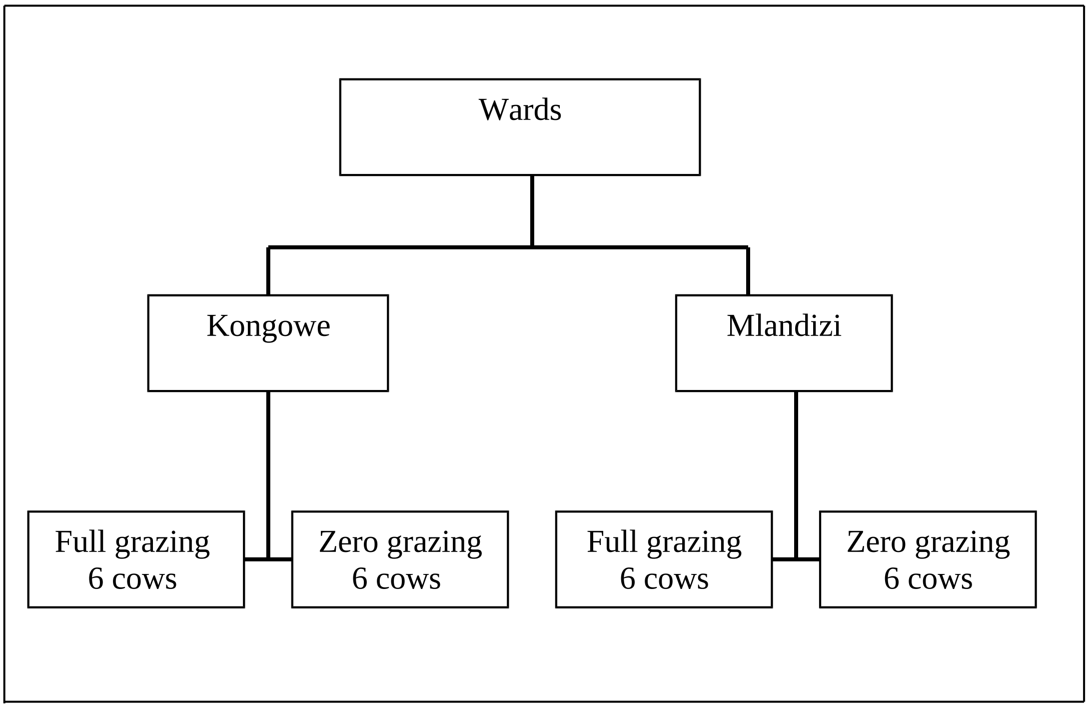

Figure 1: Selection pattern of experimental cows by feeding practice in the two wards

3.3.2 Experimental animals and their management

The experimental animals used were lactating cows, of Friesian and Zebu crosses, whose individual breed blood levels is not known. Cows under full grazing depended on forages found on the communal grazing lands as basal diet. These cows were grazed for eight hours, and thereafter returned home where they were confined in the night cow sheds. Cows under zero grazing depended mainly on natural pastures harvested from the communal lands as their basal diet. All lactating cows reared in both practices were supplied with 1kg of maize bran per day during milking. Farmers milked their cows by hand twice per day, in the morning and evening. Health management, such as control of external and internal parasites was done by the farmers themselves. While cases of retained placenta, dystocia and diseases treatments were done by the local animal health attendants and local Para-vets.

3.3.3 Sampling of mixed forage under full grazing

Forage samples for estimating nutrient contents grazed by lactating cows were collected twice within a month, in the first and last nine days of January 2007. Two observers followed the cows while grazing, and collected mixed forage species which cows selected. Three main communal grazing lands were identified and selected from each ward. Three (3) representative samples each weighing 0.2 kg from each communal grazing land were collected and pre-dried under the sun light for four days before being taken to the laboratory. Thirty six (36) samples that is eighteen (18) from each ward were collected from these two wards for the two collection periods, as illustrated in Fig 2.

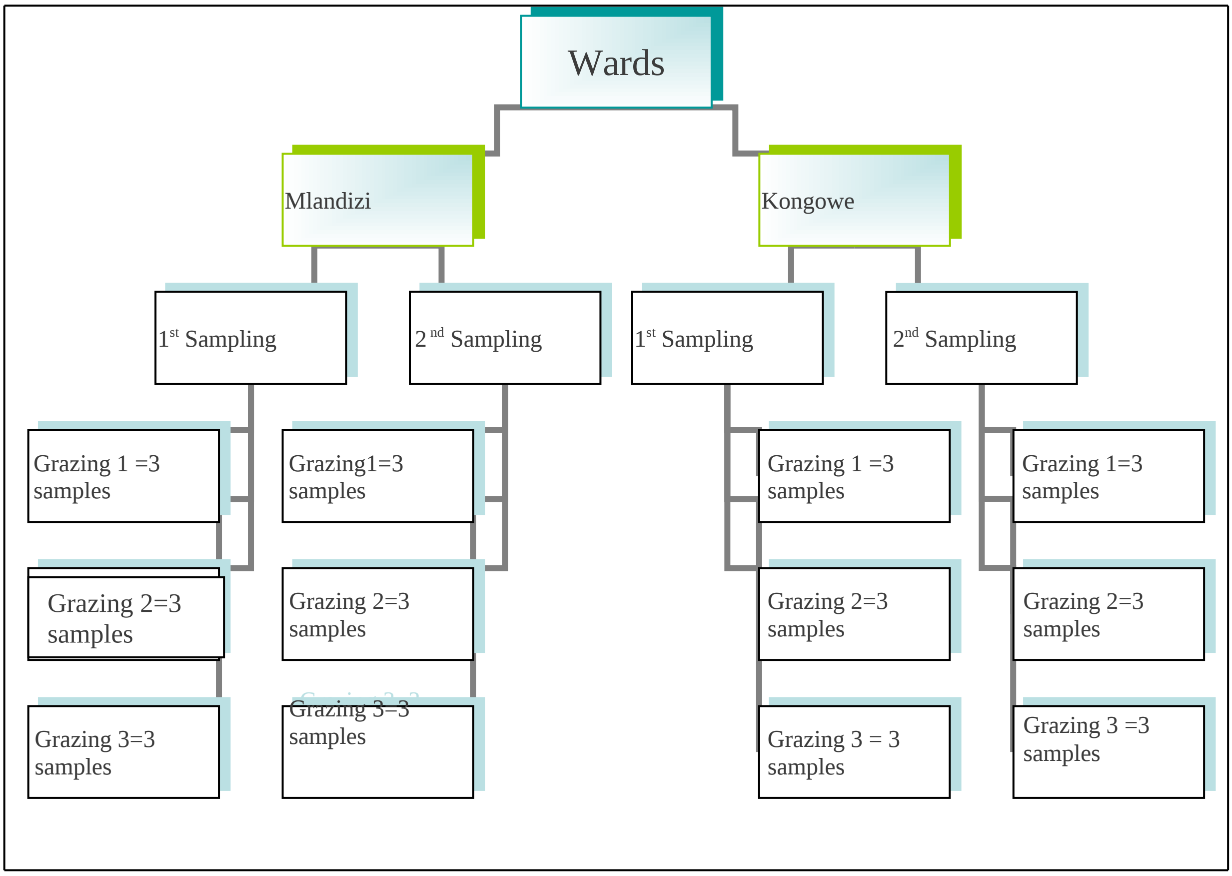

Figure 2: Number of forage samples collected from each grazing land per each ward

3.3.4 Collection of mixed forage samples and refusals under zero grazing

Feed samples for chemical analysis were collected from farmers forage bundles brought for feeding dairy cows. About 0.2 kg of mixed forages and 0.2 kg of refusals per cow from each ward were sampled twice per week, weighed and pre- dried using sunlight for four days before being taken to the laboratory. For the four weeks experimental period, a total of 96 feed samples and 96 refusal samples were collected.

3.3.5 Collection of concentrate samples

Concentrate samples were collected once per whole experimental period, from each farmer practicing both zero and full grazing. About 0.2 kg of concentrates per cow from each farmer was sampled. Twenty four (24) samples were collected.

3.3.6 Measurement of feed intake and estimation of nutrient intakes

Feed offered to lactating cows under zero grazing was monitored for 28 days. Farmers were trained on how to weigh feeds using spring balance and get involved in the measurements of feed offered to lactating cows. The amount of feed offered to cows was estimated by weighing the bundles of feed offered to cows using spring balance. Every morning before feeding, all refusals of the previous day's feeding were removed and weighed using spring balance. The daily feed intakes by each cow were estimated by taking the difference between amount of feed offered and the quantity refused. Nutrients intakes of lactating cows under zero grazing were determined by calculating the nutrient offered less that in the refusals.

3.3.7 Measurements of body weights

Body weights of cows was estimated by taking the length of heart girth using weighing band tape to establish association between body weight and feed intakes.

3.3.8 Determination of milk yield during monitoring

Lactating cows both raised under zero and full grazing in the two wards were milked by farmers daily at 0700 h and 1830 h. The milk obtained from each cow was measured by farmers using milk measuring jars and buckets. Milk was recorded daily by farmers in the recording sheet. These recording activities were performed for 28 days. However, farmers were visited by observers regularly during milking and recording time.

3.3.9 Sample preparation for chemical analysis

The collected forage samples from the communal grazing lands and those from farmer's bundles as well as refusals were dried in an oven at 65°C for 48 hours to get dry weight, which was used to calculate DM of mixed forages and refusal samples. Both mixed forage and refusal samples were ground. The ground forage samples from farmer's bundles for each cow were mixed thoroughly to get one representative sample per cow. This exercise resulted into six representative forage samples from each ward. Similarly, the ground refusal samples were mixed thoroughly to get one representative sample per cow. Six representative refusal samples from six cows in each ward were stored. Furthermore, ground forage samples from communal grazing land were mixed thoroughly to get one representative sample per grazing land. Three representative samples of mixed forages from three communal grazing lands in each ward were stored.

3.3.10 Determination of *in-vitro* dry matter digestibility

In vitro dry matter digestibility (IVDMD) of both feed offered and refusal were determined in the laboratory using two stage techniques according to Tilley and Terry (1963).

3.3.11 Chemical analysis of feed samples

All representative forage samples were analysed for dry matter (DM), crude protein (CP), calcium (Ca) and Phosphorus (P) according to A.O.A.C. 1990 techniques. DM was determined using proximate analysis by oven drying method at 105^{o}C. CP was analysed using kjeldahl method No. 988.05. Ca was analysed using atomic absorption spectrophotometric method No. 968.08. P was analysed using photometric method No. 965.17. The Neutral detergent fibre (NDF) values were determined according to Van Soest (1991).

3.3.12 Estimation of Energy intake

Metabolisable energy (ME) contents of the feed and refusal samples were computed according to MAFF (1975) using the following equation; ME (MJ/kgDM) =0.16 DOMD

(Digestible Organic Matter in Dry Matter) where as DOMD = (0.92 ×IVDMD) -1.20. ME intake was calculated as ME offered minus ME in the refusal.

3.4 Data Analysis

Data on milk yield of lactating cows and amount of nutrient intakes were analyzed using General Linear Model (GLM) procedures of Statistical Analysis System (SAS, 2000). The following statistical model was used:

Y_{ij} = $\mu + F_i + W_j + E_{ij}$

Y_{ij} = Milk yield or nutrient intakes as affected by i^{th} feeding practice and j^{th} wards

μ = Overall mean

F_i = effects of feeding practice (full grazing or zero grazing)

W_j = effects of wards

E_{ij} = Random error

CHAPTER FOUR

4.0 RESULTS

4.1 Study 1 -Results from Baseline Survey

4.1.1 General observations

Zero grazing and full grazing were the main production practices used by smallholder dairy farmers in the area. About two-thirds of respondents practiced zero grazing and the rest practiced full grazing. Dairy cattle under zero grazing were totally confined in the house. Feeds and drinking water were offered to them, mostly by hired labour, since most of them had other income generating activities (crop farming, civil servants and business man) other than dairy farming. These animals, depended largely on forage bundles brought by farmers from different feed sources such as communal grazing lands, around the road side, river banks and flood plains. During the dry season when there was a shortage of forages, animals were supplemented with maize stover, rice straws, sweet potato vines and banana pseudostem. These crop residues were mainly offered to milking cows purposely for increasing milk yield. However, these dry season feeds were not enough for normal production performances, since most of these roughages have low nutritive values due to high lignification. Dairy cattle under full grazing practice, were grazed daily for 8 hours in the communal grazing lands, there after were returned to be confined in the night bomas. The distance from communal grazing land to their bomas, on average was about 3 km. However, during grazing time, these animals were not supplied with drinking water, until they returned home and being watered. There were no watering points in the grazing lands. Animals under this practice depended solely on natural grown pastures found in the grazing land as their main basal diets. There were no strategies employed to improve those pastures. Dairy cattle under this practice, experiences forage deficity during the dry season. However, few farmers recovered forage deficity to their animals by offering crop residues during the evening after returning from grazing. In both feeding practices, maize bran and mineral blocks were the main concentrates supplemented mainly to milking cows. About 1kg of maize bran was offered to cows daily during milking time.

4.1.2 Household characteristics

The household characteristics of smallholder dairy farmers practicing full and zero grazing in Kibaha District are shown in Table 1. The mean age of farmers was 49.2±12.6 years. The respondents comprised of both male and female headed-households, where the majority of respondents under zero grazing were male-headed households, and those in the grazing practice, the male and female headed households were equal. The majority of respondents were married couples in both feeding practices. The level of education in the district varied from one household to another, ranging from non- formal to university level. Majority of heads of households in both feeding practices had primary education, followed by secondary education, and post secondary college. Information from the formal survey also indicated that 20 % of the farmers in both feeding practices had training in dairy cattle husbandry. In the current survey farmers practicing full grazing owned an average of 6.1±3.6 acres and those practicing zero grazing owned 5.9±4.9 acres. The land owned under established fodder by farmers practicing zero grazing was less than one acre. However, there was no land owned under established fodder for farmers practicing full grazing.

Table 1: Household characteristics in Kibaha District

Parameter	Feeding practices		Overal Mean
	Full grazing (N[1]=10)	Zero grazing (N=20)	
Mean age in years[2]	49.2±12.6	49.2±12.6	49.1±10.4
Head of household[3]			
Male	50 (5)	65 (13)	60 (18)
Female	50 (5)	35 (7)	40 (12)
Marital status			
Married	90 (9)	80 (16)	83.3 (25)
Widow	0 (0)	15 (3)	10 (3)
Single	10 (1)	5 (1)	6.7 (2)
Education			
No formal education	0 (0)	5 (1)	3.3 (1)
Primary school	30 (3)	60 (12)	50 (15)
Secondary school	40 (4)	15 (3)	23.4 (7)
Post secondary college	30 (3)	15 (3)	20 (6)
University	0 (0)	5 (1)	3.3 (1)
Farmers training in dairy cattle			
Farmers received training	20 (2)	20 (4)	20 (6)
No training	80 (8)	80 (16)	80 (24)
Land ownership in acreage[2]			
Total land owned	6.1±3.6	5.9±4.9	6.0±4.5
Land owned under cash crops	3.9±3.4	3.8±2.2	3.85±2.8
Land owned under food crops	2.2±1.2	1.6±0.7	1.9±0.6
Land owned under established fodder	0	0.5±0.2	0.5±0.2

In this and subsequent tables;
1. N=Number of respondents
2. ± represents standard deviation
3. Numbers in brackets represent number of respondents and those outside indicate percentages

Food and cash crops grown varied between feeding practices (Table 2). Sorghum production was considered not important by all respondents (100 %) practicing full grazing, whilst few respondents (20 %) practicing zero grazing ranked sorghum production to be important. Majority of respondents in both feeding practices ranked maize, Cow peas, Groundnuts and Sweet potatoes production to be not important. Cassava production was ranked by 55 % of respondents practicing zero grazing to be the most important crop.

However, respondents (70 %) practicing full grazing, ranked cassava production to be not important. Respondents (50 %) practicing full grazing and those practicing zero grazing (30 %) ranked rice production to be important. The common cash crop grown in the study area was cashew nuts, although this crop was grown by only few households (10-15 %) as a source of income.

Table 2: Number of respondents under different feeding practices, producing different Food and cash crops

	Feeding practices[1]		Total
Ranks	**Full grazing (N=10)**	**Zero grazing (N=20)**	
Sorghum production			
Important	0 (0)	20 (4)	13.3
Not important	100 (10)	80 (16)	86.7
Maize production			
Important	30 (3)	30 (6)	30.0
Not important	70 (7)	70 (14)	70.0
Cowpeas production			
Important	20 (2)	35 (7)	30.0
Not important	80 (8)	65 (13)	70.0
Groundnuts production			
Important	10 (1)	10 (2)	10.0
Not important	90 (9)	90 (18)	90.0
Sweet potatoes production			
Important	10 (1)	25 (5)	20.0
Not important	90 (9)	75 (15)	80.0
Cassava production			
Impotant	30 (3)	55 (11)	46.7
Not important	70 (7)	45 (9)	53.3
Rice production			
Important	50 (5)	30 (6)	36.7
Not important	50 (5)	70 (14)	63.3
Cashew nut production			
Important	10 (1)	15 (3)	13.3
Not important	90 (9)	85 (17)	86.7

1 Numbers in brackets represent number of respondents and those outside indicate percentages

4.1.3 Dairy herd size and composition

Dairy herd size and composition per household are indicated in Table 3. Dairy cattle breeds kept in Kibaha district were crosses of Friesian and Tanzania short horn Zebu. Their individual breed blood level was not known, since farmers did not keep breeding records and no genetic characterization was done in the district. Farmers practicing full grazing had higher average number (per household) of lactating cows, breeding cows, breeding bulls, heifers, young bulls and female calves than those practicing zero grazing. However, farmers practicing zero grazing had higher average number of male calves, than those practicing full grazing.

Table 3: Number of different categories of dairy cattle per household under different feeding practice

Livestock Category	Zero grazing practice (N=20)				Full grazing practice (N=10)			
	Minimum	Maximum	Total	Mean	Minimum	Maximum	Total	Mean
Lactating cows	1	8	40	2.0	1	6	34	3.4
Breeding cows	1	13	48	2.45	1	15	44	4.4
Breeding bulls	0	2	6	0.3	1	1	10	1.0
Heifers	0	3	9	0.45	0	4	14	1.4
Young bulls	0	2	4	0.2	0	2	6	0.6
Female calves	0	2	15	0.75	0	3	8	0.8
Male calves	0	5	18	0.9	0	3	6	0.6

4.1.4 Husbandry activities

Husbandry activities and household responsibilities are summarized in Table 4. The results indicated that, under full grazing practice grazing was done by hired labour (100%). Milking and health management were mostly done by hired and family labour. Milk sales were mainly done by husband, wife, family and hired labour. On the case of zero grazing practice, feed collection, feeding and house cleaning were mainly done by children, hired labour and family labour. Milking is done by wives (25 %) and children (25 %) while milk sales are done by husbands (55 %). Health management was done by husband, wife, hired and family labour. Thus, both hired and family labour played a great role in dairy cattle farming.

Table 4: Percentage of respondents showing players in different husbandry activities under different feeding practices in Kibaha District

Players	Husbandry activities						
	Grazing	Feed collection	Feeding	House cleaning	Milking	Milk sales	Health management
Full grazing practice (N=10)							
Husband and wife	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	40 (4)	10 (1)
Children	0 (0)	0 (0)	0 (0)	10 (1)	10 (1)	10 (1)	0 (0)
Hired labour	100 (10)	0 (0)	0 (0)	50 (5)	30 (3)	10 (1)	0 (0)
Family labour	0 (0)	0 (0)	0 (0)	10 (1)	10 (1)	10 (1)	20 (2)
Hired and family labour	0 (0)	0 (0)	0 (0)	30 (3)	50 (5)	30 (3)	70 (7)
Zero grazing practice (N=20)							
Husband	0 (0)	10 (2)	10 (2)	0 (0)	10 (2)	55 (11)	10 (2)
Wife	0 (0)	5 (1)	5(1)	5 (1)	25 (5)	10 (2)	5 (1)
Husband and wife	0 (0)	5 (1)	0 (0)	5 (1)	5 (1)	0 (0)	30 (6)
Children	0 (0)	40 (8)	20 (4)	25 (5)	25 (5)	15 (3)	5 (1)
Hired labour	0 (0)	30 (6)	30 (6)	30 (6)	20 (4)	5 (1)	5 (1)
Family labour	0 (0)	10 (2)	35 (7)	20 (4)	15 (3)	10 (2)	15 (3)
Hired and familylabour	0 (0)	0 (0)	0 (0)	15 (3)	0 (0)	5 (1)	30 (6)

1 Numbers in brackets represent number of respondents and those outside indicate percentages

4.1.5 Feeds and feeding

Natural pasture grasses were the main roughage offered to calves, milking cows, dry cows and bulls in all wards (Fig.3). Most of farmers practicing either full or zero grazing depended on natural pasture grasses as the main source of feed for their animals.

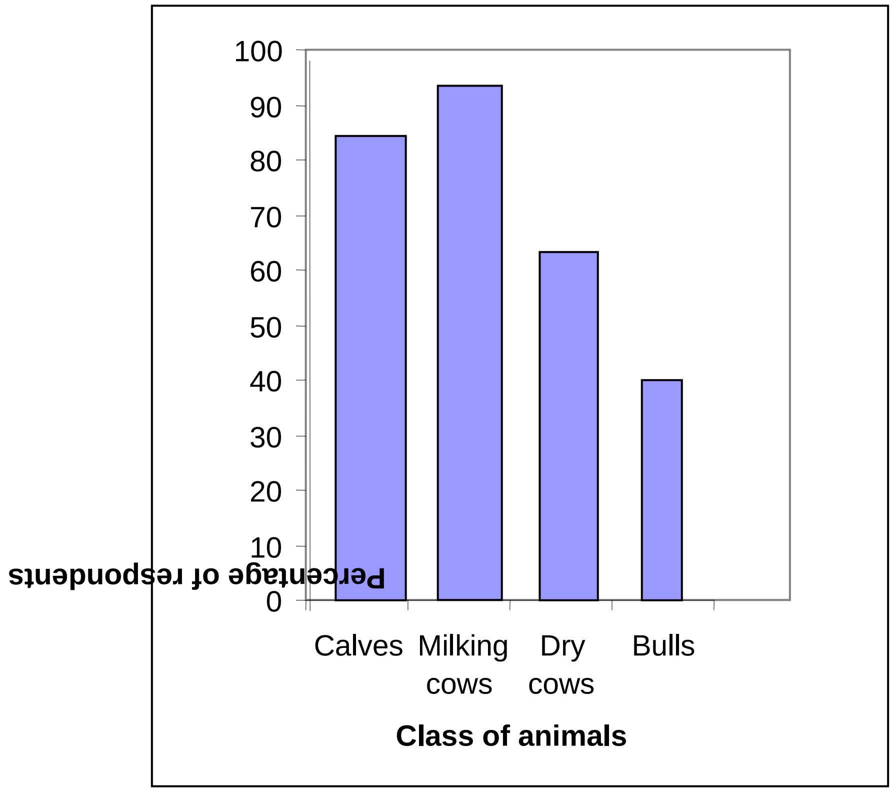

Figure 3: Percentage of respondents that offer natural pasture grasses to different classes of dairy cattle

Fodder grasses offered to dairy cattle are indicated in Figure 4. Fodder grasses were fed to calves, milking cows, dry cows and bulls under zero grazing practice in small amounts. Farmers practicing full grazing were not supplementing their animals with fodder; instead they were depending largely on pastures grazed on communal lands.

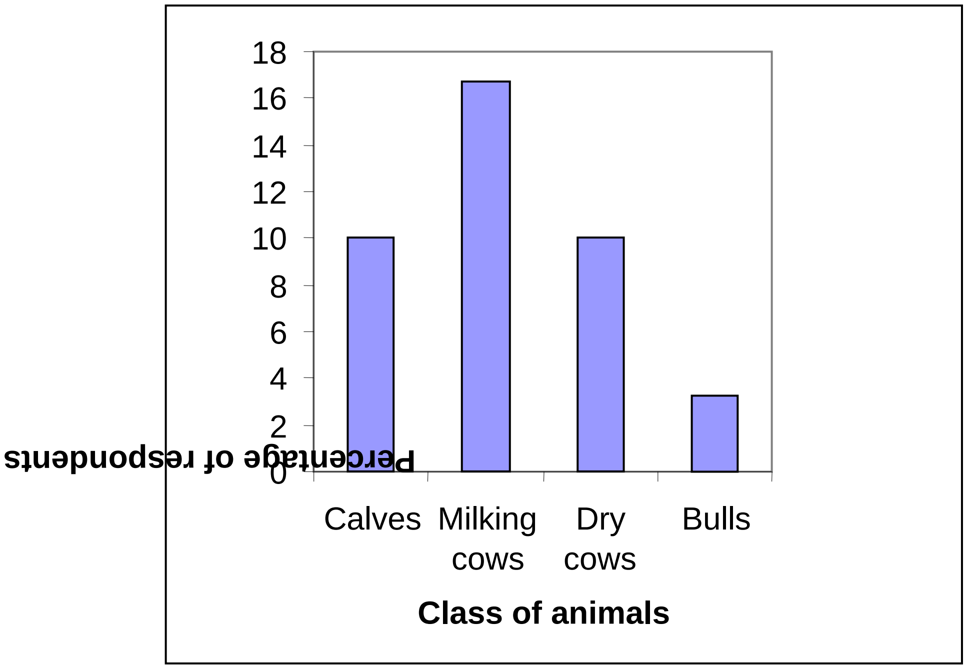

Figure 4: Percentage of respondents that offered fodder grasses to different classes of dairy cattle

Crop residues offered to dairy cattle are indicated in Table 5. Rice straws, maize stover, sweet potatoe vines and banana pseudostems were the main crop residues offered to dairy cattle in the study area. Farmers practicing zero grazing offered crop residues mainly to calves and milking cows as supplements during the dry season. Minimal crop residues were offered to cattle under full grazing practice. Although there were abundant rice straw in the study area, much of it was left in the field without being utilized. Farmers claimed that rice straw was not preferred by cows.

Table 5: Percentage of respondents that offer crop residues to different classes of dairy cattle in different feeding practices

Class of animals	Feeding practices[1]			
	Full grazing (N=10)		Zero grazing (N=20)	
	Yes	No	Yes	No
Rice straws				
Calves	0 (0)	100 (10)	40 (80	60 (12)
Milking cows	0 (0)	100 (10)	45 (9)	55 (11)
Dry cows	0 (0)	100 (10)	20 (4)	80 (16)
Bulls	0 (0)	100 (10)	25 (5)	75 (15)
Maize stover				
Calves	0 (0)	100 (10)	30 (6)	70 (14)
Milking cows	0 (0)	100 (10)	35 (7)	65 (13)
Dry cows	0 (0)	100 (10)	5 (1)	95 (19)
Bulls	0 (0)	100 (10)	5 (1)	95 (19)
Sweet potato vines				
Calves	10 (1)	90 (9)	45 (9)	55 (11)
Milking cows	20 (2)	80 (8)	55 (11)	45 (9)
Dry cows	0 (0)	100 (10)	40 (8)	60 (12)
Bulls	0 (0)	100 (10)	10 (2)	90 (18)
Banana pseudostem				
Calves	0 (0)	100 (10)	45 (9)	55 (11)
Milking cows	10 (1)	90 (9)	55 (11)	45 (9)
Dry cows	0 (0)	100 (10)	10 (2)	90 (18)
Bulls	0 (0)	100 (10)	10 (2)	90 (18)

1 Numbers in brackets represent number of respondents and those outside indicate percentages
The observations are not mutually exclusive

The types of concentrates offered to dairy cattle are as indicated in Table 6. Feeding concentrates to dairy cattle was one of the strategies used by all smallholder farmers for improved production. However, there was less use of concentrates to dairy cattle under full grazing. It was observed from the survey that home made concentrates based on maize bran and cotton seed cakes were mainly fed to milking cows. Maize bran was sometimes fed alone or mixed with cotton seed cakes at various proportions. Inclusion of other ingredients and proportions mixed to form the concentrates were variable and depended more on availability and financial constraints. The mineral types offered to dairy cattle under both practices were mainly mineral blocks. Approximately 50 % of respondents under full grazing, and 80 % under zero grazing offered mineral blocks to milking cows.

Table 6: Percentage of respondents that offer supplements to different classes of dairy cattle in different feeding practices

Class of animals	Feeding practices[1]			
	Full grazing (N=10)		Zero grazing (N=20)	
	Yes	No	Yes	No
Home made concentrates				
Calves	0 (0)	100 (10)	45 (9)	55 (11)
Milking cows	50 (5)	50 (5)	80 (16)	20 (4)
Dry cows	0 (0)	100 (10)	15 (3)	85 (17)
Bulls	0 (0)	100 (10)	10 (2)	90 (18)
Maize bran				
Calves	0 (0)	100 (10)	35 (7)	65 (13)
Milking cows	50 (5)	50 (5)	80 (16)	20 (4)
Dry cows	0 (0)	100 (10)	15 (3)	85 (17)
Bulls	0 (0)	100 (10)	10 (2)	90 (18)
Cotton seed cake				
Calves	0 (0)	100 (10)	30 (6)	70 (14)
Milking cows	10 (1)	90 (9)	55 (11)	45 (9)
Dry cows	0 (0)	100 (10)	5 (1)	95 (19)
Bulls	0 (0)	100 (10)	5 (1)	95 (19)
Minerals (mineral blocks)				
Calves	10 (1)	90 (9)	40(8)	60 (12)
Milking cows	50 (5)	50 (5)	80 (16)	20 (4)
Dry cows	0 (0)	100 (10)	15 (3)	85 (17)
Bulls	0 (0)	100 (10)	5 (1)	95 (19)

1 Numbers in brackets represent number of respondents and those outside indicate percentages
The observations are not mutually exclusive

The main sources of feed materials for dairy cattle are indicated in Table 7. The main source of local pastures in the study area was communal grazing lands. Other sources were farmers'own farms. The main sources of ingredients for home made concentrates and minerals were from input shops and milling machines.

Table 7: Sources of feeds for dairy cattle as indicated by respondents in Kibaha district

Type of feeds	Sources		
	Communal land	**Own farm**	**Do not use**
Roughages			
Local pasture grass	90 (27)	10 (3)	0 (0)
Fodder grass	6.7 (2)	13.3 (4)	80 (24)
Rice straws	6.7 (2)	23.3 (7)	70 (21)
Maize stover	3.3 (1)	26.7 (8)	70 (21)
Sweet potatoes	0 (0)	33.3 (10)	66.7 (20)
Banana pseudo stems	0 (0)	20 (6)	80 (24)
Ingredient for home made concentrates	**Milling machine**	**Input shops**	**Do not use**
Maize bran	36.7 (11)	20 (6)	43.3 (13)
Cotton seed cake	0 (0)	40 (12)	60 (18)
Mineral blocks	0 (0)	56.7 (17)	43.3 (13)

Numbers in brackets represent number of respondents and those outside indicate percentages

4.1.6 Performance of dairy cattle

Breeding of dairy cattle under different feeding practices is shown in Table 8 Natural mating was the only breeding method practiced in the study area. All the interviewed farmers had knowledge on the use of signs for oestrus detection. Changes in cows' behaviour (mounting, bellowing and restlessness) were reported to be used for oestrus detection by over 90% of the respondents in both feeding practices followed by mucus discharges. Signs of oestrus were observed twice a day by farmers. However, there were no records kept by farmers pertaining to reproductive performances.

Table 8: Percentage of respondents indicating breeding of dairy cattle under different feeding practices

Breeding aspect	Feeding practices[1]			
	Full grazing (N=10)		Zero grazing (N=20)	
	Yes	No	Yes	No
Breeding methods				
Natural mating	100 (10)	0 (0)	100 (20)	0 (0)
AI	0 (0)	100 (10)	0 (0)	100 (20)
Use of signs of oestrus				
Change in cows behaviour	90 (9)	10 (1)	100 (20)	0 (0)
Change in milk production	0 (0)	100 (10)	0 (0)	100 (20)
Change in feed intake	20 (2)	80 (8)	30 (6)	70 (14)
Mucus discharge	60 (6)	40 (4)	75 (15)	25 (5)

1 Numbers in brackets represent number of respondents and those outside indicate percentages

The reproductive performance of dairy cattle is shown in Table 9. Animals under full grazing calve for the first time much later and have shorter calving intervals than those under zero grazing.

Table 9: Percentage of respondents indicating age at first calving (AFC) and calving interval (CI) of dairy cattle under different feeding practices

Reproductive parameters	Full grazing (N=10)	Zero grazing (N=20)	Total
Age At first Calving (AFC)			
1 year	0 (0)	0 (0)	0 (0)
2 years	30 (3)	55 (11)	46.7 (14)
Over 2 years	70 (7)	45 (9)	53.3 (16)
Calving Intervals (CI)			
1 year	60 (6)	30 (6)	40 (12)
2 years	20 (2)	45 (9)	36.7 (11)
Over 2 years	20 (2)	25 (5)	23.3 (7)

Numbers in brackets represent number of respondents and those outside indicate percentages

The results for milk production reported by respondents during baseline survey are summarized in Table 10. Average daily milk yield from cows in both feeding practices was reported to be higher in wet season than in dry season. However, milk yield from cows under zero grazing was reported to be higher than those under full grazing practice in both wet and dry seasons.

Table 10: Milk yield (litres/day/cow) of lactating cows as reported by respondents under different feeding practices

Season	Feeding practices		Mean
	Full grazing(N=10)	Zero grazing (N=20)	
Milk yield l/cow/day			
Wet season	6.5±1.3	8.2±1.6	7.4±1.5
Dry season	4.0±1.4	4.9±1.0	4.5±1.2
Mean	5.3±1.2	6.6±1.3	5.9±1.2

4.1.7 Major constraints

The major feeding constraints in the study area were shortage of feed, high costs of concentrates and lack of labour (Table 11). Seasonal shortage of basal feeds was reported by 80 % of respondents under zero grazing and 50 % of respondents under full grazing practice to be a serious problem. High costs of concentrates and lack of labour were reported to be a frequent problem by 45 % of respondents under zero grazing and 40 % of respondents under full grazing practice. Availability of concentrates was indicated to be the least problem by majority of respondents in both feeding practices. Feed conservation was not done by more than 90 % of the respondents in both feeding practices.

Table 11: Major dairy cattle feeding constraints in the different feeding practices as indicated by smallholder dairy farmers

Parameter	Feeding practices[1]		Total
	Fullgrazing (N=10)	Zero grazing (N=20)	
Shortage of basal feed			
Always a problem	0 (0)	10 (2)	6.7 (2)
Seasonal problem	50 (5)	80 (16)	70 (21)
None	50 (5)	10 (2)	23.3 (7)
High cost of concentrates			
Always a problem	40 (4)	45 (9)	43.3 (13)
Seasonal problem	20 (2)	20 (4)	20 (6)
Not a serious problem	30 3)	15 (3)	20 (6)
None	10 (1)	20 (4)	16.7 (5)
Shortage of concentrates			
Seasonal problem	20 (2)	10 (2)	13.4 (4)
Not a serious problem	40 (4)	15 (5)	30 (9)
None	40 (4)	65 (13)	56.6 (17)
Lack of labour			
Always a problem	40 (4)	45 (9)	43.3 (13)
Seasonal problem	10 (1)	15 (3)	13.4 (4)
Not a serious problem	20 (2)	20 (4)	20 (6)
None	30 (3)	20 (4)	23.3 (7)
Feed conservation			
Do nothing	90 (9)	95 (19)	93.3 (28)
Conserve crop residues	10 (1)	5 (1)	6.7 (2)

1 Numbers in brackets represent number of respondents and those outside indicate percentages
None implies respondents who do not say anything

4.2 Study 2-Results from the Field Monitoring

4.2.1 Nutritive values of feeds under different feeding practices

The forage species composition in the bundles collected for feeding zero grazed animals, varied from ward to ward. In Mlandizi ward, the main forage species contained in the bundles for feeding dairy cattle, were *Cynodon dactylon, Panicum maximum, Brachiaria brizantha, Eragrostis superba, Chloris gayana* and *Vigna unguiculata*. In Kongowe ward, forage species fed to dairy cattle were *Cynodon dactylon, Panicum maximum, Eragrostis superba,* green maize stover and *Vigna unguiculata.* However, forage species, such as *Sesbania sesban, Puareria phaseolides, Microptilium atropurpureum,* and *Leucaene* *leucocephala* were available in both wards, especially around the road side, but were not found in the forage bundles brought to the stalls.

Dairy cattle under full grazing depended on natural pasture species found in the communal grazing lands. In Mlandizi ward, main forage species grazed by dairy cattle were *Cynodon dactylon, Panicum maximum, Brachiaria brizantha, Eragrostis superba, Hyparrhenia rufa* and *Themeda spp.* The forage species such as *Cynodon dactylon, Panicum maximum, Eragrostis superba, Hyparrhenia rufa and Themeda spp,* were mainly abundant in communal grazing lands of Kongowe ward.

The mean values for the chemical composition, *in vitro* dry matter digestibility (IVDMD) and ME contents of mixed forages offered / grazed by cows under different feeding practices in the two wards are shown in Table 12 and appendix 2. The CP, P, IVDMD and NDF content of mixed forages used for zero grazing dairy cattle in Mlandizi were slightly higher than those under zero grazing in Kongowe, except ME values were lower than that of Kongowe. However, Ca content of mixed forages under zero grazing in both wards was not different. The mean values of CP, P, NDF and ME of mixed forages grazed by cattle under full grazing in Mlandizi, were slightly higher than that of Kongowe. But Ca and IVDMD were higher in Kongowe than in Mlandizi.

The mean values of the chemical composition, *in vitro* dry matter digestibility (IVDMD) and ME contents of refusals of mixed forages collected from zero grazed cows in the two wards, are also shown in Table 12. The mean values of CP, Ca, P, and ME of refusals for Mlandizi were significantly ($P<0.05$) higher than those of Kongowe. There was no significant ($P>0.05$) difference between the wards in NDF content of refusals of mixed forages. However, the mean values of IVDMD of refusals for Kongowe was significantly ($P< 0.05$) higher than that of Mlandizi.

The means of the chemical composition, *in vitro* dry matter digestibility (IVDMD) and ME contents of concentrates offered to cows under different feeding practices in the two wards are shown in Table 12. The CP, Ca, P, IVDMD and ME values offered to zero grazed cows in Mlandizi, were slightly higher than those of Kongowe, except for NDF which was lower than that of Kongowe. Likewise, CP, Ca, IVDMD and ME values offered to cows under full grazing in Kongowe, were slightly higher than those of Mlandizi except P and NDF values which were slightly lower than those of Mlandizi (Appendix 2 and 3).

Table 12: Chemical composition, *in vitro* dry matter digestibility (IVDMD) and ME contents of mixed forages, concentrates and refusals from zero grazed cows

Components (% DM)	Grazing system	Overall means	Wards		SE	P-values
			Kongowe	Mlandizi		
CP	**Forages**					
	Full	6.18	5.97	6.40	0.290	**0.3534**
	Zero	6.09	5.94	6.25	0.290	**0.4766**
	Refusals	2.13	1.85	2.41	0.215	**0.001**
	Concentrate					
	Full	12.85	12.88	12.83	0.989	**0.6955**
	Zero	12.35	12.28	12.42	0.989	**0.8888**
Ca	**Forages**					
	Full	0.25	0.28	0.22	0.02	**0.1547**
	Zero	0.24	0.24	0.24	0.02	**0.8899**
	Refusals	0.17	0.16	0.18	0.025	**0.3672**
	Concentrate					
	Full	0.56	0.71	0.41	0.740	**0.0884**
	Zero	2.29	1.95	2.63	0.740	**0.0414**
P	**Forages**					
	Full	0.16	0.14	0.18	0.002	**0.3896**
	Zero	0.18	0.15	0.21	0.002	**0.1877**
	Refusals	0.16	0.14	0.19	0.063	**0.0001**
	Concentrate					
	Full	0.84	0.77	0.91	0.145	**0.4962**
	Zero	0.95	0.93	0.98	0.145	**0.8110**
IVDMD	**Forages**					
	Full	49.07	49.20	48.94	2.43	**0.7675**
	Zero	48.09	47.56	48.63	2.43	**0.9482**
	Refusals	42.02	44.06	40.10	0.765	**0.0001**
	Concentrate					
	Full	70.26	70.48	70.04	2.801	**0.9118**
	Zero	71.73	70.67	72.80	2.801	**0.5681**
NDF	**Forages**					
	Full	73.58	72.96	74.21	0.499	**0.1103**
	Zero	74.20	74.08	74.32	0.499	**0.8771**
	Refusals	76.7	76.83	76.57	0.469	**0.7224**
	Concentrate					
	Full	52.90	52.83	52.97	2.137	**0.6374**
	Zero	51.08	52.00	50.16	2.137	**0.5999**
ME (MJ/kgDM)	**Forages**					
	Full	6.88	6.81	6.96	0.36	**0.7646**
	Zero	7.02	7.03	7.01	0.36	**0.9694**
	Refusals	6.1	5.86	6.34	0.288	**0.0001**
	Concentrate					
	Full	10.1	10.18	10.02	0.396	**0.7795**
	Zero	10.33	10.21	10.45	0.396	**0.6666**

4.2.2 Body weight and nutrients intakes by lactating cows

The mean values of body weights and daily nutrient intakes of lactating cows under zero grazing in Kongowe and Mlandizi wards are shown in Table 13. Animals in Kongowe were significantly ($P<0.05$) heavier than those in Mlandizi. The total daily intakes of DM, CP, Ca, and P by animal in Kongowe were significantly (P<0.05) higher than those of Mlandizi. The DM, and ME intakes by the lactating cows per metabolic body weight were not significantly (P>0.05) different between the two wards. Crude protein intake was slightly higher in Mlandizi than in Kongowe. Similarly calcium and P intakes by the cows in Mlandizi were significantly (P<0.05) higher than those of Kongowe. However, total intakes of P by cattle in Mlandizi was significantly (P<0.05) higher than those of Kongowe (Appendix 4 and 5).

Table 13: Body weight and daily nutrient intakes by lactating cows in Kibaha district

Parameters	Overall mean	Wards		SE	P-value
		Kongowe	Mlandizi		
Body weight (kg)	394.17	439.17	347.17	47.267	**0.002**
Total Daily intakes					
DM (kg)	10.81	11.94	9.68	0.330	**0.0001**
CP (g)	657.97	706.91	609.03	19.980	**0.0006**
Ca (g)	26.06	28.68	23.44	0.803	**0.0001**
P (g)	18.79	17.52	20.06	0.578	**0.002**
ME (MJ)	76.42	83.91	68.91	2.448	**0.0001**
Daily intakes (g/ kgW$^{0.75}$)					
DM	120	120	120	3.0	**0.5149**
CP	7.48	7.37	7.60	0.215	**0.4500**
Ca	0.26	0.23	0.29	0.009	**0.0001**
P	0.21	0.18	0.25	0.006	**0.0001**
ME (MJ)	0.86	0.87	0.85	0.027	**0.5538**

4.2.3 Daily milk yield of lactating cows under different feeding practices

Average daily milk yield of lactating cows recorded during monitoring experiment in the different feeding practices in Kongowe and Mlandizi wards are presented in Table 14. Mean milk yield of cows under zero grazing was significantly (P<0.05) higher than that of cows under full grazing. Average milk yield of cows in Kongowe ward was significantly (P<0.05) higher than that of Mlandizi ward (Appendix 6 and 7).

Table 14: Effects of feeding practice on milk yield of cows in Kongowe and Mlandizi wards

	Overall	**Wards**			
Feeding practices	**mean l/day**	**Kongowe**	**Mlandizi**	**SE**	**P-value**
Full grazing	5.45	6.23	4.68	0.144	**0.0001**
Zero grazing	6.59	7.71	5.47	0.144	**0.0001**
P-value	**0.0001**	**0.0001**	**0.0001**		

CHAPTER FIVE

5.0 DISCUSSION

5.1 Feeding Practices and Strategies for Feeding Dairy Cattle in the Study Area

The observation that smallholder dairy keepers in Kibaha District practice both zero and full grazing is in agreement with that reported elsewhere in Tanzania (Urassa, 1999; Teendwa, 2005; Gimbi, 2006). Most farmers practiced zero grazing to avoid exposing their dairy cattle to environment with ecto and endo-parasites, vectors of tick borne diseases and trypanosomiasis. The study by Swai *et al. (*2007) reported that zero grazing was normally advocated in many smallholders dairy development programmes in East Africa with the major reason of avoiding environmental stress on high grade dairy cattle. Those few farmers practicing full grazing were trying to minimize labour cost of feeding these animals if they adopted zero grazing since they had slightly large herd size. On the other hand, there was little land for grazing animals since most of the land in the study area was used for crop farming, making animals move long distances looking for uncultivated land. The observation that majority of respondents in both feeding practices were married couples, implies that a greater proportion of the respondents were mature (adults) people who have influence on production aspects. The observed equal number of male and female heads of households, who practices full grazing, implies that there were no sex discrimination in dairying activities. Instead, both male and females had equal opportunity in dairy cattle farming. However, this was different from dairy farmers practicing zero grazing where by male heads were higher than female heads. This phenomena of most households to be headed by males is common to African tradition where by males are the main decision makers as well as dominant in resource use than their counterparts.

The observation that large proportion of dairy farmers had primary, secondary education and post secondary college in the present study was similar to findings by Safari *et al.* (2000) and Lyimo (2006). Level of education is important to dairy farming since it imparts the desire of an individual to learn more, to attend training and seek information regarding dairy cattle farming (Luhosi, 1998). It also increases the ability of farmers to keep production and reproduction records, so that they can be able to measure dairy cattle performances and identify area of weakness for improvement (Gimbi, 2006). Despite high literacy level of farmers observed in the present study, both reproduction and production performances of dairy cattle were low. This was probably contributed by low level of knowledge in dairy cattle management since 80% of interviewed farmers had no training in dairy cattle husbandry.

In the current study, it was revealed that dairy farmers practiced crop farming apart from dairy farming. Dairy farmers practicing both full and zero grazing were highly involved in rice and cassava production than other crops, since type of soils endowed in the area favoured the production of these two crops. Cassava was grown in the areas with sandy loam soils. Lekule *et al.* (2002) reported that cassava grows well in areas with low rainfall and on poor soils with pH from 4 to 9.0. Cassava withstand drought and it is sometimes a nutritionally strategic famine reserve in the area of unreliable rainfall. Likewise, rice was cultivated in areas with clay loamy soils found along the flood plains of different rivers. Both rice and cassava were produced purposely to supply food for dairy farmers as well as generating income to supplement those obtained from dairy farming. Cashew nut performs well in the study area, since the climate of that area favour its production. However, most of farmers seemed to have lost interest in growing cashew nut because of unreliable market.

The herd size and composition in both feeding practices, observed in this study was similar to that reported by Teendwa (2005) in Tanga region. The observed high mean herd size of farmers practicing full grazing than those under zero grazing was due to the fact that, farmers practicing full grazing had more breeding bulls than their counterparts. Insuficient breeding bulls automatically results into poor reproductive performance of the herd, and consequently slow down the number of animals in the dairy herds (Lovince, 2004).

In the present study, dairy cattle husbandry practices such as feeding, collection of feeds, house cleaning, milking and health management were performed by both family and hired labour with exception of grazing which was done by hired labour only. These findings were similar to those reported by Teendwa (2005) in Tanga and Kivaria *et al.* (2006) in Dar es salaam. It was observed that hired labourers used for collecting grasses, did not select pastures with good quality; instead they were fetching any pasture in order to save time. These contributed to poor performance of dairy cattle compared to those fed by the owner. Teendwa (2005) argued that farmers are more committed to their work and suggested close supervision for hired labour. Women (wives) were mostly engaged in dairy activities than husbands. This was due to the fact that most of women found in the study area were not engaged in any other income generating activities other than taking care of the dairy cattle and family. These findings are in agreement with those reported by Mlay (2001) that women were playing a bigger role in running most dairy enterprises in Morogoro municipal purposely for increasing household income. The observation that milk sales were mostly done by husbands, was due to the fact that, it was easier for husbands to ride a bicycle and move around hotels and individual customers, which are scattered within and outside the ward to sale milk, of which wives could not manage.

The main sources of forages offered to dairy cattle under both full and zero grazing practices were from communal grazing lands. Natural growing leguminous species such as *Sesbania sesban* and *Macroptilium atropurpureum* were available in the study area, especially in Mlandizi ward, but they were not being offered to dairy cattle. Feeding grasses alone without combining with other forage species do not meet the nutrient requirements of dairy cattle for maintenance and production. Similar observation was reported by Mlay *et al.* (2001) that dairy farmers in Morogoro were feeding their animals largely on natural grass and that these feeds were unable to meet nutritional requirements of the animals for both maintenance and production. Feeding one type of forages to dairy cattle attributed to lack of knowledge on proper feeding of dairy cattle for achieving higher performance. These can be true since most of respondents interviewed had no training in dairy cattle husbandry. Training of these farmers on how to feed their animals properly could bring greater improvement in animal performance. Urassa (1999) reported different milk yield levels of 9.3±1.9, 7.64±1.83 and 6.6±1.84 L/day/cow in Tanga, Muheza and Lushoto, respectively due to influence of training in dairy cattle husbandry. Tanga and Muheza performed better than Lushoto since 86% and 83.3% of their respondents had been trained in dairy cattle husbandry while in Lushoto only 33.3% respondents had been trained. The current study in Kibaha showed that 20% of farmers who had received training in dairy cattle husbandry, had their cows producing more milk (10 l/day) compared to those with no training (6 l/day). Therefore, proper feeding remains the corner stone in dairy cattle performance and through regular training of farmers, improvement in dairy cattle performance can be achieved.

The argument pointed out by farmers practicing full grazing that crop residues such as rice straws were less preferred by cows, was an indication that farmers lack knowledge on the importance and methods of improving crop residues. Training of farmers on various methods of improving quality of crop residues could be one of the strategies of supplementing nutrients to cows during dry season and hence reduce the problem of underfeeding. Molasses and urea supplementation and treating of the straws using wood ash and urea, are some of the feeding strategies reviewed intensively in this study and which can be used by the farmers in the study area to improve utilization of crop residues (Mtamakaya, 2002; Mlay, 2001). Thus, researchers and extension officers are urged to find a way on how these technologies could be disseminated to farmers in the study area.

Cultivated fodder grasses could be used as dry season feeds to cover for the shortage of local grasses but they are less grown in the study area. Farmers know the importance of feeding fodder grasses to cows especially during dry season. Despite its importance, the use of fodder grasses in Kibaha District was very low. The reason given by farmers was lack of enough water for irrigating their established fodder gardens during the dry season. Another reason was the dominance of sand soils in the study area. This type of soil has low water holding capacity. It needs regular irrigation during dry season. In order to reduce this problem of shortage of fodder during dry season, farmers should establish enough fodder during the rainy season when there is adequate moisture and conserve them in form of silage ready for being utilized in the dry season. Farmers in the study area were neither conserving forages nor natural grasses in form of silage or hay, due to lack of exposure on conservation methods. Efforts should be made by development agencies to make sure that conservation methods are introduced and adopted by farmers. This may reduce the problem of feed shortage during the dry season.

In the current study, concentrates were fed mainly during milking to stimulate milk let down as well as means of restraining cows. Despite the fact that most farmers supplemented concentrates to their milking cows; the average milk yield in the study area was still very low. This was probably contributed by small amount of supplements supplied to cows and poor mixing ratio of ingredients used for home made concentrates. Similar findings were reported by Lovince (2004) that, concentrate supplementation of cows in Bukoba district and Turiani division was not effective in relation to milk production, due to sub optimal levels of supplementary feeds in relation to requirements and irregular frequency of supplementation. Half of farmers under full grazing were not supplementing concentrates to milking cows due to what they considered as high cost. Mlay (2001) reported similar observation that smallholder farmers in Morogoro found it hard to invest more cash to feed their animals with concentrates. Farmers should be educated on the importance of supplementing good quality and sufficient quantity of concentrates so as to improve performance of their dairy cattle.

The minimal mineral salts supplemented to dairy cattle under full grazing practice were probably due to lack of insight on the importance of supplementing mineral salts to dairy cattle. The low use of minerals to dairy cattle could be one of the reasons contributing to low milk yield of lactating cows under full grazing practice. Mineral salts supplementation has been reported to improve both production and reproduction performance of dairy cattle. Thus, farmers in the study area should be encouraged to use mineral salts for better improvement of their livestock productivity.

Major feed constraints such as shortage of feeds especially during dry season, high cost of concentrates as perceived by farmers and lack of labour conform to the reported constraints of other smallholder dairy farmers elsewhere in Tanzania (Urassa, 1999; Teendwa, 2005, Kivaria *et al*., 2006). However, smallholder farmers could solve some of the constraints, such as feed shortage during dry season, through feed conservation in form of hay and silage. Farmers should have enough knowledge and skills in silage and hay making. These skills and knowledge could help them to conserve a lot of forage during the period of plenty and feed them to dairy cattle during the dry season. Therefore it can be concluded that optimal feeding of dairy cattle in both full and zero grazing is not attained probably due to lack of knowledge on proper feeding. Feeding mixture of local pasture grasses and legumes, proper mixing of concentrates, proper utilization of crop residues, use of fodder grasses and feed conservation could be the good strategies to be used by farmers to improve the existing feeding practices for better animal performance.

5.2 Nutrient Intakes and Performance of Lactating Cows

The CP content of mixed forages observed in Kibaha District was similar to that reported by Ulime *et al.* (2004) and higher than that reported by Mtui (2004) but lower than that reported by Mwita (2003) and Gimbi (2006). The difference could be due to differences in stages of growth of the forages, types of plant species and amount of plant species in the feed bundles fed to those animals and type of soils where those forages were grown. The observed higher CP content of mixed forages in Mlandizi ward than those collected in Kongowe ward could probably be due to difference in grass-legume composition such as *Cynodon dactylon, Panicum maximum, brachiaria brizantha, Eragrostis superba, chloris gayana*, *Vigna unguiculata* and *Puareria phaseolides* offered to animals from farmers feed bundles in Mlandizi, as compared to forage species such as *Cynodon dactylon, Panicum maximum, Eragrostis superba,* green maize stover and cow peas, offered to animals in Kongowe. Generally, the CP contents of forages in both wards under full and zero grazing practice was insufficient to meet the nutritional requirement of dairy cows if fed alone without supplementation. This was probably due to the fact that, mixed forage species were collected at the end of short rain season, when those forages were approaching maturity stage. Crowder and Chheda (1982) argued that, during the two months after the onset of rain the CP content of forage grasses is above 7 % as grasses advance in maturity, CP contents ranges from 4 % to 6 %. Low CP contents of mixed forages offered to dairy cattle may increase incidence of silent heat and lower conception rate.

The observed values of Ca (0.1-1.3% DM) were similar to those reported by Phiri (2001) and Gimbi (2006). The low content of Ca in mixed forages in all wards was probably due to the fact that Ca content does not change much with the growth stage of the forage (McDonald *et al*., 2002). The P contents of 0.16 and 0.18% DM observed from mixed forages under zero and full grazing in all wards are within the range of 0.1-0.34% DM of forages reported by Phiri (2001) and Gimbi (2006) in Iringa Region and Rungwe, Districts respectively. The observed slightly higher P contents of forages used in Mlandizi than those of Kongowe could probably be due to variation in plant species and growth stages of those forages. These results are in agreement with the findings by Aregheore (2002) that, mineral composition of forages varies according to various factors, such as plant age, soils, fertilization, species, variety, seasons and grazing pressure. The IVDMD of mixed forage samples observed in this study was slightly higher than those of mixed forages reported by Urassa (1999) in Tanga Region. However, it was within the reported range of 30 % to 75 % of tropical grasses (Skertman and Rivores 1990). Furthermore, Temu (1997) argued that good forage that can support high production must have IVDMD of 70 % and above and for moderate production, 50-60 % IVDMD is desired. Those forages with IVDMD less than 50 % will require animals to increase intake to compensate for low digestibility. From those arguments, the overall means of IVDMD of 48.01 and 49.08 of forages under full and zero grazing observed in this study, was low to support high production of dairy cattle. Thus, digestibility of forages used in the study area should be improved through concentrates supplementation.

The high NDF contents of mixed forages under zero grazing in Mlandizi than those of Kongowe, is an indication that forages fed to dairy cattle in Mlandizi, were slightly matured than those of Kongowe. The NDF contents increases as forages approaches maturity (McDonald *et al.*, 2002). Also, the higher NDF contents of refusals of mixed forages under zero grazing in Mlandizi than those of Kongowe, give vivid evidence that, forages of Mlandizi were slightly mature than those of Kongowe.

The ME contents of mixed forages under full grazing (6.88 MJ/kg DM) and under zero grazing (7.02 MJ/kgDM) were higher than those reported by Gimbi (2006) but lower than those reported by Lyimo (2006). The difference was probably due to differences in plant species composition found in the communal grazing lands. Similar observation was reported by Gimbi (2006) that, differences in grass species, stage of maturity, seasons and year when the pasture was cut and analysed, were the main causes of variation in ME content of natural pastures in Rungwe District. Generally, the nutritive values of forages offered to dairy cattle were below the recommended values of 10 MJ/kgDM for supporting high production (Doto *et al.*, 2004). Hence, developing supplementary ration to cover the nutrient deficit and eventually improve animal performance in the study area could be a good feeding strategy.

The observed chemical compostion of concentrates in this study, are in agreement to those reported by Katakweba (2002), Mtui (2004) and Lyimo (2006). However, the observed higher Ca and P contents in concentrates offered to cows under zero grazing than those of cows under full grazing was probably due to the fact that farmers under zero grazing were supplementing more minerals to cows than their counterparts.

In the current study, the observed higher total daily DMI in Kongowe ward than those of Mlandizi, could probably be due to variation in body weight, since cows kept in Kongowe had higher body weight than those of Mlandizi. However, the observed DMI of 120 g/ $kgW^{0.75}$ of cows kept in Kongowe and Mlandizi, was an indication that, cows were not offered enough feeds since they were supposed to consume about 130 g/ $kgW^{0.75}$ and 140g/ $kgW^{0.75}$ for cows of Mlandizi and Kongowe, respectively so as to meet the DMI requirements (McDonald *et al*., 2002). Furthermore, equal DMI observed in Kongowe and Mlandizi could be influenced by high NDF contents of the mixed forage found in those wards. Forages from those wards had similar NDF content which led to similar values of DMI. Feeds with high NDF contents, usually have low digestibility and require more resident time in the rumen and hence limits further intakes (Reed *et al.,* 2000). The observed higher CP, Ca, and P intakes in Mlandizi ward than Kongowe ward, was probably attributed by high CP, Ca and P contained in both forages and concentrates offered to cows in Mlandizi than those of Kongowe.

The observed ages at first calving (AFC) reported by majority of farmers practicing both full and zero grazing of over 2 years old, were similar to values reported by Lovince (2004) of 35.1±9.7 months in Bukoba. The AFC observed in the study area was higher than the recommended AFC of 24 months in a well managed herd under tropical condition.

This was attributed by feeding one type of feed, where most farmers feed their cows with natural pasture with little supplementation of maize bran, cotton seed cake and minerals. Also, poor feeding observed in this study, probably reduced the growth rate of those animals and hence, delayed age at puberty. Furthermore, high temperature found in the study area, could be among the factors delayed growth rates in those animals.

The observation that calving intervals (CI) for full grazing was lower than that of zero grazing cows was due to the fact that, it was easy for bulls to detect cows on heat and mate them during grazing as compared to cows under zero grazing (Nkya and Swai, 1999). This is because confinement and isolation of animals contributed to decrease in oestrus expression in animals that have to be accurately identified to be in heat for timely and successful breeding. On the other hand, long CI of cows under zero grazing was contributed by fewer bulls kept in the study area. Some of the farmers had no access to bulls for mating their cows on time and some time cows were mated when oestrus was approaching the end due to travelling long distances seeking for bulls. This led to lower conception rate in such a way that cows did not calve yearly and resulted into long CI. Artificial insemination (AI) could be used to supplement the breeding bulls in the study area, since it increases the genetic merit of the herd through use of semen from sounding bulls. It also eliminates the cost of keeping bulls and reducing risk of acquiring veneral diseases. Although there is no access to AI services in the study area, livestock officers in Kibaha district should find a means of initiating AI services purposely for improving reproductive performances and genetic make up of the dairy herd.

The observation that cows under zero grazing practice performed better than those under full grazing practice in both wet and dry season in terms of milk production was due to the fact that, farmers practicing full grazing were supplementing low concentrate and minerals to their lactating cows, which contributed mainly to low milk yield as compared to cows under zero grazing. Similarly farmers practicing zero grazing are able to harvest green forages from wetlands during the dry season where grazing animals have no access. In addition, little crop residues supplemented to those cows during dry season was another reason that contributed to low milk yield. Similar observation has been reported by Gimbi (2006) that, variation in mean milk yield in Rungwe District was largely due to difference in feeding management, especially concentrate feeding, because milk yield is strongly influenced by the amount of concentrate fed. Similarly, Teendwa (2005) reported average milk yield of 9.84, 8.65 and 6.94 l /cow/day in Tanga, Muheza and Lushoto, respectively. The difference in milk yield was due to level of use of concentrate supplementation of which Tanga had higher use of concentrates compared to other districts.

The observed higher milk yield of cows under full grazing in Kongowe than that of Mlandizi during field monitoring was probably due to feeding lactating cows with different plant species found in those wards. This finding is supported by Ribeiro Filho *et al.* (2004) who reported reduction in milk production by 1.3 kg/day from cows grazing in mixed swards as compared to those grazing in rye grass swards due to slight reduction of herbage nutritive value. It was also observed in the current study that, lactating cows under zero grazing in Kongowe had higher average milk yield than those of Mlandizi. It was expected that, cows in Mlandizi could produce more milk than those of Kongowe since cows in Mlandizi had higher CP, Ca and P intakes than those of Kongowe. But it happened differently. The difference in average milk yield between those two wards could probably be attributed to variation in genetic make up of the animals it could be cows in Kongowe had higher genetic make up for milk production than those of Mlandizi.

The findings that average milk yield of lactating cows measured under zero grazing in all wards to be slightly higher than lactating cows under full grazing is in agreement with that reported by Urassa (1999) in Tanga district that, cows under zero grazing had higher milk yield (9.1 l/day) than those under full grazing (7.3 l/day). The reason for these differences is probably not due to nutritive value of the mixed forages, since there was no significant difference between practices in nutritive values observed in the study area. The reason could probably be due to the fact that cows under full grazing were spending some energy for walking long distances (3 km) during grazing, which might have contributed to low milk yield. Cows under full grazing were exposed to solar radiation for a long time during grazing which caused heat stress to those cows and consequently, reduced milk yield as compared to those confined in the shade. Lack of water during grazing could be another reason that contributed to low milk yield. Cows were grazed for long time in the communal grazing land without being offered drinking water. Those cows were watered after grazing time. Lack of drinking water during grazing probably reduced their feed intakes and this resulted into low milk yield of those cows. The average milk production observed in the current study was almost similar to what has been reported by Mtui (2004) of above 5 l/cow/day during the wet season in Turian Division in Morogoro Region. However, this amount was low compared to what has been reported elsewhere in Tanzania for cross bred cattle (Mlay, 2001; Lyimo, 2004; Gimbi, 2006). The poor milk production could be due to poor feeding practice which did not meet the nutrient requirements for lactating cows in the study area. Also, high temperature found in Kibaha district could be another factor that contributed to low milk yield of those cows, since high temperature reduces animal feed intakes and eventually result into low milk production. Moreover, the amount of feed offered to lactating cows did not meet the expected production potential of 15 l/day (Falvey and Chantalakhana, 1999) for cross bred cows weighing 400kg.

The reported higher milk yield of cows during survey under both feeding practices than the yield observed during field monitoring was due to the fact that farmers in the study area were not keeping records making it difficult for them to estimate the exact amount of milk they got from their cows. However, the recorded milk yield of cows in both experiments was low compared to their genetic potential of producing an average of 15 l/cow/d (Falvey and Chantalakhana, 1999). Thus, formulation of cost effective feeding strategy could improve the nutrients intake and hence improve livestock productivity in the study area.

5.3 Feeding Plan to Improve Performance

It has been revealed that cows in the study area are not producing according to their genetic potential mainly because of underfeeding. Currently, the estimated daily nutrient intakes of 76.42 MJME, 658g CP, 26.06g Ca and 18.79g P (Appendix 8) obtained when cows are offered mixed ration in the wet season, do not meet a production potential of these cows to produce 15 l/day of milk. Supplementary ration could cover the nutrient deficit and enable the cows to increase production. According to NRC (2001), cows weighing 400 kg will require 118.2 MEMJ, 1670 g CP, 64 g Ca, and 40.7 g P, to produce 15 l/day. Therefore, supplementary ration supplying 41.6 MJ, 1012 g CP, 38 g Ca and 22 g P per day will be required to cover the deficit of 9 l/day of milk. This can be obtained when a cow is fed supplementary ration that consists of 1.0 kg DM of maize bran (1.1 kg as fed), 0.4 kgDM of cassava meal (0.5 kg as fed); 2.53 kg of cotton seed cake (3 kg as fed) and 0.15 kg of cattle mix (Appendix 8). This ration is formulated based on the available ingredients in the study area and the current feeding management of those cows. The available nutrient concentration was estimated according to Tanzania Feedstuff Table (Doto *et al*., 2004). The nutrients required for supplementary ration were balanced using algebraic equation as indicated in Appendix 8.

This supplementary ration is assumed that it will increase milk yield from 6 to 15 l/day per cow in the study area during the wet season. However, it should be tested to validate the response in terms of milk yield before being used by farmers in the study area during the wet season. Also, another monitoring study should be done during the dry season so as to establish the supplementary ration which will help to improve milk production of cows during the dry season in that area. These rations should be tested for both full and zero grazing practices during wet and dry seasons. This will help to make some modification of the ration so as to meet the production potential of these cows.

The gross margin of proposed supplementary ration for producing 9 l of milk per day is indicated in appendix 8. It can be derived using the current prices of ingredients available in the study area. However, this can change depending on time the ration is being used.

5.4 Limitations of the Study

1. Some of the information collected from farmers relied on memories of respondents and their openness in explaining facts and figures. This was due to the fact that farmers were not keeping records. In many cases, however, farmers do not recall everything or be faithful as expected.
2. The study area had no enough dairy cows; so, it was difficult to consider parameters such as breed effects, stage of lactation, parity and age and size of cows.
3. Nutrients intakes for cows under full grazing was not determined due to lack of resources. However, their performance was predicted based on the evaluation of quality of grazed forages found in the communal grazing lands.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the results of the present study, the following conclusions were drawn:

(i) Two feeding practices that is zero grazing and full grazing were practiced in the study area.

(ii) Lactating cows under zero grazing performed better in terms of milk yield and reproductive performance than those under full grazing.

(iii) Production performance of cows under the two feeding practices was below their genetic potential attributed to underfeeding.

6.2 Recommendations

(i) More training of farmers on dairy cattle husbandry should be conducted regulary so as to improve livestock performance in Kibaha district.

(ii) Further monitoring of performance of cows and quality of feeds offered to those cows during dry season is required for establishing supplementary ration, which could be used to improve productivity of dairy cattle in Kibaha district.

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APPENDICES

Appendix 1: Survey questionnaire

SITE AND FARM IDENTIFICATION
Questionnaire serial No.
Enumerator's name……………………………….…Code……………….
Respondent's name:……………………………. Age:………………Sex: M[ ]F[ ]
Sub location/village:……………………………
Location/Ward:…………………………………
Division:……………………………………..
1. District:…………………………………………
2. Province/Region:………………………………
3. Country:……………………………………….

RESPONDENT PROFILE
(**If possible, these questions should be asked at the end of the interview)**
4. Is the respondent the head of this household : Yes [ ] No [ ]
   If no to the above:
5. What is the respondent's relationship to the head of household?
   Husband [ ] Wife [ ] Son [ ] Daughter [ ] Farm worker [ ] others (Specify…..]
6. What is the marital status of the respondent?
   Married [ ] Single [ ] Widow/Widower [ ] Divorced [ ]
7. Is the respondent having any formal education? Yes [ ] No [ ]
8. If yes to the above, what is his/her highest level of education?
   Primary school [ ] Secondary school [ ] Post secondary college [ ] University [ ]
9. Have you attended any of the following agriculture-based training
   Short courses in agriculture [ ] Certificate agriculture [ ] Farmer Field School Training [ ] others (specify …………]

HOUSEHOLD STRUCTURES AND FARM LABOUR USE

10 How many persons reside in the household according to their age groups and sex? **Give numbers**

	0-14 yrs	15-45 yrs	45-60yrs	Over 60 yrs	Total
Male					
Female					

11 How many persons in the households are involved in farming activities according to age group and sex? **Give numbers**.

	9-14 yrs	15-45 yrs	45-60yrs	Over 60 yrs	Total
Male					
Female					

12 Who performs the following activities on the farm ***(Tick where relevant)***

Activity	**Actor/ Actress**						
	Father	**Mother**	**Son**	**Daughter**	**Hired labour**	**Others**	**Remarks**
Grazing							
Feed collection							
Feeding							
Milking							
Milk sales							
Health management/care							

HOUSEHOLD LAND OWNERSHIP AND USE

13What is the total land acreage owned by the household?.............

14Of the total land owned, how many acres are under: Cash crops [ ] Food crops [ ] Pastures [ ] Planted fodders [ ] others (specify)…………..

15Which of these food crops did the households grow during last year's long rains season? **(Rank from 1= most important to 7= least important)**

CROP	**RANKS (1 to 7)**						
	1	2	3	4	5	6	7
Sorghum							
Maize							
Beans							
Groundnuts							
Sweet potatoes							
Cassava							
Cashew nuts							
Rice							

16 Out of the income form farm produce, what proportion (%) comes from: Cash crop [ ] Milk sales [ ] Livestock sales [ ] others (specify……………]

LIVESTOCK INVENTORY AND HERD STRUCTURE

17 What type of livestock do you keep on the farm? (**Rank them in order of importance**) (**Rank from 1=most important to 5=least important)**

SPECIES/TYPE	**RANK**						
	1	2	3	4	5	6	7
Local cattle							
Exotic cattle							
Sheep							
Goats							
Local chicken							
Exotic chicken							
Others (specify…..)							

18 What is the herd structure of your livestock?

(i) Give numbers in each category for cattle

	Mature livestock				**Young livestock**			
Total	Breeding females	Breeding males	Non-Breeding males	Non-breeding females	Heifers	Bulls	Heifer calves	Bull calves

19 What livestock management/production system do you practice on your farm? ***(Tick the relevant system)***

	Cattle	**Goats**	**Sheep**
All grazing			
Grazing with some stall feeding			
Stall feeding with some grazing			
Zero grazing			
Tethering			
Others (specify)			

20 Are your cattle housed: Only at night [ ] Part of the day [ ] both day and night [ ] Not at all [ ].

21 If household at any time, what type of housing do you have?

(i)Enclosed structure: wooden walled [ ] stone/brick walled [ ] others (Specify ….)

(ii)Housing structure: Iron roofed with concrete flow [ ] Iron roofed with murram floor [ ] Grass thatched with murram floor [ ] others (specify……………..)

LIVESTOCK FEEDS AND FEEDINGS PRACTICES

22 Enumerate the Feed types and amount offered per cow/day on your farm

Class of feed	**Type (specify)**	**Source**	**Class of animal fed *(Tick the relevant)***			
Roughage	1. Local pasture grass		Calves	Milking cows	Dry cows	Bulls
	2. Fodder grasses					
	3. Crop residue (specify……)					
Concentrates	1. Purchased dairy meal					
	2. Home made concentrate (specify ingredients….)					
	3. Agro-industrial by products (specify ………)					
Minerals salts	1. Purchased compound salts					
	2. Common table salt					
	3. Others (specify……..)					
Water						
Others e.g poultry droppings, banana pseudostems, sweet potato vines etc (specify)	1. 2. 3. 4. 5. 6.					

23 What other potential feed resources do you think could be utilized locally for livestock feeding?

	Cattle	**Goats**	**Sheep**
1.			
2.			
3.			
4.			

MAJOR FEEDING CONSTRAINTS

24 Which of the following are major constraints to livestock feeding on your farm?
(Rank follows: 1=always a problem; 2= only a problem seasonally; 3= not a serious problem)

Constraints	Rank		
	1	2	3
Shortage of basal feeds			
High cost of concentrate feeds			
Unavailability of concentrate feeds			
Lack of labour for feeding livestock			
Others (specify…..)			

25 In which months of the year do you experience?
Surplus feeds [i……..,ii………,iii…….] and feed shortage [i……, ii…….,iii…...]

26 What do you normally do when you have excess feed on your farm?
Conserve as hay [ ] Conserve as silage [ ] Sale [ ] Do nothing [ ] Others; specify…[ ]

27 What do you normally do when you have shortage of feed on your farm?
Purchase feeds [ ] Sale some animals [ ] temporarily loan to friends/relatives [ ]
Do nothing [ ]

28 What is the source of water for livestock on your farm?
River [ ] Pond [ ] Lake [ ] Dam [ ] Borehole [ ] Piped water [ ] Protected spring [ ]
Other, specify….[ ]

29 How far is the main water source from your farm?
It is on the farm [ ] less than 500 m [ ] about 1km [ ] about 2 km over 2km away [ ]

REPRODUCTIVE PERFORMANCE

30 What is the source of your replacement stock? (Tick where appropriate)
Rear Own [ ] Buy from market [ ] Exchange/barter [ ] others; specify…….[ ]

31 How do you often know if your cow needs bully/services? (Tick where appropriate)

Change in cow behaviour (mountain, bellowing, restlessness etc.	
Change in milk production	
Change in feed intake	
Mucus discharge form the vulva	
Do not know	

32 How often do your cows come on heat? (Tick where applicable)?
Every month [ ] every two months [ ] Do not know [ ] others, specify [ ]

33 At what age do your cows produce their first call? (Tick where applicable)
In less than 2 years old [ ] when 2 years old [ ] when over 2 years old [ ]

34 How often do your cows calve down? (Tick where applicable)
Every year [ ] every two years [ ] after more than 2 years [ ]

MILK PRODUCTION

35 What is the average milk production per animal per day during

a) The wet season?……..litres
b) The dry season?……..litres

Appendix 2a: Chemical composition of mixed forages and concentrates from Mlandizi and Kongowe wards in two feeding practices

COW	WARD	FEEIND P PRACTICE	DM	%CP	%IVDMD	ME	%Ca	%P
MIXED FORAGS								
1	Mlandizi	Zero	31.4	6.88	49	6.63	0.25	0.23
2	Mlandizi	Zero	25.8	6.45	43.58	7.03	0.22	0.18
3	Mlandizi	Zero	35.9	5.8	47.3	6.76	0.27	0.24
4	Mlandizi	Zero	39.2	6.6	57.31	6.8	0.24	0.2
5	Mlandizi	Zero	30	6.3	45	7.24	0.26	0.19
6	Mlandizi	Zero	38.7	5.53	51.6	7.6	0.2	0.21
1	Kongowe	Zero	32	6.09	50.08	7.4	0.26	0.15
2	Kongowe	Zero	34	5.82	47	6.61	0.23	0.13
3	Kongowe	Zero	28.1	6	48.61	7.06	0.21	0.13
4	Kongowe	Zero	36.48	5.9	48.15	6.88	0.24	0.16
5	Kongowe	Zero	32.3	6.02	50.44	6.9	0.25	0.17
6	Kongowe	Zero	33.96	5.6	49.5	7.23	0.23	0.14
GRAZING LAND								
1	Mlandizi	Full	25.54	6.17	44.87	6.41	0.21	0.25
2	Mlandizi	Full	26.05	6.6	50.17	7.19	0.2	0.16
3	Mlandizi	Full	26.58	6.38	50.84	7.29	0.25	0.12
1	Kongowe	Full	3060	5.2	47.28	6.77	0.3	0.14
2	Kongowe	Full	31.31	6.24	47.56	6.85	0.26	0.17
3	Kongowe	Full	30.75	6.47	47.89	6.8	0.27	0.15
CONCENTRATES								
1	Mlandizi	Zero	95.63	17.32	65.53	9.45	0.3	0.86
2	Mlandizi	Zero	95.08	9.53	72.94	10.27	5.72	0.94
3	Mlandizi	Zero	94.94	11.65	71.64	10.35	1.86	0.94
1	Kongowe	Zero	93.63	11.9	78.04	11.29	0.96	1.36
2	Kongowe	Zero	95	14.66	68.26	9.86	1.02	0.87
3	Kongowe	Zero	95.14	12.1	65.15	9.4	0.15	0.08
1	Mlandizi	Full	95.16	12.3	69.98	10.1	0.02	0.83
2	Mlandizi	Full	94.55	12.31	79.6	11.32	1.14	1.25
3	Mlandizi	Full	95.33	12.64	68.82	9.94	0.06	0.86
1	Kongowe	Full	94.47	14.31	72.05	10.41	1.68	0.82
2	Kongowe	Full	95.32	11.87	67.76	9.78	0.13	0.96
3	Kongowe	Full	95.92	10.67	72.21	10.43	4.04	1.01

Appendix 2b: Chemical composition of refusals from Mlandizi and Kongowe wards in zero grazing

COW	WARD	%CP	%Ca	%P	%IVDMD	ME
1	KONGOWE	1.8	0.19	0.23	43.17	6.57
2	KONGOWE	2.55	0.14	0.19	45.12	5.88
3	KONGOWE	1.55	0.16	0.08	47.48	5.72
4	KONGOWE	1.62	0.18	0.1	42.25	6.01
5	KONGOWE	1.75	0.15	0.06	44.77	5.39
6	KONGOWE	1.85	0.17	0.16	41.59	5.62
7	MLANDIZI	3.22	0.18	0.24	37.5	5.43
8	MLANDIZI	3.04	1.1	0.21	40.18	6.23
9	MLANDIZI	1.98	1.3	0.27	41.72	5.7
10	MLANDIZI	1.49	0.16	0.59	39.34	6
11	MLANDIZI	2.22	0.19	0.26	41.3	6.67
12	MLANDIZI	2.5	1.4	0.69	40.59	7.98

Appendix 2: ANOVA for effect of feeding practice on the chemical composition, invitro dry matter digestibility (IVDMD) and ME contents of mixed forages by wards in Kibaha district

Dependent Variable: D M

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing systems	1	66.74083333	66.74083333	7.59	0.0249
Ward	1	13.27203333	13.27203333	1.51	0.2542
Grazing system*ward	1	22.30413333	22.30413333	2.54	0.1500

Dependent Variable: CP

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing systems	1	0.02083333	0.02083333	0.08	0.7859
Ward	1	0.39603333	0.39603333	1.50	0.2555
Grazing systems*wards	1	0.00750000	0.00750000	0.03	0.8704

Dependent Variable: IVDD

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing systems	1	2.88120000	2.88120000	0.16	0.6970
Wards	1	0.50430000	0.50430000	0.03	0.8700
Grazing systems*ward	1	1.22880000	1.22880000	0.07	0.7987

Dependent Variable: MEC

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing systems	1	0.05467500	0.05467500	0.14	0.7156
Wards	1	0.01400833	0.01400833	0.04	0.8532
Grazing systems*ward	1	0.02340833	0.02340833	0.06	0.8111

Dependent Variable: Ca

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing systems	1	0.00030000	0.00030000	0.37	0.5613
Wards	1	0.00213333	0.00213333	2.61	0.1447
Grazing systems*wards	1	0.00270000	0.00270000	3.31	0.1065

Dependent Variable: P

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing systems	1	0.00140833	0.00140833	0.49	0.5056
Wards	1	0.00800833	0.00800833	2.76	0.1351
Grazing systems*wards	1	0.00040833	0.00040833	0.14	0.7172

Appendix 3: Raw data for DM, CP, Ca, P intakes in kg or g per kg metabolizable body weight.

DMI-MLANDIZI (kg/ kg W $^{0.75}$)

COW 1	COW 2	COW3	COW4	COW 5	COW6
0.110531	0.106552	0.095362	0.081189	0.137635	0.113639
0.114137	0.110531	0.137138	0.125451	0.137884	0.137635
0.135149	0.124207	0.063641	0.042894	0.153674	0.105558
0.138381	0.123959	0.067263	0.073729	0.163869	0.169215
0.140619	0.134278	0.150566	0.135646	0.154793	0.10133
0.158523	0.089022	0.091259	0.145717	0.105558	0.153674
0.14783	0.114137	0.127067	0.075842	0.159642	0.15902
0.141365	0.120602	0.127937	0.135149	0.168594	0.154793
0.116996	0.129554	0.155539	0.133159	0.137635	0.137635
0.106801	0.147084	0.116499	0.082929	0.143976	0.143976
0.110531	0.102449	0.085416	0.100336	0.147333	0.149447
0.099341	0.106552	0.151063	0.165983	0.141862	0.137014
0.096233	0.120602	0.106925	0.06142	0.144598	0.144598
0.117742	0.095984	0.100211	0.099714	0.132786	0.127564
0.096854	0.119483	0.116996	0.068755	0.156907	0.154793
0.113142	0.112893	0.119731	0.124207	0.130673	0.138133
0.093249	0.115628	0.143479	0.127067	0.147333	0.147333
0.099341	0.119483	0.07808	0.106677	0.149944	0.153674
0.086411	0.119731	0.133905	0.127689	0.152058	0.152058
0.120602	0.136516	0.103693	0.112396	0.139127	0.132786
0.090016	0.117493	0.094492	0.089892	0.098595	0.128062
0.092876	0.108666	0.089643	0.073729	0.137387	0.149447
0.110158	0.10046	0.100584	0.099714	0.154171	0.152058
0.117493	0.134278	0.120602	0.07721	0.120477	0.115753
0.100336	0.117618	0.127937	0.088151	0.148452	0.176924
0.106677	0.100211	0.105931	0.103941	0.157031	0.15156
0.107174	0.116623	0.10332	0.067015	0.150193	0.149447
0.103941	0.106801	0.093124	0.081686	0.170832	0.156907

DMI-KONGOWE(kg/ kg W $^{0.75}$)

COW 1	COW 2	COW3	COW4	COW 5	COW6
0.07151	0.056708	0.124778	0.20171	0.112061	0.182633
0.078599	0.067132	0.119879	0.236631	0.111435	0.212134
0.099864	0.049307	0.07495	0.23194	0.108412	0.167622
0.100281	0.019493	0.109768	0.246221	0.118732	0.199729
0.117586	0.038466	0.116856	0.219327	0.115084	0.126968
0.127906	0.032732	0.109872	0.24299	0.148546	0.093193
0.116543	0.049307	0.103826	0.258835	0.126134	0.141457
0.121443	0.05431	0.129782	0.221307	0.085375	0.162202
0.139581	0.061295	0.109872	0.235588	0.115814	0.183154
0.117586	0.051809	0.104764	0.223184	0.115814	0.124778
0.127906	0.055874	0.063901	0.28281	0.126134	0.108204
0.1204	0.067966	0.049932	0.212968	0.089127	0.143542
0.113833	0.061503	0.064005	0.217763	0.115084	0.153966
0.143229	0.075993	0.062963	0.23809	0.089127	0.135307
0.092984	0.051809	0.075889	0.221828	0.119462	0.128948
0.117586	0.053268	0.069843	0.248098	0.126134	0.128114
0.139477	0.05848	0.088502	0.239133	0.08944	0.149797
0.142291	0.057333	0.067132	0.274784	0.122485	0.124778
0.152403	0.078599	0.05994	0.238507	0.096424	0.126134
0.163974	0.077661	0.057959	0.226207	0.119462	0.116335
0.093297	0.050349	0.054936	0.216408	0.122485	0.169811
0.121755	0.057229	0.067966	0.214531	0.118732	0.173043
0.128635	0.050558	0.065881	0.223913	0.092776	0.121338
0.098822	0.080371	0.067966	0.184822	0.115814	0.123632
0.112791	0.062754	0.109872	0.223601	0.118732	0.1548
0.089023	0.062546	0.059001	0.242156	0.148442	0.128531
0.111018	0.06807	0.049932	0.206609	0.118732	0.131554
0.117273	0.067966	0.074846	0.206401	0.144793	0.128948

CP INTAKES MLANDIZI (g/ g W $^{0.75}$)

COW 1	COW 2	COW3	COW4	COW 5	COW6
7.604526	7.330797	4.424779	5.424779	8.836181	7.295636
7.852592	7.604526	6.837063	6.837063	8.852145	8.836181
9.298222	8.545468	2.337747	3.337747	9.865871	6.7768
9.520627	8.52836	4.018215	5.018215	10.5204	10.86363
9.674599	9.238344	7.392702	6.392702	9.93771	6.505408
10.90638	6.12468	7.941564	7.645564	6.7768	9.865871
10.17073	7.852592	4.133408	4.1243408	10.24901	10.2091
9.725923	8.297401	7.365597	7.866597	10.82372	9.93771
8.049335	8.913291	7.25718	6.35618	8.836181	8.836181
7.347905	10.11941	4.519644	4.829644	9.243267	9.243267
7.604526	7.048514	5.468295	5.278295	9.458784	9.59448
6.834664	7.330797	9.046065	8.152065	9.107572	8.79627
6.620813	8.297401	3.347383	4.517383	9.283178	9.283178
8.100659	6.603705	5.434415	6.832415	8.524879	8.524879
6.663583	8.220415	3.747171	4.527171	10.07341	9.93771
7.78416	7.767052	6.769302	6.569302	8.389183	8.389183
6.415517	7.955241	6.925152	6.785152	9.458784	9.458784
6.834664	8.220415	5.813875	5.333875	9.865871	9.865871
5.945045	8.237523	6.959033	6.979033	9.762104	9.762104
8.297401	9.392316	6.125575	6.415572	8.931966	8.524879
6.193112	8.083551	4.899105	5.778104	8.221559	8.221559
6.389855	7.476215	4.018215	4.618217	9.59448	9.59448
7.578864	6.91165	5.434415	5.135415	9.897799	9.762104
8.083551	9.238344	4.207945	4.007145	7.431332	7.431332
6.903096	8.092105	4.80424	4.40721	11.35852	11.35852
7.339351	6.894542	5.664802	5.884802	9.730175	9.730175
7.373567	8.023673	5.630921	5.238101	9.59448	9.59448
7.151163	7.347905	5.075283	5.457233	10.07341	10.07341

CP INTAKES KONGOWE (g/ kg W $^{0.75}$)

COW 1	COW 2	COW3	COW4	COW 5	COW6
4.354988	3.453518	7.361931	11.90087	6.521943	10.62925
4.786678	4.088356	7.072866	13.96122	6.485542	12.34619
6.081747	3.002783	4.422079	13.68446	6.309601	9.755613
6.107141	1.187147	6.476285	14.52705	6.910226	11.62423
7.160972	2.342552	6.894506	12.94027	6.697884	7.389513
7.789461	1.993391	6.482435	14.33639	8.645366	5.42383
7.097488	3.002783	6.125717	15.27124	7.340978	8.232816
7.395862	3.307505	7.657146	13.05712	4.968811	9.440133
8.50048	3.732847	6.482435	13.89972	6.740352	10.65959
7.160972	3.155144	6.18107	13.16783	6.740352	7.262108
7.789461	3.402731	3.770145	16.68581	7.340978	6.297467
7.332378	4.139143	2.946002	12.5651	5.18722	8.354154
6.93243	3.745544	3.776295	12.84801	6.697884	8.960846
8.722673	4.627968	3.714792	14.04733	5.18722	7.874867
5.662754	3.155144	4.477431	13.08788	6.952695	7.504785
7.160972	3.244022	4.120713	14.63776	7.340978	7.456249
8.494131	3.561441	5.22162	14.10883	5.205421	8.718169
8.665537	3.491608	3.960805	16.21224	7.128635	7.262108
9.28133	4.786678	3.536433	14.07193	5.611905	7.340978
9.986	4.729542	3.419577	13.34619	6.952695	6.770687
5.681799	3.066267	3.241218	12.76806	7.128635	9.883019
7.414907	3.48526	4.010007	12.65735	6.910226	10.07109
7.8339	3.078964	3.887001	13.21088	5.399562	7.061899
6.018263	4.8946	4.010007	10.90451	6.740352	7.195372
6.868946	3.821724	6.482435	13.19243	6.910226	9.009382
5.421516	3.809027	3.48108	14.28719	8.639299	7.480517
6.761024	4.145492	2.946002	12.18993	6.910226	7.656458
7.141926	4.139143	4.415928	12.17763	8.426957	7.504785

Ca INTAKES MLANDIZI (g/ kg $W^{0.75}$)

CaCOW1	CaCOW2	CaCOW3	CaCOW4	CaCOW5	CaCOW6
0.298433	0.287691	0.261355	0.162377	0.344088	0.284098
0.308169	0.298433	0.214472	0.250901	0.34471	0.344088
0.364901	0.33536	0.113391	0.085789	0.384185	0.263894
0.373629	0.334689	0.134154	0.147457	0.409673	0.423039
0.379672	0.362551	0.278006	0.271292	0.386982	0.253326
0.428012	0.240358	0.258113	0.291434	0.263894	0.384185
0.399142	0.308169	0.180281	0.151685	0.399105	0.397551
0.381686	0.325625	0.23536	0.270297	0.421485	0.386982
0.31589	0.349795	0.206764	0.266319	0.344088	0.344088
0.288363	0.397128	0.191844	0.165859	0.35994	0.35994
0.298433	0.276613	0.214099	0.200671	0.368333	0.373617
0.268221	0.287691	0.310954	0.331966	0.354656	0.342534
0.259828	0.325625	0.14323	0.12284	0.361494	0.361494
0.317904	0.259157	0.220937	0.199428	0.331966	0.331966
0.261507	0.322604	0.162253	0.137511	0.392267	0.386982
0.305483	0.304812	0.194082	0.248415	0.316584	0.326682
0.251772	0.312197	0.238344	0.254134	0.338333	0.368333
0.268221	0.322604	0.229765	0.213353	0.346186	0.384185
0.233308	0.323275	0.20552	0.255377	0.380144	0.380144
0.325625	0.368594	0.234365	0.224792	0.347818	0.331966
0.243044	0.317232	0.199304	0.179784	0.320154	0.320154
0.250765	0.293398	0.172075	0.147457	0.373617	0.373617
0.297426	0.271242	0.228397	0.199428	0.385428	0.380144
0.317232	0.362551	0.179535	0.15442	0.335382	0.289382
0.270906	0.317568	0.148949	0.176302	0.64211	0.44231
0.288027	0.270571	0.225662	0.207883	0.421941	0.378901
0.28937	0.314883	0.250653	0.206639	0.373617	0.355522
0.280642	0.288363	0.154793	0.186249	0.344427	0.392267

Ca INTAKES OF KONGOWE (g/ kg W $^{0.75}$)

CaCOW1	CaCOW2	CaCOW3	CaCOW4	CaCOW5	CaCOW6
0.157323	0.124758	0.274513	0.443761	0.31377	0.511373
0.172918	0.147691	0.263734	0.520588	0.312019	0.593975
0.219702	0.108475	0.164891	0.510268	0.303555	0.469342
0.220619	0.042885	0.241489	0.541687	0.332451	0.559241
0.258689	0.084624	0.257083	0.482519	0.322235	0.355509
0.281393	0.072011	0.241718	0.534577	0.415928	0.26094
0.256395	0.108475	0.228417	0.569436	0.353174	0.39608
0.267174	0.119483	0.285521	0.486876	0.239049	0.454164
0.307078	0.134848	0.241718	0.518295	0.324278	0.512832
0.258689	0.113979	0.230481	0.491004	0.324278	0.34938
0.281393	0.122923	0.140582	0.622183	0.353174	0.302971
0.264881	0.149526	0.109851	0.468529	0.249557	0.401918
0.250433	0.135307	0.140811	0.479078	0.322235	0.431106
0.315105	0.167184	0.138518	0.523799	0.249557	0.37886
0.204566	0.113979	0.166955	0.488023	0.334494	0.361055
0.258689	0.11719	0.153654	0.545815	0.353174	0.35872
0.306849	0.128656	0.194704	0.526092	0.250433	0.419431
0.313041	0.126134	0.147691	0.604524	0.342958	0.34938
0.335286	0.172918	0.131867	0.524716	0.269989	0.353174
0.360742	0.170854	0.12751	0.497655	0.334494	0.325738
0.205254	0.110768	0.120859	0.476097	0.342958	0.475472
0.267862	0.125904	0.149526	0.471969	0.332451	0.48452
0.282998	0.111227	0.144939	0.492609	0.259773	0.339748
0.217409	0.176816	0.149526	0.406609	0.324278	0.346169
0.248139	0.138059	0.241718	0.491921	0.332451	0.433441
0.195851	0.1376	0.129803	0.532743	0.415636	0.359887
0.244241	0.149755	0.109851	0.45454	0.332451	0.368352
0.258001	0.149526	0.164662	0.454081	0.405421	0.361055

P INTAKES OF MLANDIZI (g/ kg W $^{0.75}$)

PCOW1	PCOW2	PCOW3	PCOW4	PCOW5	PCOW6
0.331593	0.319657	0.163161	0.138021	0.220216	0.181823
0.34241	0.331593	0.180997	0.213266	0.220614	0.220216
0.405446	0.372622	0.106465	0.072921	0.245878	0.168892
0.415144	0.371876	0.187505	0.125339	0.262191	0.270745
0.421858	0.402835	0.225152	0.230598	0.247669	0.162129
0.475569	0.267065	0.173281	0.247719	0.168892	0.245878
0.443491	0.34241	0.208256	0.128932	0.255427	0.254432
0.424095	0.361805	0.124389	0.229753	0.26975	0.247669
0.350988	0.388661	0.218985	0.226371	0.224257	0.220216
0.320403	0.441253	0.115019	0.14098	0.227229	0.230362
0.331593	0.307348	0.141577	0.170571	0.235733	0.239115
0.298023	0.319657	0.257839	0.282171	0.22698	0.219222
0.288698	0.361805	0.104414	0.104414	0.199167	0.231356
0.353226	0.287952	0.169514	0.169514	0.265287	0.212458
0.290563	0.358448	0.116884	0.242708	0.251051	0.247669
0.339426	0.33868	0.211153	0.266729	0.247582	0.209076
0.279746	0.346885	0.216014	0.178714	0.224468	0.235733
0.298023	0.358448	0.18135	0.18135	0.199577	0.245878
0.259232	0.359194	0.217071	0.217071	0.243292	0.243292
0.361805	0.409549	0.191073	0.191073	0.222604	0.212458
0.270048	0.35248	0.150541	0.152816	0.229765	0.210494
0.278627	0.325998	0.142173	0.125339	0.241228	0.239115
0.330474	0.30138	0.176762	0.169514	0.246674	0.243292
0.35248	0.402835	0.131257	0.158809	0.214472	0.185205
0.301007	0.352853	0.149857	0.15631	0.271615	0.283078
0.32003	0.300634	0.1767	0.146761	0.247756	0.242497
0.321522	0.349869	0.175643	0.214149	0.264901	0.239115
0.311824	0.320403	0.158312	0.165771	0.259269	0.226184

P INTAKES OF KONGOWE (g/ kg W $^{0.75}$)

PCOW1	PCOW2	PCOW3	PCOW4	PCOW5	PCOW6
0.092964	0.07372	0.149734	0.242051	0.212916	0.347003
0.102179	0.087272	0.143855	0.283957	0.211727	0.403054
0.129824	0.064099	0.089941	0.278328	0.205984	0.318482
0.130366	0.025341	0.131721	0.295465	0.225592	0.379485
0.152861	0.050005	0.140227	0.263192	0.218659	0.241238
0.166277	0.042552	0.131846	0.291588	0.282237	0.177067
0.151506	0.064099	0.124591	0.310601	0.239654	0.268769
0.157876	0.070604	0.155739	0.265569	0.162212	0.308183
0.181455	0.079683	0.131846	0.282706	0.220046	0.347993
0.152861	0.067351	0.125717	0.26782	0.220046	0.237079
0.166277	0.072636	0.076681	0.339372	0.239654	0.205587
0.15652	0.088356	0.059919	0.255561	0.169342	0.27273
0.147983	0.079954	0.076806	0.261316	0.218659	0.292536
0.186198	0.098791	0.075555	0.285708	0.169342	0.257083
0.12088	0.067351	0.091066	0.266194	0.226978	0.245002
0.152861	0.069248	0.083811	0.297717	0.239654	0.243417
0.18132	0.076024	0.106202	0.286959	0.169936	0.284614
0.184979	0.074534	0.080559	0.32974	0.232722	0.237079
0.198124	0.102179	0.071927	0.286209	0.183207	0.239654
0.213166	0.100959	0.069551	0.271448	0.226978	0.221036
0.121286	0.065454	0.065923	0.259689	0.232722	0.322642
0.158282	0.074398	0.081559	0.257438	0.225592	0.328781
0.167226	0.065725	0.079058	0.268696	0.176274	0.230543
0.128469	0.104482	0.081559	0.221787	0.220046	0.2349
0.146628	0.08158	0.131846	0.268321	0.225592	0.294121
0.11573	0.081309	0.070802	0.290587	0.282039	0.244209
0.144324	0.088492	0.059919	0.247931	0.225592	0.249953
0.152455	0.088356	0.089815	0.247681	0.275107	0.245002

ME INTAKE MLANDIZI(MJ/ kg W $^{0.75}$)

COW 1	COW 2	COW3	COW4	COW 5	COW6
0.666501	0.64251	0.548835	0.525898	1.134114	0.936387
0.688243	0.666501	0.880402	0.848047	1.136163	1.125784
0.814946	0.748971	0.290402	0.314833	1.266274	0.869795
0.834439	0.747471	64783.34	0.498406	1.350282	1.394335
0.847934	0.809698	0.761307	0.916966	1.275494	0.834962
0.955893	0.5368	0.862007	0.985045	0.869795	1.266274
0.891417	0.688243	0.63945	0.512694	12.59234	1.310327
0.852432	0.727229	0.792745	0.913604	1.389213	1.275494
0.705487	0.781209	0.895303	0.900157	1.231037	1.134114
0.64401	0.886919	0.68653	0.560602	1.189529	1.186363
0.666501	0.617769	0.735784	0.678269	1.126992	1.231441
0.599026	0.64251	1.058138	1.122044	1.168947	1.128992
0.580283	0.727229	0.536043	0.415198	1.221823	1.191486
0.709985	0.578784	0.624185	0.674067	1.100997	1.056859
0.584032	0.720481	0.58886	0.464787	1.292911	1.275494
0.682245	0.680746	0.71633	0.839642	1.070576	1.126475
0.56229	0.69724	0.734192	0.858973	1.240495	1.214025
0.599026	0.720481	0.671558	0.721134	0.134855	1.266274
0.521056	0.721981	0.902544	0.863175	1.33274	1.252955
0.727229	0.823193	0.722538	0.759796	1.133975	1.094159
0.542797	0.708486	0.604432	0.607669	1.179162	1.055228
0.560041	0.655256	0.549237	0.498406	1.24822	1.231441
0.664252	0.605774	0.751169	0.674067	1.270372	1.252955
0.708486	0.809698	0.521273	0.52194	0.983781	0.953803
0.605024	0.709235	0.587476	0.595902	1.501591	1.457854
0.64326	0.604275	0.623193	0.702643	1.307329	1.248857
0.646259	0.703238	0.667399	0.698441	1.240336	1.231441
0.626766	0.64401	0.638389	0.629521	1.340995	1.292911

ME INTAKE KONGOWE (MJ/ kg W $^{0.75}$)

COW 1	COW 1	COW 1	COW 1	COW 1	COW 1
0.499143	0.395822	0.858476	1.387762	0.8102	1.320438
0.548621	0.468583	0.824768	1.62802	0.805678	1.533728
0.697054	0.344161	0.515659	1.595747	0.783822	1.211909
0.699965	0.136064	0.755201	1.694002	0.858435	1.44404
0.820748	0.26849	0.80397	1.508967	0.832057	0.917976
0.892782	0.228471	0.755918	1.671769	1.073986	0.673785
0.813472	0.344161	0.714321	1.780782	0.911946	1.022736
0.84767	0.379087	0.892901	1.522594	0.617259	1.172718
0.974275	0.427837	0.755918	1.620849	0.837332	1.324206
0.820748	0.361624	0.720776	1.535503	0.837332	0.902148
0.892782	0.390001	0.439637	1.945735	0.911946	0.782314
0.840394	0.474404	0.343534	1.465218	0.644392	1.03781
0.794554	0.429292	0.440354	1.498209	0.832057	1.113177
0.999741	0.530431	0.433183	1.638061	0.644392	0.97827
0.649032	0.361624	0.522114	1.52618	0.863711	0.932295
0.820748	0.371811	0.480517	1.706911	0.911946	0.926266
0.973547	0.408191	0.608894	1.645233	0.646653	1.08303
0.993193	0.400188	0.46187	1.890512	0.885568	0.902148
1.063772	0.548621	0.412384	1.64093	0.697149	0.911946
1.144537	0.542072	0.398757	1.556301	0.863711	0.841101
0.651214	0.351438	0.377959	1.488886	0.885568	1.227736
0.849853	0.39946	0.467608	1.475976	0.858435	1.2511
0.897876	0.352893	0.453264	1.540523	0.67077	0.877277
0.689778	0.56099	0.467608	1.271577	0.837332	0.893858
0.787278	0.438024	0.755918	1.538372	0.858435	1.119207
0.621382	0.436568	0.405929	1.666031	1.073233	0.929281
0.774909	0.475132	0.343534	1.42147	0.858435	0.951137
0.818566	0.474404	0.514942	1.420035	1.046854	0.932295

Appendix 5: ANOVA for effects of feeding practice on nutrients intake of lactating cows by wards in Kibaha district

Dependent Variable: DM

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing system	0	0.0000000	.	.	.
Ward	1	431.2787170	431.2787170	23.57	<.0001
Grazing system*Ward	0	0.0000000	.	.	.

Dependent Variable: M E

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing system	0	0.00000	.	.	.
Ward	1	18903.30014	18903.30014	18.77	<.0001
Grazing system*Ward	0	0.00000	.	.	.

Dependent Variable: CP

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing system	0	0.0000	.	.	.
Ward	1	804723.5526	804723.5526	12.00	0.0006
Grazing system*Ward	0	0.0000	.	.	.

Dependent Variable: Ca

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing system	0	0.000000	.	.	.
Ward	1	2300.207015	2300.207015	21.22	<.0001
Grazing system*Ward	0	0.000000	.	.	.

Dependent Variable: P

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Grazing system	0	0.0000000	.	.	.
Wards	1	544.4010003	544.4010003	9.70	0.0020
Grazing system*Ward	0	0.0000000	.	.	.

Appendix 6: Milk yield recorded for 28 days during monitoring in Kongowe and Mlandizi

Zero grazing practice

FEEDING	WARD	COW 1	COW2	COW3	COW4	COW 5	COW6
ZERO	KONGOWE	9	7.5	4	9.5	5	9.5
ZERO	KONGOWE	10	7.5	4	10	5	9.5
ZERO	KONGOWE	9.5	8.5	5	10	5	8.5
ZERO	KONGOWE	10	8.5	5	10	6	8
ZERO	KONGOWE	8	7.5	6	10	5	9.5
ZERO	KONGOWE	9	8.5	7	10	7	8
ZERO	KONGOWE	10	8	8	10	8	8
ZERO	KONGOWE	10	7.5	8	10	6	6.5
ZERO	KONGOWE	9	8.5	9	10	5	7.5
ZERO	KONGOWE	10	8	9	10	5	6
ZERO	KONGOWE	10	8.5	8.5	10	5	6
ZERO	KONGOWE	9	9	8	10	7	5
ZERO	KONGOWE	8	8	7	10	8	5
ZERO	KONGOWE	10	7.5	7	10	8	5.5
ZERO	KONGOWE	11	8.5	7	10	9	6
ZERO	KONGOWE	10	9	6	10	7	7
ZERO	KONGOWE	10.5	8	5	8	6	7
ZERO	KONGOWE	10	8	4	9	7	6
ZERO	KONGOWE	10	8	4	9	4	6
ZERO	KONGOWE	10	8.5	4	9	5	6
ZERO	KONGOWE	11	7.5	4	9	7	6.5
ZERO	KONGOWE	10.5	8.5	4	9	6	6
ZERO	KONGOWE	10.5	7.5	4	8	8	7
ZERO	KONGOWE	10.5	7.5	4	8	6	7.5
ZERO	KONGOWE	10	8.5	4	8	5	7
ZERO	KONGOWE	11	7.5	4	8	6	7
ZERO	KONGOWE	11	8	4.5	8	7	7
ZERO	KONGOWE	10.5	8.5	4	8	8	7
ZERO	MLANDIZI	5	5.5	3	2	8	7
ZERO	MLANDIZI	5	5.5	2.5	1.5	8	7
ZERO	MLANDIZI	4	5	3	1.5	9	7.5
ZERO	MLANDIZI	4	5	3	1.5	10	7
ZERO	MLANDIZI	5	5	3	1.5	10	7.5
ZERO	MLANDIZI	6.5	5.5	2.5	1.5	9	7.5
ZERO	MLANDIZI	5.5	4.5	3.5	1.7	9	6.5
ZERO	MLANDIZI	5.5	4.5	3	2	9	6.5
ZERO	MLANDIZI	4.5	6.5	4	2	10	6.5
ZERO	MLANDIZI	4.5	6.5	3	1	10	6.5
ZERO	MLANDIZI	5	7	5	2	10	7
ZERO	MLANDIZI	5	7	3.5	2	10	6
ZERO	MLANDIZI	6	7	3.5	1.5	10	6
ZERO	MLANDIZI	4.5	7	3	2	10	6.5
ZERO	MLANDIZI	4.5	7	3	2	10	7
ZERO	MLANDIZI	4.5	7	3.5	2	10	7

ZERO	MLANDIZI	5	7	1.5	1	10	7
ZERO	MLANDIZI	5.5	7	1.5	1	10	7.5
ZERO	MLANDIZI	5.5	7	3	1.5	10	7.5
ZERO	MLANDIZI	5	7	3.5	1.5	10	7
ZERO	MLANDIZI	6	7	4	1.5	10	8
ZERO	MLANDIZI	5	6.5	3.5	2	10	8
ZERO	MLANDIZI	5	7	3.5	2	10	7.5
ZERO	MLANDIZI	5	6.5	3.5	1.5	10	7
ZERO	MLANDIZI	5	6.5	3.5	1.5	10	7
ZERO	MLANDIZI	5	7	3.5	1.5	10	7
ZERO	MLANDIZI	5	6	3	1	10	7
ZERO	MLANDIZI	5	6	2.5	1	8	7

Full grazing practice

FULL	KONGOWE	7	8	6	4	7	7
FULL	KONGOWE	7.5	7.5	6.5	6	6.5	8.5
FULL	KONGOWE	7	7	6.5	6	6.5	7
FULL	KONGOWE	7.5	7.5	7	6	6	7
FULL	KONGOWE	6	7	6.5	6	6	7
FULL	KONGOWE	7.5	7.5	6.5	6	5	7
FULL	KONGOWE	6.5	7.5	6	6	6	6
FULL	KONGOWE	6.5	7.5	6	6	5	6
FULL	KONGOWE	6.5	7.5	6	6.5	6.5	6
FULL	KONGOWE	6.5	7.5	6.5	6	6	6
FULL	KONGOWE	7	7.5	6	6	6	6
FULL	KONGOWE	6	7	6.5	6	6	7
FULL	KONGOWE	6	7	6.5	6	6	6
FULL	KONGOWE	6.5	7	6.5	6	4.5	6
FULL	KONGOWE	6	7	6	6	4.5	6
FULL	KONGOWE	6	7	6	6	4.5	6
FULL	KONGOWE	6	7	6.5	6	5.5	6.5
FULL	KONGOWE	6.5	7	6.5	6	5.5	5
FULL	KONGOWE	6.5	7	6.5	6.5	5	5
FULL	KONGOWE	6	7	6.5	6.5	5	6
FULL	KONGOWE	6.5	7	6	6	6.5	5
FULL	KONGOWE	6	7	6	5	6	5
FULL	KONGOWE	6	7	6	6	6	5
FULL	KONGOWE	6	7	6	6.5	6	5
FULL	KONGOWE	6	7	6	6	5	5
FULL	KONGOWE	6	6.5	6	6	5	5.5
FULL	KONGOWE	5.5	6.5	6.5	6	5	5.5
FULL	KONGOWE	6	7	6	6	5	5.5
FULL	MLANDIZI	7	5	3.5	2.5	6	4
FULL	MLANDIZI	7.5	5	3.5	2.5	6.5	4
FULL	MLANDIZI	7.5	4	2.5	2.5	7	4
FULL	MLANDIZI	6.5	4.5	3.5	3.5	6	4
FULL	MLANDIZI	7	4	3.5	3.5	6	4
FULL	MLANDIZI	7	3.5	3.5	3.5	6	4
FULL	MLANDIZI	7	4	4	4	6.5	4
FULL	MLANDIZI	7	5	3.5	3.5	6.5	4
FULL	MLANDIZI	7	5	3.5	3.5	7	3.5
FULL	MLANDIZI	7	4.5	3.5	3.5	7	3.5
FULL	MLANDIZI	6.5	4.5	3.5	3.5	6.5	4
FULL	MLANDIZI	7	4.5	3.5	3.5	6	3.5
FULL	MLANDIZI	7	4	3.5	3.5	6.5	3.5
FULL	MLANDIZI	7	4	3.5	3.5	6	3
FULL	MLANDIZI	7	4	3	3.5	6.5	4
FULL	MLANDIZI	7.5	5.5	3	3.5	6	3.5
FULL	MLANDIZI	7.5	5	3.5	3.5	6	3.5
FULL	MLANDIZI	7	4.5	3.5	3.5	6	3
FULL	MLANDIZI	7.5	4	2.5	3.5	6	4
FULL	MLANDIZI	7	5	2.5	3.5	6	4

FULL	MLANDIZI	7	5	2.5	3.5	6	4
FULL	MLANDIZI	7	5.5	2.5	3.5	6	4
FULL	MLANDIZI	6.5	4.5	2.5	3.5	6	3.5
FULL	MLANDIZI	7	5	2.5	3.5	5	4
FULL	MLANDIZI	6.5	5	2.5	3.5	5	4
FULL	MLANDIZI	6.5	5	2.5	3.5	5	4
FULL	MLANDIZI	7.5	5	2.5	3.5	6	4
FULL	MLANDIZI	7	5	2.5	3.5	6	4

Appendix 7: ANOVA for effects of feeding practice on milk yield of cows by wards in Kibaha district

Dependent Variable: Milk yield

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Wards	1	604.1105174	604.1105174	172.69	<.0001
Grazing systems	1	216.5429164	216.5429164	61.90	<.0001
Wards*grazing systems	1	19.7259373	19.7259373	5.64	0.0178

Appendix 8: Formulation of supplementary diet

According to NRC (2001), cows weighing 400 kg will require 118.2 MEMJ, 1670 g CP, 64 g Ca, and 40.7 g P, to produce 15 l/day. Therefore, a cow weighing 400 kg and having a potential of producing 15 L/ day of milk, but currently producing 6L/day when supplied with mixed forage having 76.42 MJ, 657.99g CP, 26.06 g Ca and 18.79 g P, will be require supplementary ration contains 41.6 MJ, 1012g CP, 38g Ca and 22 P, to cover the deficit of 9 L/day of milk. The ingredients for supplementary ration used are maize bran, cassava meal, cotton seed cake and cattle mix. And their nutrient contents are indicated in the table below.

Ntrient intake and live weight of lactating cows in Kibaha district

Parameter	Overall mean	Wards		SE	P-value
		Kongowe	Mlandizi		
Live weight (kg)	394.17	439.17	347.17	47.267	0.002
Daily intakes					
DM (Kg)	10.81	11.94	9.68	0.330	0.0001
CP (g)	657.97	706.91	609.03	19.980	0.0006
Ca (g)	26.06	28.68	23.44	0.803	0.0001
P (g)	18.79	17.52	20.06	0.578	0.002
ME MJ	76.42	83.91	68.91	2.448	0.0001

The nutrient concentration of feed available to the farmer in Kibaha district

Feeds	%DM	MEMJ	%CP	%Ca	%P
Maize bran	90	11.2	11.8	4.3	6.9
Cotton seed cake	85	10.4	34.9	3.1	9.9
Cassava meal	90	12.2	3.0	0	0
Cattle mix	0	0	0	17.5	12.0

Source: Doto *et al.*, (2004) and Katakweba, (2002)

Calculation of nutrients to be contained in supplementary diet

The nutrients required to be contained in the supplementary ration, was balanced using algebric equation as indicated below;

Maize bran was fixed to 1kg DM to contain 11.2 MJ, 118gCP, 4.3g Ca and 6.9g P.

The proportion of cassava and cotton seed cake was balanced on the basis of their protein content and the needed protein content in the mixture as:

Let x be cassava and y be cotton seed cake

Needed energy = MJ x + MJ y

Needed protein = MJ X. 2.46 (gcp/ME MJ) +MJy.33.5 (gcp/ME MJ)

X +y =30.4   where 30.4 were obtained by taking 41.6 MJ -11.2 MJ

2.46x + 33.5y =894   where 894 were abtained by taking 1012g CP – 118g CP

x =Cssava=4.06

y=Cotton seed cake =26.34

Proportion of cassava in the diet= 4.06/12.2 =0.33 approx. 0.4kg DM

Note: 12.2 was the ME MJ/kg DM content of cassava.

Proportion of cotton seed cake in the diet =26.34/10.4 =2.53kg DM

Note: 10.4 were the ME MJ /kg DM of cotton seed cake.

0.15kg of cattle mix was added to cover mineral deficit of supplementary ration.

Composition of supplementary ration

Ingredient	**Kg DM basis**	**Kg as fed**	**ME MJ**	**CPg**	**Ca g**	**Pg**
Maize bran	1.0	1.1	11.2	118	4.3	6.9
Cotton seed cake	2.53	3.0	26.31	883	7.8	2.5
Cassava meal	0.4	0.5	4.88	0	0	0
Cattle mix	0.15	0.15	0	0	26.25	24.0
Required			**41.6**	**1012.0**	**38.0**	**22.0**
Total	4.08	4.75	42.39	1013	38.35	33.4
Balance			+ 0.79	+ 1	+ 0.35	+ 11.4

Gross margin of a proposed supplementary diet for producing 9L of milk per day was calculated as follows;

Gross margin =Total revenue – Total cost

Total revenue of producing 9L =400/=(Tsh) x 9 =3600/=

Total cost of formulating supplementary diet was as follows;

Ingredients	**Amount kg**	**Cost of ingredient Per kg (Tsh)**	**Total cost**
Maize bran	1.1	100	110
Cotton seed cake	3	300	900
Cassava meal	0.5	300	150
Cattle mix	0.15	300	45
Total	**4.75**		**1205**

Gross margin =Total revenue – Total cost = 3600/= -1205/= = 2395/= (Tshs).