STUDIES ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF CROSSBRED DAIRY CATTLE IN SELECTED URBAN AND PERI URBAN AREAS OF TANZANIA

KEJERI ATHUMAN GILLAH

A THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2017

EXTENDED ABSTRACT

In Tanzania, urban and peri urban dairying is commonly practiced by people from different socio-economic and cultural groups. This provides them regular income, employment opportunities and alleviates poverty. The demand for milk and milk products is high and this motivates farmers to increase their cattle herds in urban and peri urban areas. Despite the high demand for milk and milk products, the average daily milk yield, quality of milk and reproductive performance of crossbred dairy cows is low due to management factors, poor quality feeds and feeding of the dairy cattle. In order to address some of the challenges to high milk production and reproduction performance of cows, a series of studies were undertaken in urban and peri urban areas of Dar es Salaam city and Morogoro municipality. In this study an in-depth literature review on urban and peri urban dairy farming in East African cities was done (Paper I). The results revealed that urban and peri urban dairy production system is very common in all East African cities but significantly varying in intensity. Dairy cows were fed on forages that contained 6 to 6.8%CP and produced average milk yield that ranges from 5.7–17.1 litres/cow/day. The range for lactation lengths, ages at first calving, calving to conception interval, calving interval and number of services per conception of crossbred dairy cows were 8.8 to 11.2 months, 29.7 to 46.0 months, 123 to 276 days, 406 to 562 days and 1.7 to 2.3, respectively. The trend in average milk yield and reproductive performance of the dairy cows was not clear. The major constraints hindering dairy production in East African cities differed between and within countries and production systems due to differences in data collection, physical locations, dairy breeds kept and seasons of the year.

In the second study (Paper II and III), a cross sectional study using a random sample of 153 dairy farmers in Dar es Salaam city (71) and Morogoro municipality (82) was done

by collecting data on management and production levels of dairy cattle. The two study sites fall under the same agro ecological zone and were meant to compare the performance of dairy cows. The results showed that one third of farmers practised free grazing system and dairy cows were mainly fed low quality forage and energy concentrate. Forage/fodder was collected from communal areas and dairy farmers in Dar es Salaam city covered significantly longer distance (14.7±1.2 km) than Morogoro municipality (3.07±1.2 km). Steaming up of dry cows was fairly common among dairy farmers in Dar es Salaam city but rarely done in Morogoro municipality. Artificial insemination service was not a common breeding method in the study areas. Over half of the cattle sheds had high stocking density and were poorly designed (Paper III). Dairy cows produced significantly higher average milk yield in Dar es Salaam city (10.5±1.2 litres/cow/day) than in Morogoro municipality (6.2±0.4 litres/cow/day). One third of the dairy farmers (29.2 percent of 153 respondents) planned to decrease their cattle herds, many of them from Morogoro municipality (16.0 percent of 153 respondents) due to shortage of feeds.

The third study (Papers IV) was based on a longitudinal study design in which 60 dairy farmers with a total of 309 dairy cattle were monitored for nine (9) months to assess effect of management on chemical composition of milk and to quantify the microbial load of raw milk. Dairy cows were monitored during the wet and dry seasons to capture seasonal effect on milk yield and quality. The results showed the average milk yield to be 7.0±0.1 litres/cow/day and was significantly affected by parity, stage of lactation, season of calving, employment status of the farmers and means used to collect forage from the sources to the dairy units. However, milk yield was not influenced by grazing systems, breeds of the cows and types of farm labour. Dairy cows in the third parity, dairy cows owned by self-employed farmers and dairy farmers who used bikes to collect forage

produced 7.8±0.2, 7.5±0.5 and 6.7±0.5 litres/cow/day higher than dairy cows in other parities, dairy cows owned by government-employees and dairy farmers who used cars to collect forage, respectively. The wet season had significantly higher total bacterial counts (5.9±0.04 log_{10}cfu/ml) and coliform counts (2.4±0.08 log_{10}cfu/ml) than 5.7 ±0.04 log_{10}cfu/ml and 2.0±0.08 log_{10}cfu/ml bacterial counts and coliform counts, respectively observed in the dry season. However, grazing systems had no significant effect on microbial load. Stocking density significantly influenced total bacterial counts but not coliform counts. Further, employment status of the dairy farmers and source of farm labour had no effect on bacterial loads.

Lastly, study four (Paper V) evaluated the effects of pre partum concentrate supplementation on milk yield, milk chemical composition and reproduction of crossbred dairy cows. The cost of concentrate supplementation of different treatment groups was also analysed. In this study, 48 dry crossbred cows in their last stage of gestation were used and divided into three groups according to concentrate supplementation and lasted for 24 weeks of lactation. The first treatment group was fed 4 kg/day of home-made ration during pre- and post-partum period (HMR-PPP) while the second group was fed a similar amount as the first group, but during the post-partum period (HMR-PP) only. The third group was a control and was fed maize bran 4 kg/day during the post partum period only (MB-PP) and simulated the farm's feeding practice. The results on this study have shown that dairy cows supplemented with home made ration during pre and post-partum had significantly higher (8.5±0.3 litres/cow/day) milk yield followed by post-partum supplemented cows (6.2±0.3 litres/cow/day) with home-made ration. The control group which simulated farm's feeding practices had the least milk yield (4.5 litres/cow/day). Concentrate supplementation had significant effect on percent total solids but not on percent butter fat and percent solids not fat. Effect of breed was significant on percent

butter fat and percent total solids but not on percent solids not fat. Parity had a significant influence on percent total solids but not on percent butter fat and percent solids not fat. Breed had no significant effect on milk yield while parity significantly influenced milk yield. The supplementation regime and breed of dairy cows had no significant effect on number of services per conception, interval from calving to first insemination, interval from calving to conception and calving interval. Supplementing dairy cows with home-made concentrates during both pre and post-partum periods was cost effective and economical compared to post-partum concentrate supplementation alone. It is concluded that the production levels are lower than 15 l/cow/day expected to be produced by crossbred dairy cows. However, the production levels can be improved through strategic concentrate supplementation coupled with good husbandry practices. The microbiological quality of the milk was relatively poor. There is a need therefore to train dairy farmers on dairy cattle husbandry and the importance of clean milk production in order to safe guard the consumers of milk and milk products.

DECLARATION

I, KEJERI ATHUMAN GILLAH, do hereby declare to the Senate of Sokoine University of Agriculture that this thesis is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

_____ _____

KEJERI ATHUMAN GILLAH Date

(PhD Candidate)

The above declaration is confirmed by

_____ _____

Prof. GEORGE C. KIFARO Date

(1st Supervisor)

_____ _____

Prof. JORGEN MADSEN Date

(2nd Supervisor)

COPYRIGHT

ACKNOWLEDGEMENTS

I praise the Almighty Allah for giving me the courage and strength to carry out this study. My first earnest appreciations go to my research supervisors, Prof. George C. Kifaro (Sokoine University of Agriculture) and Prof Jorgen Madsen (University of Copenhagen) for spending their tireless time to give constructive and timely advices and to correct manuscripts and thesis from the very beginning to the end. I am also grateful to Copenhagen Life Science University library for granting permission to search publications and reference materials during the preparation and writing of this thesis. I would like to extend my thanks to DANIDA through the Peri urban Livestock Farming Project for financing my study. My thanks go to Prof Mtambo Madundo and Prof John Olsen DANIDA project leaders for timely logistic adjustments and support. I especially thank the dairy cattle farmers and livestock extension officers in all participating wards in Dar es Salaam city and Morogoro municipality for giving a helping hand during data and sample collection. Also, I am thankful to the management team of Kingolwira dairy farm for their cooperation and assistance during concentrate feeding trial and data collection.

My deepest gratitude goes to all my colleagues Ms Maliwaza Mbwana, Dr. Erick Komba, Dr. Athuman Msalale and Dr. Abdul Katakweba who offered me comprehensive moral support that enabled me to succeed throughout my academic life. I owe them more than a mere expression of thanks.

I acknowledge the Permanent Secretary, Ministry of Livestock and Fisheries (MLF) who agreed to grant me a four year study leave. I also appreciate laboratory technical staff from Department of Animal, Aquaculture and Range Sciences of Sokoine University of Agriculture, Morogoro Tanzania who assisted in data analysis. Much appreciation is

extended to my lovely parents, brother and sister, who encouraged me throughout the study period. Lastly, I would like to thank my dearest wife Hadija Hamisi Temba, sons Hilal and Abbas and daughters Laila, Latipha, Rehema and Fadhila for their prayers, tolerance as well as spiritual support during my absence. May Almighty Allah bless all.

DEDICATIONS

This work is dedicated to my father Athuman Maulid Gillah, Rest in Peace and Mother Tatu Seleman Chuzi for their excellent upbringing.

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF APPENDICES

ORGANIZATION OF THE THESIS

This thesis is arranged in four chapters. The first chapter contains an abstract, general introduction, objectives and research hypotheses. The abstract gives a brief of the thesis and was developed from all presented papers. The general introductory part gives highlights of the dairy sub sector in urban and peri urban areas of Tanzania. The objectives of keeping dairy cattle by farmers are also given. The authenticity of dairying in urban and peri urban areas of Tanzania was described and weak points were identified. The milk production and reproductive performance of crossbred dairy cows and their limiting factors are highlighted. The chapter also addresses the overall theme of the thesis and the research hypotheses that form the basis for the argument when concluding the results. The second chapter contains the descriptions of the general methodologies used to conduct the various studies reported in this thesis.

Chapter three of the thesis presents research results obtained from each specific objective. This chapter also contains published (Papers I, II, IV and V) and accepted paper (Paper III) to peer reviewed scientific journals. All papers are presented ahead of chapter four of the thesis. Chapter four draws overall conclusions and recommendations obtained from the four studies. This chapter ends with references to support issues cited in chapter three and a list of appendices.

LIST OF PAPERS

The present thesis is based on published papers in scientific journals:

Paper I: Gillah K A, Kifaro G C and Madsen J 2012: Urban and peri urban dairy farming in East Africa: A review on production levels, constraints and opportunities

Status: Published in *Livestock Research for Rural Development* Volume 24, Article #198. http://www.lrrd.org/lrrd24/11/gill24198.htm.

Paper II: Gillah K A, Kifaro G C and Madsen J 2013: Management and production levels of cross-bred dairy cattle in Dar es Salaam city and Morogoro urban and peri urban areas.

Status: Published in *Livestock Research for Rural Development.* Volume 25, Article #165.http://www.lrrd.org/lrrd25/9/gill25165.htm.

Paper III: Gillah K A, Kifaro G C and Madsen J 2017: Cattle shed design, management and its legal implications in urban and peri urban areas of Dar es Salaam city and Morogoro municipality, Tanzania.

Status: Accepted for publication in Journal of Natural Sciences Research.

Paper IV: Gillah, K .A, Kifaro, G .C. and Madsen, J. 2014: Effects of management practices on milk yield, chemical and microbiological qualities of milk from smallholder dairy units in urban and peri urban areas of Morogoro municipality, Tanzania.

Status: Published in Tropical Animal Health Production 2014: 46 (5):1177 - 1183, Jun 15. http://www.ncbi.nlm.nih.gov/pubmed/24930022.

Paper V: Gillah K A, Kifaro G C and Madsen J 2014: Effects of pre partum supplementation on milk yield, reproduction and milk quality of crossbred dairy cows raised in a peri urban farm of Morogoro municipality Tanzania.

Status: Published in *Livestock Research for Rural Development. Volume 26, Article #9.* http://www.lrrd.org/lrrd26/1/gill26009.htm.

LIST OF ABBREVIATIONS

AFC	Age at First Calving
AI	Artificial Insemination
ANOVA	Analysis of variance
BF	Butter fat
BMRT	Brucella Milk Ring Test
CBOs	Community Based Organizations
CC	Coliform count
CCI	Calving to conception Interval
CFSI	Calving to first service interval
Cfu	Colony forming unit
CI	Calving interval
CLR	Corrected lactometer reading
CP	Crude Protein
DAFCO	Dairy Farming Company
DANIDA	Danish International Development Agency
DO	Days Open
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GLM	General Linear Models
GM	Gross margin
HMR	Home-made ration
HMR-PP	Home -made ration-post partum
HMR-PPP	Home -made ration-pre and post partum

IDF	International Dairy Federation
ILRI	International Livestock Research Institute
IVDMD	*In vitro* dry matter digestibility
IVOMD	*In vitro* organic matter digestibility
Kg	Kilogram
LL	Lactation Length
LMY	Lactation Milk Yield
LSM	Least Squares Means
MB-PP	Maize bran-post partum
MLFD	Ministry of Livestock and Fisheries Development
NGOs	Non-Government Organizations
NS	Not significant
NSC	Number of services per conception
PDIFF	Probability of difference
p-value	Probability value
s.e	Standard error
SADC	Southern African Development Community
SAS	Statistical Analysis System
SEM	Standard error of means
SNF	Solids not fat
SUA	Sokoine University of Agriculture
TBC	Total Bacterial Count
TBS	Tanzania Bureau of Statistics
TDB	Tanzania Dairy Board
TDL	Tanzania Dairies Limited

TFDA	Tanzania Food and Drug Authority
TS	Total solids
UMMB	Urea-Molasses Multi Nutrient Blocks
UN	United Nations
URT	United Republic of Tanzania
USD	United States Dollar

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background Information

Tanzania is among the most rapidly urbanizing countries in Sub-Saharan Africa. According to URT (2006a) urban residents of Tanzania have increased from 6.4% in 1967 to 23.1% of the total population in 2002. Much of this growth occurred mainly in Dar es Salaam city which is home to about 29% of the total urban population of Tanzania (UN Habitat, 2009). Other urban centres with big number of urban residents in the country in descending order include Arusha (31.3%), Morogoro (27.0%), Mwanza (20.5%), Mbeya (20.4%), Iringa (17.2%) and Dodoma (12.6%) (UN Habitat, 2009). Rural-urban migration and natural growth equally share the increase in urban population in Tanzania to date (UN Habitat, 2009). Due to rapid population growth, Tanzania faces an acute shortage of formal employment within the government and urban areas are mostly affected with unemployment rate reaching 22.3% (Mcha, 2012). Private informal activities have become a necessary strategy for survival and the rate of employment in the sector has increased from 8.8 to 11.3% in year 1990/1991 to 2005/2015, respectively (Mcha, 2012).

Among the informal sectors, urban agriculture is one of them and it employs 6.5 percent and 15 percent of the informal urban labour in Dar es Salaam and Mwanza cities, respectively (Kadonya *et al.,* 2002). As a form of urban agriculture, dairy farming is widely practised in big urban centres of Tanzania (Lupala, 2002; Msangi *et al*., 2004; Mageka, 2005). In Tanzania, urban dairy farming started in 1921 within and around Dar es Salaam and the activity was meant to supply milk to the city hospitals, Europeans, Asians and served as a training and demonstration site (Sumberg, 1996). In some Tanzanian

towns such as Morogoro people started to keep livestock in towns in the late 1970s, to supplement their income and most of them were civil servants (Tuvana, 2005). With effect from mid 1980s the national policy changed towards private ownership of major businesses and civil servants were allowed officially to carry out private businesses including urban agriculture to supplement their incomes (Mageka, 2005).

Existence of urban and peri-urban dairy farming in Tanzania is motivated by factors such as closeness to urban markets, better access to supplementary feeds and veterinary services, and the use of less expensive transport in comparison to rural dairying (Jacobi *et al*., 2000; Kurwijila, 2001, URT, 2011). In view of all these, urban and peri-urban dairying is more profitable compared to rural dairying (Limbu, 1999) and may continue to supply the largest portion of milk to urban populations in Tanzania as opposed to rural dairying (Jacob *et al*., 2000). Similarly, the potential of urban dairying to contribute the largest portion of milk to urban dwellers can be found in other African cities, such as Dakar, Senegal (Mbaye and Moustier, 2000) and Addis Ababa Ethiopia (Tegegne *et al*., 2000) where it contributes 60 and 79 percent of milk, respectively supplied to cities and towns.

Urban centres in Tanzania with highest population such as Dar es Salaam, Mwanza, Tanga, Mbeya, Morogoro, Iringa and Arusha are also experiencing the highest increase in the number of dairy cattle (Figure 1) in order to capture high urban milk market. Nonetheless, the number of improved dairy cattle is growing faster in Dar es Salaam city while in Tanga city the number of cattle is growing at a slow rate while Morogoro municipality has remained stagnant (URT, 2014). Similarly, an increase in the number of dairy cattle is seen in all East African cities and towns (Foeken, 2005; Prain *et al*., 2010). In principle, urban dairying is recognised, regulated and guided by several laws,

regulations and declarations (Takawira and Shingirayi, 2006; Kassenga and Mbuligwe, 2012).

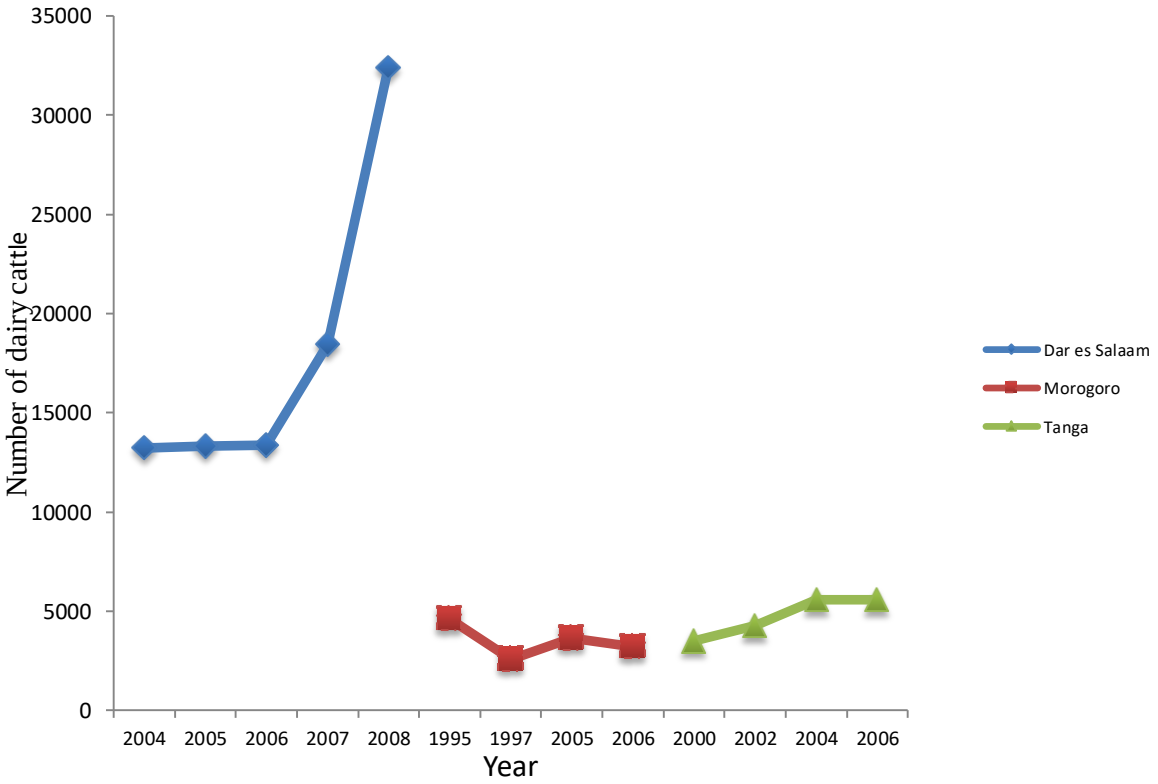

Figure 1: Number of improved dairy cattle by years in urban centres of Dar es Salaam city, Morogoro municipality and Tanga city (Source: URT, 2014)

In view of this, Tanzania and in particular Dar es Salaam city was the first to develop by-laws to regulate urban and peri urban agriculture in 1982 before the African regional recognition of the role of urban farming (Kassenga and Mbuligwe, 2012). Other towns in Tanzania such as Morogoro Municipality followed later in 1999. However, East African cities such as Kampala and Nakuru took seven years later to develop by-laws on urban and peri urban livestock keeping (Dubbeling and Pasquini, 2010).

Nevertheless, the practice of dairying in urban centres is basically unregulated and unplanned (Jacob *et al*., 2000; Lupala, 2002; Mlozi, 2005). In order to promote urban and peri urban dairy farming to have meaningful contribution to livelihood, representatives of African government leaders met and signed a declaration in 2002 in Addis Ababa in a workshop called "Feeding Cities in the Horn of Africa" (Appendix 1). Furthermore, in 2003, the government representatives from Kenya, Malawi, Swaziland, Tanzania and Zimbabwe signed the Harare Declaration on urban and peri urban agriculture (Appendix 2). All the declarations acknowledged the existence of urban and peri urban agriculture as a widely practiced activity in and around cities and towns in the region.

1.2 Problem Statement and Justification

1.2.1 Problem statement

According to UN Habitat (2009), the number of people in the world living in urban areas (3.42 billion) had surpassed the number living in rural areas (3.41 billion). The implication of the findings is that the world has become more urban than rural. The trend in increase in urban population in Tanzania is not an exception as the proportion of people living in urban areas in 2012 was 27 percent as compared to 18.4 percent in 1988 (URT, 2006a; URT, 2013).

In the same way, the number of affluent people in urban centres increases and creates demand for milk and milk products. Unfortunately, there is a concern on the growing gap between domestic milk production and national milk and milk products demand (Kurwijila, 2001). Various scientists have attempted to improve milk production and reproduction performance of dairy cows kept in peri urban areas of Tanzania by using different feeding strategies/technologies (Nkya *et al*., 1999; Msangi *et al*., 2004; Mlay

et al., 2005). Unfortunately, little has been realized in term of milk and reproduction improvement of dairy cows using the foresaid feeding technologies. Further investigation on suitable, appropriate and cost effective feeding technologies is imperative as pointed out in the Livestock Policy of the Ministry of Livestock and Fisheries Development, Tanzania (URT, 2006b). The major emphasis of the Livestock policy is the promotion of appropriate technologies for milk production in order to raise income of dairy stakeholders and improve their standard of living.

1.2.2 Justification of the study

Animal feed is one of the most important constraints that limit high milk production and reproduction performance of dairy cattle. In Tanzania, most dairy cattle use natural pastures that have low crude protein and rumen degradability as basal feed. Due to this, the natural pastures hardly support milk yields of over 5 kg per cow per day (Kavana and Msangi, 2005).

Improved feeding technologies such as the use of urea-molasses multi nutrient blocks (UMMB), straw treatments and formulated concentrates have been introduced to dairy farmers aiming at improving and sustaining post partum milk production and reproductive parameters. However, post-partum supplementation with the UMMB has limited application under farmers' production condition and had no effect on reproductive parameters (Nkya *et al*., 1999). Also, post-partum supplementation with formulated concentrates has shown to have no significant effect on milk yield and reduction in calving interval (CI) as compared to control group (Msangi *et al.*, 2004). Other studies by Mlay *et al*. (2005) on post-partum supplementation with formulated concentrates showed some (23-50%) improvement in milk yield when compared to the control group. On station strategic supplementation of pre partum dairy cows in Nigeria has been

reported to improve milk quality, sustain high milk production and reproduction performance (Olafadehan and Adewumi, 2008). However, on farm evaluation of such a practice in Tanzania has not been attempted. Therefore, there was a need to evaluate on farm pre partum concentrate supplementation of crossbred dairy cows in urban and peri-urban areas of Tanzania in order to improve milk production, reproduction and milk quality.

Milk is very valuable and nutritious food for humans and young mammals. However, improper handling of milk right from the cow to the consumers may contaminate it with microorganisms and render it unsafe for human consumption or unfit for processing (Ali and Abdelgadir, 2011). The level of bacterial contamination in milk is influenced by several factors and understanding those factors is indispensable in order to protect the milk consumers from potential adverse effects. Very little work has been done to quantify the effects of seasons and management on milk yield and quality produced from peri urban dairy units in Tanzania.

1.3 Study Objectives

1.3.1 Overall objective

To assess the management factors that affect milk production, reproductive performance and milk quality of crossbred dairy cattle in selected urban and peri-urban areas of Tanzania.

1.3.2 Specific objectives

The specific objectives were:

i) To identify the constraints to high milk production and reproductive performance of dairy cattle in urban and peri-urban areas

ii) To evaluate the effect of the existing feeding systems on performance of crossbred dairy cows kept in urban and peri-urban areas.

iii) To evaluate the effect of formulated concentrate fed to crossbred dairy cows during late pregnancy on milk production, reproduction and milk quality.

1.4 Research Hypotheses

i. Ho: There is no difference in the constraints that limit milk production and reproductive parameters between crossbred dairy cows managed in Dar es Salaam and Morogoro urban and peri-urban areas.

ii. H_o: Crossbred dairy cattle managed in Dar es Salaam and Morogoro urban and peri-urban areas have similar milk production and reproductive performance.

iii. Ho: There is no differences in milk production, milk quality and reproductive parameters between crossbred dairy cows managed in zero grazed and partial zero grazed feeding systems in peri urban areas of Morogoro municipality.

iv. H_o: There is no difference in milk production, milk quality and reproductive parameters between pre partum supplemented and non-supplemented crossbred dairy cows kept in a peri urban dairy farm of Morogoro municipality.

v. H_o: There is no difference in gross margin and cost benefit between pre partum supplemented and non-supplemented crossbred dairy cows kept in a peri urban dairy farm of Morogoro municipality.

CHAPTER TWO

2.0 GENERAL METHODOLOGY

To achieve specific objective I, a total of 153 smallholder dairy farmers were randomly selected, visited and interviewed in Morogoro municipality (82) and Dar es Salaam city (71). The farmers were subdivided into three sub groups according to herd sizes namely: 1- 10, 11- 20 and 21-50 dairy cattle. Semi-structured questionnaires and personal observations using a check list were used to collect information on farmers' demographic characteristics, farm labour, land size, dairy production, processing and marketing.

The floor spaces of the cattle sheds were measured in order to establish stocking density. The stocking density was classified in reference to the recommended floor space of $6.7m^2$ per one cattle (FAO, 1998) and categorised as less than 1 animal in $6.7m^2$, 1 animal in $6.7m^2$ and greater than 1 animal in $6.7m^2$. Parameters related to cattle shed designs such as presence of roof, types of walls and floors and presence or absence of cubicles were assessed. The types of cattle sheds were categorised as cement block walls tin roofed, burnt brick tin roofed, timber/poles off cuts walls tin roofed and timber/poles off cuts open. The floor types were classified as concrete, stone paved and earthen floors. The hygienic condition of the cattle sheds was assessed as good for cattle sheds that were cleaned with water regularly or poor for the one that manure was removed by hand scrubbing.

Two papers (Paper II and III) were generated from this study. Paper II looked at management aspects of crossbred dairy cattle and their respective production levels and the results obtained from this study gave comparative information of the two urban

centres. Paper III focused on cattle shed designs/types and their implications on management of the dairy cattle.

To achieve objective II, a longitudinal study design was adopted and covered the wet and dry seasons. The study involved 60 smallholder dairy farmers in Morogoro municipality who had at least one lactating cow and practiced zero or partial zero feeding systems. Vegetations from natural pastures were the major source of feeds while concentrates were used as supplementary feeds to lactating cows during milking time. Farmers were interviewed by using a structured questionnaire to obtain information on types of farm labour and feeds, while personal observation was used to gather information on milking hygiene and practices.

Milk yield was recorded from 123 dairy cows in the morning and evening and the animals were partitioned into three stages of lactation: early (7 to 90 days), mid (91 to 180 days) and late (181 to 210 days). Morning raw milk samples were collected after every two (2) months, kept in ice packed cool boxes and transported to Sokoine University of Agriculture laboratory, where microbial count was done within 2 hours. Part of the milk samples were deep frozen in the laboratory pending further analysis. Milk samples were analysed for butter fat percent using Gerber method while crude protein was calculated from nitrogen content from Kjeldahl method analysis (AOAC, 1995). The percentage total solids were determined by the reference method of oven drying at 105 °C in acid-washed sand for 12 hours. Solids not fat percent were calculated as the difference between total solids and butter fat percentages. Tanzania Dairy Industry Regulations (URT, 2007) were used to grade butter fat percentages. The test procedure for total bacterial count followed the guidance given by International Dairy Federation standard methods (IDF, 1992). Countable colonies of bacteria between 30 and 300 colony forming units (cfu) per plate

were chosen for counting with an aid of colony counter and computed following guidelines by Maturin and Peeler (2001). Interpretation and grading of total bacterial counts and coliform counts of the raw milk samples were done according to the Tanzania Bureau of Standards guidelines (TBS, 1983). Total bacteria count and coliform count data were converted into logarithm of the number of colony forming units per millilitre of raw cow milk samples (log_{10} cfu/ml) before being analysed by using General Linear Models (GLM) procedures of SAS (2002). The results obtained from this study were reported in paper IV.

Finally, for objective III, forty eight pregnant crossbred (*Bos taurus x Bos indicus*) cows in their last one third of gestation were involved in the study. The animals were equally divided into three groups with cows having similar parity numbers (2,3,4), stage of pregnancy (two third of the gestation period) and breeds (Friesian and Ayrshire crossbreds). The grouping was based on concentrate supplementation. The first treatment (HMR-PPP) was fed 4 kg/day of home-made ration (HMR) for an average of 56 days pre partum and the same amount during 24 weeks postpartum. The second group of cows (HMR-PP) was given 4 kg/day of HMR after calving (postpartum) for 24 weeks. The home-made ration was composed of maize bran (72.5%), sunflower seed cake (14.5%), cotton seed cake (12.0%), bone meal (0.5%), limes (0.5%) and supplied 150g/kg CP. The third group (MB-PP) was a control group fed 4 kg/day of maize bran for 24 weeks postpartum which supplied 91.9g/kg CP. The control group simulated the farm's concentrate feeding practice. During pre-partum period, cows in HMR-PPP were given HMR individually, once per day, during the morning before grazing. All experimental cows were temporally identified by tying nylon string on the neck, each group having different string colour. Apart from supplementation, the experimental animals received similar management practices as the rest of the cows.

Monthly representative pasture samples were collected from the grazing area and analysed for dry matter, crude protein, *in vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD). *In vitro* digestibility was conducted according to Tilley and Terry (1963).

Milk yield was recorded (litres/cow) in milk record book every day. A total of 288 milk samples (200 ml each) were collected in bottles on monthly intervals for 24 weeks, kept in the cool box and thereafter deep frozen in the laboratory at the Department of Animals, Aquaculture and Range Sciences of Sokoine University of Agriculture (SUA). Milk samples were analysed for butter fat (BF %), solids not fat (SNF %) and total solids (TS%) contents. Milk butterfat percent was determined by Gerber method and total solids were calculated by using a standard formula (TS=CLR/4+ (1.22 x BF %) + 0.72), whereby CLR is the corrected lactometer reading and BF is the butter fat content (O'Mahony, 1988). The SNF content was estimated by subtracting BF from TS percentages.

Days from calving to first insemination (CFSI), calving to conception interval (CCI), number of services per conception (NSC) and calving interval (CI) were calculated based on records kept by the farm. The costs and income from milk sales as a result of concentrate supplementation of using either maize bran alone or home-made formulated ration were analyzed. No attempt was made to estimate the overall profitability of the dairy enterprises. General Linear Models procedures of SAS were used to analyze the data and the results of this analysis are reported in paper V.

CHAPTER THREE

3.0 GENERAL RESULTS AND DISCUSSIONS

The results from this study showed that the overall average milk yield in the study areas of Dar es Salaam city and Morogoro municipality was 7.0 litres/cow/day (Paper IV). This amount of milk yield falls within the range of 5.7– 12.7 litres/cow/day reported from other urban and peri urban dairy units of East Africa (Mlay *et al*., 2001; Bee *et al*., 2006; Prain *et al*., 2010). According to Msanga and Kavana (2002) a crossbred cow should produce at most 15 l of milk per day. This implies that cows in the present study were producing at 46.7 percent of their genetic potential.

Location of the study areas had significant effect on average milk yield whereby dairy cows in Dar es Salaam city produced more (10.5±1.2 litres/cow/day) milk than 6.2±0.4 litres/cow/day produced in Morogoro municipality (Paper II). Similarly, some authors in their studies on milk production in peri urban areas of Tanzania have reported effect of location on milk yield (Msanga *et al*., 2000; Msangi *et al*., 2005; Bee *et al*., 2006). The difference in average milk yield between locations could possibly be explained by the fact that dairy farmers in the two study areas employed different management practices and methods of acquiring feed resources (Paper II).

Tanzanian urban and peri urban dairy farmers keep different breeds of dairy cattle (Paper I). Among the breeds kept, Friesian and Ayrshire crossbred dairy cows had similar milk production performance (Paper II and V). The crossbreeds from the two breeds could possibly have the same exotic blood levels (Msanga *et al*., 2000; Mlay *et al*, 2001) and they were kept under the same environment and received similar management. Lack of controlled breeding system may result into indiscriminate mating of livestock. The non-

significant effect of breed of cows on milk yield is in agreement with previous studies carried out in peri urban dairy units of East African countries (Bee *et al.,* 2006). However, when the crossbreeds from the two breeds were given concentrate supplementation, Friesian crossbreed cows had relatively better performance in terms of milk yield and displayed slightly better lactation curve than Ayrshire crossbreds. On the other hand, Ayrshire crossbred cows had similar (p=0.32) butter fat and total solids contents to Friesian crossbred cows (Paper V).

Effect of parity had a significant effect on daily milk yield (Paper IV and V). Generally, there was a tendency for milk yield to increase up to the third parity and cows in the third parity produced more (p<0.05) daily milk yield while cows in second parity produced similar daily milk yield as those in parity four and five (Paper V). The tendency of increasing milk yield up to third party could be a result of increased development of the udder and body size during subsequent pregnancies. Similarly, Bee *et al.* (2006) observed the same trend in crossbred dairy cows kept in peri urban areas of Tanzania.

Daily milk yield was significantly affected by seasons of calving (Paper IV). Dairy cows produced significantly higher (7.3 l/cow/day) milk yield during the wet season compared to the dry season (6.4 litre/cow/day). The low milk yield (6.4 l/cow/day) observed during the dry season was probably caused by the low quality and quantity of forages (Paper II and V) and that leads to larger seasonal fluctuations of daily milk yield. Results from the current study (Paper V) has shown that the CP content and digestible organic matter of the forage was lower than the minimum of 7 and 55 percent of CP and *IN*VOMD respectively, required for maintenance and milk production (McDonald *et al*., 1995). The lower digestibility of the natural pasture was due to increasing proportion of stem as opposed to the leaves as the plants mature. This implies that in order to realize optimum milk yields

from lactating dairy cows that rely mainly on natural pasture as basal diet, concentrate supplementation is very important. The current findings on CP, IVDMD and IVOMD were similar to results reported by Kavana *et al.* (2007) in a study conducted in peri urban areas of Tanga, Tanzania. The results support the fact that peri urban areas of Morogoro and Tanga municipalities fall under similar agro ecological zone. Results on pasture quality reported by Njau *et al.* (2013) in Dodoma municipality Tanzania communal grazing land had relatively lower nutritive value probably due to differences in agro ecology which is drier than Morogoro or Tanga.

Season of the year had a significant effect on total bacterial counts (TBC) and coliform counts (CC) of raw milk samples collected at farm level. In this regard, raw milk samples collected during the wet season had higher (5.8 $\log_{10}$cfu/ml) total bacterial counts and coliform counts (2.2 $\log_{10}$cfu/ml) compared to the dry season (Paper IV). Comparable observations were reported by several authors in other peri urban dairy units in African cities (Kilango *et al.*, 2011; Lues *et al.*, 2012). Muddy conditions during the rains could probably increase the levels of contamination especially for cows kept in high stocking density and poorly constructed cattle sheds (Slaghuis, 1996).

There are two major feeding systems i.e zero and free grazing that have been identified across the cities in East Africa (Shiferaw *et al.*, 2003). However, Nkya *et al.* (2007) reported three types of feeding systems in Tanga and Dar es Salaam peri urban dairy units of Tanzania that included full-time zero grazing, partial grazing and full-time grazing systems. A combination of partial zero and free grazing systems were the predominant grazing/feeding systems in Dar es Salaam city compared to Morogoro municipality. (Paper II). In both study areas, grazing/feeding of animals was taking place in the communal lands that are public-owned lands. According to Municipal council by-laws,

free grazing of livestock in Tanzanian towns is not allowed, is regarded as an offence and contravenes the by-laws which require all livestock to be kept under zero grazing system. Thus, free grazing system in peri urban areas is still a concern in most East African countries (Foeken, 2005; Prain *et al.,* 2010).

Lack of agricultural land for livestock production could possibly be the reason for dairy farmers in peri urban areas of Tanzania to rely on communal grazing land. For instance, very few dairy farmers in Dar es Salaam and Morogoro peri urban areas allocated land for cultivated pasture production and/or set aside grazing area (Paper II). Similar results were reported in peri urban areas of Addis Ababa city (Ayenew *et al*., 2009). Some of the contributing reasons for not allocating land for pasture production were availability of alternative sources of pasture from communal land, land scarcity, lack of pasture seeds and technical know-how on pasture establishment (Shiferaw *et al*., 2003; Kavana and Msangi, 2005; Mtengeti *et al*., 2008). Nevertheless, a different scenario was reported in peri urban areas of Tanga city, where a good number of farmers had plots for pasture production (Swai *et al*., 2005). For a long period, Tanga region in Tanzania had received technical and financial assistance from Dutch funded dairy projects. Through the projects, farmers were trained on basic dairy husbandry and were instructed to set aside land for pasture production as some of the prerequisites for a farmer to be given an in-calf heifer. Feeding systems in peri urban areas of Morogoro had no effect on neither milk yield nor milk composition (Paper IV).

The non-significant effect of feeding systems on daily milk yield is also supported by Bee *et al*. (2006) and Tebug *et al.* (2012) in their studies in peri-urban dairy units of Kibaha and Korogwe in Tanzania and Malawi, respectively. This implied that dairy cows in different feeding systems in the study area were fed similar types and qualities of feeds.

Normally, dairy farmers in Morogoro municipality did not have permanent pasture plots and therefore, cows were fed whatever was available and in most cases, the quality of the pasture was of low quality.

Communal grazing land and river banks were the main sources of forage and had similar nutritive value in the study area (Paper IV). The distance to the sources of forage varied both within and between locations in a given study area. A vivid example is reported from the current study where by Dar es Salaam city dairy farmers covered significantly ($p<0.05$) longer distance (mean of 14.7 km) in search of forages relative to Morogoro municipality (mean of 3.07 km) (Paper II).

Dairy farmers in Dar es Salaam city and Morogoro municipality used different modes of transport to collect forage from the sources to their respective dairy units (Paper II). However, the majority of the dairy farmers used mainly vehicles and bicycles/ walking on foot to collect forage for their cattle. Contrary to this observation, urban dairy farmers in Nakuru Kenya and Addis Ababa Ethiopia used mostly bicycles (40 percent) and donkeys (50.8 percent) respectively, to bring in fodder /forage to the dairy units (Shiferaw *et al.*, 2003; Prain *et al*., 2010).

Covering of longer distance in search of forage and the use of vehicle for collecting fodder / forage may increase production cost. This statement is supported by Kavana and Msangi (2005) who reported high cost of milk production (188 Tsh per kg of milk) in Kibaha (peri urban area of Dar es Salaam) relative to 171 Tsh per kg of milk (1 USD=1600 Tsh) in Morogoro. Usually, transport cost and feeds are too high and negatively affects the profitability of milk in the market (Shiferaw *et al.,* 2003). Nevertheless, the transport costs for forage vary between urban and peri urban areas, but are felt more by urban dairy

farmers compared to the peri urban dairy farmers who minimize the feed costs by grazing their cattle in open areas. Dairy cattle herd size influenced the choice of transport for forage collection from outside sources (Paper II). Generally, dairy farmers with small cattle herds used mostly bicycle or walking on foot whereas farmers with larger cattle herds had to either grazed their cattle or used vehicles (hired/own) for collecting forage.

The types of forage transportation had a significant ($p<0.05$) effect on daily milk yield (Paper IV). Dairy farmers who used bicycles/walking on foot to transport forage from the sources to the dairy units had dairy cows producing more milk than cows owned by farmers who used vehicles (own and or hired) (Paper IV). This could possibly be explained by the fact dairy farmers who used vehicles to collect forages are the ones who had relatively large cattle herds and had the tendency of underfeeding their animals as a result of reluctance to give liberal feed fearing transport cost.

Dairy farms need labour to carry out basic activities of dairying such as pre-production, production and marketing activities. Basically, there are three types of labour and include family (in kind), hired and can be secured through a social capital arrangement. Dairy units in peri urban areas of Dar es Salaam city were mainly managed by using a combination of hired and family labour, while similar units in Morogoro municipality employed hired labour to perform production activities (Paper II). The dependence of hired labour to perform dairy production activities in peri urban dairy units is supported by various authors (Lupala, 2002; Msangi *et al.*, 2005). This is an indication that dairy farming in urban and peri urban areas of East African cities, creates employment opportunities to urban dwellers and can be a good source of livelihood (Mlozi, 2005; Orodho, 2006).

It is evident that dairy farmers in peri urban areas of Morogoro municipality employ hired labour because most of them were government employees and others were small business men and women (Paper II). However, dependence of unskilled hired labour in dairy production activities may result in mismanagement of the dairy unit (Salem *et al.,* 2006). The effect of types of farm labour on daily milk yield was not significant ($p>0.05$) (Paper IV). This means possibly all dairy units in the study areas were managed by similar unskilled hired labour. But they also don't make the crucial decisions on the management of the dairy animals.

Dairy farm owners were either employed (Central Government/local Government) or self employed (formal/informal). Analysis of data indicated that the owners of the dairy units in peri urban areas of Dar es Salaam city were mostly self-employed while retired officers and government employees were the minority (Paper I1). By comparison, government employees were the most numerous in Morogoro municipality compared to Dar es Salaam city. The fact that dairy production activities in urban and peri urban areas of Tanzania involved different stakeholders was also reported by various authors (Kurwijila, 2001; Ishagi *et al*., 2002; Lupala, 2002; Mlozi, 2005).

Daily milk yield was significantly ($p<0.05$) affected by employment status of the dairy farmers in Morogoro municipality (Paper IV). People who had no regular income (self employed) had cows which produced more milk (7.5 kg/day) while cows owned by government employees produced the lowest amount (4.4 kg/day) of milk (Paper IV). The observation that cows owned by people who had no other regular income produced more milk than their counterparts could possibly be explained by the fact that the owners devoted more time and resources to ensure that their cows were well attended. The result

is in agreement with FAO (2001) who concluded that feeding systems and hence, milk yield in urban and peri-urban areas of African cities, vary with social categories.

The practice of giving extra concentrate to dry cows in the last trimester (steaming up) is rarely done by smallholder dairy farmers in peri urban areas of Tanzania (Paper II). This finding is complemented by Mellau *et al.* (2009) who carried out their research in urban and peri urban areas of Dar es Salaam city. Of late, the practice of steaming up dry cows was more prevalent in Dar es Salaam city than in Morogoro and is specifically used by dairy farmers with small cattle herd sizes (1-10 animals) than large cattle herds (21-50 animals) (Paper II).

Steaming up of dry cows improves milk yield in the next lactation. This observation is in agreement with the current study which demonstrated that lactating dairy cows which received concentrate supplementation during pre and post-partum periods produced significantly ($p<0.05$) more milk yield than those which were supplemented only during lactation period (Paper V). This implies that pre partum concentrate feeding made dairy cows to accumulate enough body reserves that were mobilized for synthesis of milk (Soto *et al.,* 2001). This finding is in agreement with Sidibé-Anago (2008), but differs to Keady *et al.* (2001) who reported concentrates supplementation in the late stage of gestation to have non-significant ($p>0.05$) effect on milk yield.

Most dairy farmers in peri urban areas of Tanzania do not use protein concentrate instead they use energy concentrate to supplement their lactating dairy cows during milking sessions (Paper II). This agrees with Mlay *et al.* (2001) who reported the same in peri urban dairy units in Tanzania. Contrary to this observation, there was a fairly good number (42 percent) of dairy farmers in peri urban areas of Nakuru who fed compounded

concentrates to lactating cows (Richards and Godfrey, 2003). Some authors have reported lack of knowledge and skills in dairy husbandry and/or fear for increased cost of supplementation to be some of the reasons for not supplementing the cows with the correct ration (Mlay *et al.,* 2005; Mtengeti *et al.,* 2008). However, it has been proved that on farm pre partum compounded ration supplementation of crossbred cows was cost effective and profitable (Paper V). Likewise, some authors in their studies reported post-partum supplementation with home-made rations to be cost effective provided there is careful consideration during compounding the ration in order to minimize feed cost (Mlay *et al.,* 2005).

Supplementing energy concentrate alone does not meet the requirements of the animals for milk production as shown by the current finding that lactating cows which were fed maize bran alone (energy concentrate) produced significantly ($p<0.05$) lower milk yield than the ones which were supplemented with compounded ration (energy and protein) (Paper V). Higher milk yield was realized by supplementing the cows with compounded ration than maize bran alone because the former had caused higher ammonia levels in the rumen that was available to rumen microbes which in turn were digested in the small intestines for milk production.

Dairy cattle herd sizes varied considerably between Dar es Salaam city and Morogoro municipality in which the former had significantly ($p>0.05$) a larger number of animals/farmers) (11.1±1.1 than the latter (5.5±0.5 animals/farmer) (Paper II). In both study areas, the average herd size was above four head of cattle per farmer which is contrary to the provisions of urban by-laws in Tanzania (URT, 1982). Yet, a good number of dairy farmers in peri urban areas of Dar es Salaam ignored the by-laws and have shown interest of increasing their cattle herds in order to capture the high market demand for milk

(Paper II). Furthermore, inefficiency in by-laws enforcement mechanisms create a loop hole for dairy farmers to contravene the urban by -laws (Mlozi, 2005).

Dairy cattle require good sheds that provide comfort to them, decrease wastage of feedstuff and ensure better environmental control (Kassa, 2003). Unfortunately, Dar es Salaam city and Morogoro municipality had few standardised cattle sheds (Paper III and IV). Failure to have standardised cattle sheds in peri urban areas of Tanzania, also contravenes Animal Welfare Act (URT, 2008) that demands animals to be kept in well designed cattle sheds. Various authors have reported absence of well designed cattle sheds in peri urban areas of East African cities (Kivaria *et al.*, 2006; Mureda and Zeleke, 2008).

Most cattle sheds were smaller in size relative to the number of cattle kept leading to high stocking density. However, the tendency of overstocking of dairy cattle was equally (p>0.05) the same between Dar es Salaam city and Morogoro municipality (Paper II). The finding that cattle sheds in peri urban areas of Dar es Salaam city and Morogoro municipality had high stocking density was also reported by some authors in other East African cities/towns (Ishagi *et al*., 2002). High stocking density was positively correlated with higher total bacterial counts in raw milk at farm level but had no significant effect on Coliform counts (Paper IV). Furthermore, stocking density was positively correlated with hygienic condition of the cattle sheds (Paper III). Dairy units which had high stocking density coupled with shortage of water had the dirtiest cattle sheds. According to Tanzania Dairy Industry Regulations (URT, 2007), it is illegal to have dirty cattle sheds and the owners were supposed to be penalised. However, the dairy inspectors in Tanzania who are charged with such duties and given powers in the performance of their functions are not performing their responsibilities.

The majority of the dairy farmers sold raw milk directly to consumers and very little was processed into dairy products (Paper II). This result agrees with Shiferaw *et al.* (2003) who reported similar trends in peri urban dairy units in Ethiopia. The small amount of milk produced per household per day and lack of skills in dairy technology made farmers unable to add value to raw milk. Under normal circumstances, selling and drinking of raw milk in Tanzania is illegal and contravenes the Dairy Industry Regulations (URT, 2007) and poses health risks to consumers since the milk contained higher total bacterial counts and coliform counts (Paper IV). Unfortunately, there is little efforts put in place to ensure that milk consumers in Tanzania are safeguarded. Instead, they are at risk of contracting milk borne diseases as a result of consuming contaminated milk and milk products. Distance to the milk market varied between the two study areas and dairy farmers in the peri urban areas of Dar es Salaam city covered significantly longer (6.6±4.1 km) distance compared to Morogoro municipality who covered only 2.3±2.1 km to milk market. Longer distance to milk market may affect the keeping quality of the milk (IDF, 1990).

Most farmers in Dar es Salaam city and Morogoro municipality used plastic buckets during milking and ferrying of milk to market places (Paper IV). Similarly, Lues *et al.* (2012) reported wide use of plastic buckets as milking and collection utensils in Kampala Uganda and South Africa peri-urban dairy units. The use of plastic buckets for milking and storage coupled with insufficient cleaning of milk vessels and the use of unclean water for cleaning increase the level of milk contamination (Kivaria *et al.,* 2006).

The fact that unclean water increases the level of milk contamination is supported by Shayo *et al*. (2007) who reported water sources in the Morogoro municipality in Tanzania to contain higher faecal coliform than the recommended levels. The overall mean calving to first service interval (CFSI) of 96.1±0.02 days obtained in Morogoro municipality

(Paper V) was slightly higher than the recommended (80-85) days to achieve the target of 365 days of calving interval. However, the current interval from calving to first service was shorter than the range of 115-170 days reported earlier for crossbred dairy cows in Ethiopia and Tanzania (Mwatawala and Kifaro, 2009). The relatively lower CFSI in the present study could be attributed to the smaller negative energy balance after calving (Butler and Smith, 1989). Contrary to this, ideal CFSI of 85.6±5.6 and 87±8.6 days for crossbred dairy cows was reported in Asella Ethiopia and Tanga Tanzania peri urban dairy farms, respectively (Lyimo *et al.*, 2004; Dinka *et al.*, 2012). The overall mean calving to conception interval (CCI) of 129.8±6.9 days for crossbred cows reported in Morogoro municipality (Paper V) is similar to 120 and 123±11 days reported for crossbred dairy cows in Ethiopia (Yifat *et al.*, 2009) and Tanga Tanzania (Lyimo *et al.*, 2004), respectively. Nevertheless, the interval was shorter than the range of 148-218.5 days reported from various dairy units in East African countries (Mwatawala and Kifaro, 2009; Lemma and Kebede, 2011). The relatively lower CCI of dairy cows in Morogoro municipality could partly be attributed to fair management and feeding of the animals.

The result of 1.7 number of services per conception (NSC) reported in the present study (Paper V) suggests relatively good insemination services of the herds during the period of study when compared to the minimum value of 1.3 NSC (Rahman *et al.*, 1998). The NSC reported in the study area was similar to 1.6 - 1.8 NSC reported earlier for crossbred dairy cows kept in urban and peri urban areas of Holeta, Zeway, Addiss Ababa in Ethiopia and Tanga Tanzania (Shiferaw *et al.*, 2003; Lyimo *et al.*, 2004; Goshu *et al.*, 2007; Yifat *et al.*, 2009). The dairy farms in Addis Ababa, Ethiopia and Tanga municipality, Tanzania in which the studies were conducted they used both natural and artificial insemination (AI) services for breeding the dairy cows. This could possibly be the reason for the fairly good NSC. Natural service as opposed to AI was mostly used by dairy farmers to breed their

cows in Dar es Salaam city and Morogoro municipality (Paper II). Notwithstanding, significantly more dairy farmers in Dar es Salaam city used AI than Morogoro municipality. Farmers' reliance on natural service as a breeding method of their choice was also reported by Msangi *et al.* (2005). The high cost of AI service, unreliability of liquid nitrogen and semen made most farmers to avoid using the service. Dairy herd genetic improvement depends on good breeding practices. The government of the United Republic of Tanzania should therefore positively intervene this by ensuring AI services are available at affordable price and reliable.

The overall mean calving interval (CI) of 410.2±0.01 days reported in peri urban dairy farms in Morogoro municipality (Paper V) is lower than 433–562 days reported for crossbred dairy cows kept in various dairy units in urban and peri urban areas of Ethiopia and Tanzania (Nkya *et al*., 1999; Shiferaw *et al*., 2003; Msangi *et al*., 2005; Kivaria *et al*., 2006; Goshu *et al*., 2007; Yifat *et al*., 2009; Ayenew *et al*., 2009). The current figure of CI reported in peri urban dairy farms in Morogoro municipality is within 365-420 days required for dairy cows to calve down regularly and hence the farm is assured of having one calf per year. Regarding effect of feeding, the current study has demonstrated that pre partum concentrate supplementation of dairy cows had no effect ($p>0.05$) on reproductive traits such as calving to first service interval, calving to conception interval, number of services per conception and calving interval (Paper V). Similarly, various authors in other study areas have reported non-significant effect of pre partum concentrate supplementation on reproductive traits (Keady *et al*., 2001; Soto *et al*., 2001; Msangi *et al*., 2004).

CHAPTER FOUR

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The main results from this study may be concluded as follows:

The dairy farmers in Dar es Salaam city and Morogoro municipality face different constraints that limit high milk production and reproductive performance. As a result, crossbred cows in Dar es Salaam city produced significantly more milk than crossbred dairy cows in Morogoro municipality. Forages had low nutritive values and dairy farmers in Dar es Salaam city obtained forages from a significantly far away distance than dairy farmers in Morogoro municipality. Artificial insemination service was rarely used in both study areas because of its unreliability and high cost. Poor welfare of dairy cattle exists in both urban and peri urban smallholder production systems of Dar es Salaam city and Morogoro municipality. The poor welfare of animals was a result of dairy farmers using substandard cattle sheds and poor animal management practices that include high stocking densities and poor hygiene of cattle sheds. Dairy farmers contravened various laws and regulations of keeping animals in urban and peri urban areas. Due to shortage of forage as a result of increased urban population and prohibitive urban by-laws, some dairy farmers were forced to decrease their cattle herds.

Feeding systems (zero and partial zero grazing) had no effect on milk yield, chemical composition and microbiological quality of milk in peri urban areas Morogoro municipality. This indicates that dairy cows received similar management, quality and quantity of feeds in the two grazing systems. Seasons of calving and social economic factors of dairy farmers influenced significantly daily milk yield and its quality. Microbiological quality of raw milk collected at farm level was poor as the milk samples

had high levels of total bacterial counts and coliform counts which were unacceptable. Poor hygiene could be a potential source of milk-borne infections.

Milk production can be increased significantly and that it is economical to substitute the maize bran with balanced home-made concentrate depending on the prevailing prices of locally available inputs. The change in supplementation regime from maize bran based concentrate to home-made ration had no significant effect on reproduction and the composition of the milk. Supplementation of a smaller amount of concentrate distributed both pre- and post-partum increased milk production significantly than supplementing all the concentrates during post-partum period.

4.2 Recommendations

It is recommended that:

i. The Ministry of Livestock and Fisheries should take a lead in creating awareness, advocacy and engage different livestock stakeholders in order to identify conflicting and contrasting areas in the legislations that regulate the dairy sector and harmonize them.

ii. Motivation in terms of transport facilitation should be provided to extension workers to visit and train dairy farmers on the importance of clean milk production.

iii. The Ministry of Livestock and Fisheries has to develop dairy farming guidelines for urban and peri urban areas, train and sensitize dairy farmers to construct cattle sheds that conform to standard design and be in line with the Animal Welfare Act. No. 19 of 2008.

iv. The government of the United Republic of Tanzania should positively intervene and ensure artificial insemination services are reliable and available at affordable price.

REFERENCES

Ali, A.A. and Abdelgadir, W.S. (2011). Incidence of Escherichia coli in raw cow's milk in Khartoum state. *British Journal of Dairy Science* 2 (1): 23-26.

AOAC (Associations of Official Agricultural Chemists), (1995). *Official Methods of Analysis*. 16th Edition AOAC Washington DC. 62 pp.

Ayenew, Y. A., Wurzinger, M., Tegegne, A. and Zollitsch, W. (2009). Handling, processing and marketing of milk in the North western Ethiopian highlands. *Livestock Research for Rural Development* 21: 97 [http://www.lrrd. org /lrrd 21/7/ayen21097.htm.] Site visited on 20/11/2012.

Bee, J. K. A., Msanga, Y. N. and Kavana, P. Y. (2006). Lactation yield of crossbred dairy cattle under farmer management in Eastern coast of Tanzania. *Livestock Research for Rural Development* 18: 2 [http://www.lrrd.org/lrrd18/2/bee 18023.htm.] Site visited on 19/7/2011.

Dinka, H. (2012). Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia International *Journal of Livestock Production* 3 (3): 25-28. [http://www.academicjournals.org/IJLP]. Site visited on 14/11/2013.

FAO (1998). *Farm structure in tropical climates:* a textbook for structural engineering and design Bengtsson, L.P. and Whitaker, J. H. (Editors). FAO/SIA Cooperative Programme. Rural structures in East and South-East Africa 167 pp.

FAO (2001). A briefing guide for the successful implementation of urban and peri-urban agriculture in developing countries and countries of transition. Revision 2, Handbook Series. Volume III. Rome.

Foeken, D. W. J. (2005). Urban agriculture in East Africa as a tool for poverty reduction: A legal and policy dilemma? Working paper 65/2005 30 pp. [http://www..ascleiden.nl]. Site visited on 18/11/2013.

Goshu, G., Belihu, K. and Berihun, A. (2007). Effect of parity, season and year on reproductive performance and herd life of Friesian cows at Stella private dairy farm, Ethiopia. *Livestock Research for Rural Development* 19: 98 [http://www.lrrd.org/lrrd19/7/gosh19098.htm]. Site visited on 16/8/2012.

IDF (International Dairy Federation), (1990). *Handbook on milk collection in warm developing countries* IDF, Brussels, Belgium 148 pp.

IDF (International Dairy Federation), (1992). *Milk and milk products. Preparation of samples and dilutions for microbial examination*. International Dairy Federation Standards, 122 pp.

Ishagi, N., Ossiya, S., Aliguma, L. and Aisu, C. (2002). Urban and peri-urban livestock keeping among the poor in Kampala City. Ibaren Konsultants, Kampala, Uganda 97pp.

Jacobi, P., Amend, J. and Kiango, S. (2000). Urban agriculture in Dar es Salaam: providing for an indispensable part of the diet. In: *N. Bakker, M. Dubbeling, S. Guendel, U. SabelKoschella and H. de Zeeuw eds. 2000*. Growing cities, growing food, urban agriculture on the policy agenda, Feldafing Germany, DSE pp. 257-281.[http://www.ruaf.org/sites/default/files/DaresSalaam.PDF]. Site visited on 19/12/2011.

Kadonya, C., Madihi, M. and Mtwana, S. (2002). Tanzania child labour in the informal sector: A rapid assessment International Labour Organization International Programme on the Elimination of Child Labour (IPEC). 70 pp.

Kassa, T.M. (2003). A study on urban agriculture: the case of small-scale urban dairy farming in selected areas of Addis Ababa, A Thesis Presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Geography 166 pp.

Kassenga, G. and Mbuligwe, S. (2012). Report on investigation of Dar es Salaam's institutional activities related to climate change. Adapting to climate change in coastal Dar es Salaam working paper 91 pp. [http://www.planning 4adaptation.eu/Docs/papers/06_Kassenga_Mbuligwe]. Site visited on 16/7/2014.

Kavana, P. Y. and Msangi, B. S. J. (2005). On farm dairy cattle feeding experience in eastern zone of Tanzania. *Livestock Research for Rural Development* 17 (6): 45-67. [http://www.lrrd.org/lrrd17/6/kava17062.htm]. Site visited on 11/09/2013.

Kavana, P. Y., Kizima, J. B., Msanga, Y. N., Kilongozi, N. B., Msangi, B. S. J., Kadeng'uka, L. A., Mngulu, S. and Shimba, P. K. (2007). Potential of pasture and forage for ruminant production in Eastern zone of Tanzania. *Livestock Research for Rural Development* 17: 144. [http://www.lrrd.org/l rrd17/12/kava 17144.htm]. Site visited on 16/10/2013.

Keady, T. W. J., Mayne, C. S., Fitzpatrick, D. A. and McCoy, M. A. (2001). Effect of concentrate feed level in late gestation on subsequent milk yield, milk composition, and fertility of dairy cows. *Journal of Dairy Science* 84: 1468-1479.

Kilango, K., Makita, K., Kurwijila, L. and Grace, D. (2011). Food safety in milk markets of smallholder farmers in Tanzania: A case study of peri-urban wards in Temeke. Paper presented at the first International Congress on Pathogens at the Human-Animal Interface (ICOPHAI), Addis Ababa, Ethiopia, and 15th -17th September 2011. [http://www.cgspace.cgiar.org/handle/10568/12452]. Site visited on 14/11/2013.

Kivaria, F. M., Noordhuizenm, J. P. T. M. and Msami, H. M. (2006). Management practices associated with pathogen specific incidence rates of clinical mastitis in smallholder dairy cows in Dar es Salaam Region Tanzania. *Tropical Animal Health and Production* 67-92 pp.

Kurwijila, L. R. (2001). An overview of dairy development in Tanzania *In*: Rangnekar, D. and Thorpe, W. (eds). 2002. Smallholder dairy production and marketing,

Opportunities and constraints. *In:* Proceedings of a South-South workshop held at NDDB, Anand, India, 13-16 March 2001. NDDB (National Dairy Development Board), Anand, India and ILRI (International Livestock Research Institute), Nairobi, Kenya. 538 pp.

Lemma, A. and Kebede, S. (2011). The effect of mating system and herd size on reproductive performance of dairy cows in market oriented urban dairy farms in and around Addis Ababa *Revue Medical Veterinary* 162 (11): 526-530.

Limbu, F. (1999). Agricultural technology economic viability and poverty alleviation in Tanzania. Paper presented at the structural transformation policy workshop Organized by the ECAPAPA, Tegemeo Institute and Michigan State University 27-30 June 1999 Serena Hotel, Nairobi Kenya. 55 pp.

Lues, J. F. R., Jacoby, A., De Beer, H., Jansen, E. K. and Shale, K. (2012). Survey on different factors influencing small-scale milking practices in a peri-urban area, *Scientific Research and Essays* 7(7): 740 -750. [http://www.academicjournals. org/SRE]. Site visited on 22/11/2012.

Lupala, A. (2002). Scoping study on urban and peri-urban livestock keepers in Dar es Salaam City. University College of Lands and Architectural Studies (UCLAS), Dar es Salaam, Tanzania 71 pp.

Lyimo, C., Nkya, R., Schoolman, L. and Van Eerdenbutg, F. J. (2004). Post-partum reproductive performance of crossbred dairy cattle on smallholder farms in sub humid coastal Tanzania. *Tropical Animal Health and Production* 36: 269-279.

Mageka, A. A. P. (2005). Challenges facing urban and peri urban agriculture and livestock production in Morogoro Municipality and policy strategies *In*: Human health risks and benefits of urban and peri urban agriculture and livestock production in Sub Saharan Africa. In: *Proceedings of the Workshop held at Bagamoyo, Tanzania*, 18 - 24th September 2005 pp. 24 - 38. Maturin, L. and Peeler, J. T. (2001). *Bacteriological analytical manual*. Aerobic Plate Count, Chapter 3. [http://www.fda.gov/Food/ScienceResearch/LaboratoryMethods/Analytical Manual BAM/ucm063346.htm]. Site visited on 16/11/2013.

Mbaye, A. and Moustier. P. (2000). Market-oriented urban agricultural production in Dakar. In: *Bakker, N., M. Dubbeling, S. Guendel, U. Sabel Koschella, H. de Zeeuw (eds.).* Growing cities, growing food, Urban agriculture on the policy agenda. DSE, Feldafing, pp. 235-256.

McDonald, P., Edwards, R. A. and Greenhalgh, J. F. D. (1995). *Animal Nutrition*. Longman Singapore Publishers Pte Ltd, 607 pp.

Mcha, M. C. (2012). Addressing employment challenges in Tanzania: Strategic policy options and actions by stakeholders. Presented at Tanzania Country Level Knowledge Network, Dar es Salaam, 15 February, 2012. [http://www.clknet. or.tz/wp-content/uploads/2012/02/Presentation-addressing-employment-challe nges-3.pdf]. Site visited on 27/11/2013.

Mellau, L. S. B., Sarimbo, A. P., Kimera, S. I. and Phiri, E. C. J. (2009). Recumbence syndrome around calving in cattle: A study of risk factors of milk fever in dairy units in Dar es Salaam, Tanzania. *Tanzania Veterinary Journal* 26 (2): 52 -56.

Mlay, P. S., Madsen, J., Pereka, A. E., Hvelplund, T. and Weisberg, M. R. (2001). Smallholder livestock production trends in urban and peri urban areas of Morogoro. *Tanzania Veterinary Journal* 21 (1): 15-26.

Mlay, P. S., Pereka, A. E., Balthazary, S. T., Phiri, E. C. J., Hvelplund, T., Weisbjerg, M. R. and Madsen, J. (2005). The effect of maize bran or maize bran mixed with sunflower cake on the performance of smallholder dairy cows in urban and peri-urban area in Morogoro, Tanzania. *Livestock Research for Rural Development* [http://www.lrrd.org/lrrd17/1/mlay17002.htm]. Site visited on 24/10/2013.

Mlozi, M. R. S. (2005). Urban animal agriculture: its palliativity and reasons for persistence in Tanzanian towns. RICS Foundation 26 pp. [http//:www.rics-foundation.org]. Site visited on 16/11/2013.

Msanga, Y. N., Bryant, M. J., Rutamu, I. B., Minja, F. N. and Zylstra, L. (2000). Effect of environmental factors and the proportion of Holstein blood on milk yield and lactation length of crossbred dairy cattle on smallholder farms in northeast Tanzania. *Tropical Animal Health and Production* 32 (1): 23–31.

Msanga, Y. N. and Kavana, P.Y. (2002). Performance of F1 Frisian x Boran crossbred bulls and their off-springs to Tanzanian shorthorn Zebu managed under the extensive traditional system. In E. K. Batamuzi and A. J. P. Tarimo (Eds.), In: *Proceedings of the First Collaborative Research Workshop on Food Security* May 2003. TARP II SUA Project pp 196-200.

Msangi, B. S. J., Bryant, M. J., Nkya, R. and Thorne, P. J. (2004). The effects of short term increase in supplementation on reproduction performance of lactating crossbred dairy cows. *Tropical Animal Health and Production* 36: 775-787.

Msangi, B. S. J., Bryant, M. J. and Thorne, P. J. (2005). Some factors affecting reproductive success in crossbred dairy cows on smallholder farms in coastal North-East Tanzania. *Tropical Animal Health and Production* 37 (5): 413- 426.

Mtengeti, E. J., Phiri, E. C. J. H., Urio, N. A., Mhando, D. G., Mvena, Z., Ryoba, R., Mdegela, R., Singh, B. R., Mo, M., Wetlesen, A., Lørken, T. and Reksen, O. (2008). Forage availability and its quality in the dry season on smallholder dairy farms in Tanzania, *Acta Agriculture Scandinavia* 58: (4): 196-204.

Mureda, E. and Zeleke, Z. (2008). Characteristics and constraints of crossbred dairy cattle production in lowland areas of Eastern Ethiopia. *Livestock Research for Rural Development.* 20: 57 []http://www.lrrd.org /lrrd20/4/mure20057 htm. Site visited on 17/11/2013.

Mwatawala, H. W. and Kifaro, G. C. (2009). Reproductive performance of artificially and naturally bred Boran heifers and cows under ranch conditions in Tanzania. *Journal of Animal and Plant Sciences* 4 (1): 267 - 275. [http://www. bio sciences.elewa.org/JAPS]. Site visited on 13/12/2013.

Njau, F. B. C., Lwelamira, J. and Hyandye, C. (2013). Ruminant livestock production and quality of pastures in the communal grazing land of semi-arid central Tanzania.

Livestock Research for Rural Development 25: 146 [http://www. lrrd.org/ lrrd25/8/Njau25146.html]. Site visited on 16/11/2013.

Nkya, R., Aboud, A. A. and Kessy, B. M. (1999). Improving productivity of smallholder dairy cattle in peri urban Morogoro Tanzania. In: *Proceedings of the final Research Co-ordination Meeting of a Co-ordinated Research Project FAO/IAEA Vienna, Austria,* 7-11 September 1998 pp. 79-86.

Nkya, R., Kessy, B. M., Lyimo, Z. C., Msangi, B. S. J., Turuka, F. and Mtenga, K. (2007). Constraints on smallholder market oriented dairy systems in the north eastern coastal region of Tanzania *Tropical Animal Health and Production* 39: 627– 636.

Olafadehan, O. A. and Adewumi, M. K. (2008). Milk production and economic impact of strategic supplementation of pre partum Bunaji cows in the peri-urban areas of derived savanna of southwestern Nigeria. *Livestock Research for Rural Development*. 20: 41. [http://www.lrrd.org/lrrd20/3 /olaf20041.htm]. Site visited on 23/2/ 2010.

O'Mahony, F. (1988). *Rural Dairy Technology;* Experiences in Ethiopia', ILCA Manual No. 4. International Livestock Centre for Africa, Addis Ababa 64 pp. [http://www.F:/Personal_KG/REFERENCE%20PAPERS/rural%20dairy%20processing_ILCA.pdf]. Site visited on 9/3/2011.

Orodho, A. B. (2006). Intensive forage production for smallholder dairying in East Africa. *In:* Grasslands: Developments Opportunities Perspectives by (Reynolds and

Frame eds) chapter 18 [http://www.fao.org/ag/AGP/AGPC/doc /Newpub /napier/eastafrica_orodho.htm]. Site visited on 3/ 9/2010.

Prain, G., Karanja, N. and Lee-Smith, D. (Editors) (2010). *African urban harvest*: Agriculture in the cities of Cameroon, Kenya and Uganda. IDRC, 335 pp.

Rahman, M.M., Islam, M.N. and Dev, A. (1998). A productive and reproductive performances of indigenous and crossbred cows under village management condition. *Journal of Production Agriculture* 2: 95-99.

Richards, J. I. and Godfrey, S. H. (Eds) (2003). Urban livestock keeping in sub-Saharan Africa: Report of a workshop held on 3-5 March 2003 in Nairobi, Kenya. Natural Resources International Ltd, Aylesford, Kent, UK. 118 pp.

Salem, M. B., Djemali, M., Kayouli, C. and Majdoub, A. (2006). A review of environmental and management factors affecting the reproductive performance of Holstein-Friesian dairy herds in Tunisia. *Livestock Research for Rural Development* 18 (4) 2006 [http://www.lrrd.org/lrrd18/4.htm]. Site visited on 15/3/2011.

SAS (Statistical Analysis System) (2002). *User Installation Guide for the SAS system,* Version 9.1, SAS Institute Inc., Cary, North Carolina, USA 221 pp.

Shayo, N. B., Chove, B. E., Gidamis, A. B. and Ngoma, O. B. (2007). The quality of water in small community supplies of Kingolwira village, Morogoro, Tanzania.Tanzania Health Research Bulletin 9 (1): 56 - 60.

Shiferaw, Y., Tenhagn, B. A., Bekana, M. and Kassa, T. (2003). Reproductive performance of crossbred dairy cows in different production systems in the central Highlands of Ethiopia, *Tropical Animal Health and Production* 25: 551-61.

Sidibé-Anago, A. G., Ouedraogo, G. A. and Ledin, I. (2008). Effect of season and supplementation during late pregnancy and early lactation on the performance of Zebu cows and calves African *Journal of Agricultural Research* 3 (9): 640-646. [http://www.academicjournals.org/AJAR]. Site visited on 12/3/ 2010.

Slaghuis, B. (1996). Sources and significance of contaminants on different levels of raw milk production. *In:* Symposium on bacteriological quality of raw milk Brussels, 13-15, March, 1996.

Soto, R., Rubio, I., Galina, C. S., Castillo, E. and Rojas, S. (2001). Effect of pre and post-partum feed supplementation on the productive and reproductive performance of grazing primiparous Brahman cows. *Tropical Animal Health and Production* 33: 253-264.

Sumberg, J. (1996). Livestock production in peri-urban areas of Africa: An analysis of Dar es Salaam, Mwanza and Shinyanga in Tanzania. Unpublished research report submitted to the ODA Livestock Systems Research Programme. Overseas Development Group, University of East Anglia, Norwich, UK 79 pp.

Swai, E. S., Karimuribo, E. D., Schooman, L., French, N. P., Fitzpatrick, J., Kambarage, D. and Bryant, M. J. (2005). Description, socio-economic characteristics, disease managements and mortality dynamics in smallholder's dairy production

system in coastal humid region of Tanga Tanzania. *Livestock Research for Rural Development* 17: 4. [http://www.lrrd.org /lrrd17/4/swa17041.htm]. Site visited on 9/3/2010.

Takawira, M. and Shingirayi, M. (2006). Integration of agriculture in urban land use planning and adaptation of city regulations *In:* Cities farming for the future, urban agriculture for green and productive cities. Edited by René van Veenhuizen. Published by RUAF Foundation, IDRC and IIRR pp. 53-86.

TBS (Tanzania Bureau of Standards), (1983). *Milk and milk products*. Microbiological specification, Tanzania Standards (TZS 185:1983). [http://www.tbstz.org/tbs_ publication]. Site visited on 10/3/2010.

Tebug, S., Kasulo, V., Malunga, S. C., Wiedemann, S., Roberts, D. J., Chagunda, M. G. G. (2012). Smallholder dairy farming in Northern Malawi: husbandry practices, constraints and prevalence of major production and zoonotic diseases *Tropical Animal Health and Production* 44 (1): 55–62.

Tegegne, A., Tadesse, M., Yami, A. and Mekasha, M. Y. (2000). *Urban and peri-urban dairy systems.* Urban agriculture magazine No 2, RUAF Foundation, Leusden. pp. 30–31.

Tilley, J. M. A. and Terry, R. A. (1963). A two stage technique for the in vitro digestion of forages. *Journal of the British Grassland Society* 18: 104-111.

Tuvana, R. (2005). Policy issues concerning urban and pen-urban agriculture: Dar es Salaam city experience *In*: Human health risks and benefits of urban and peri urban agriculture and livestock production in sub-Saharan Africa In: *Proceedings of the Workshop held at Bagamoyo, Tanzania*, 18th - 24th September pp 14-23.

UN-Habitat (2009). National urban profile Tanzania. United Nations Human Settlements Programme Regional and technical cooperation division 40 pp. [http://www.unhabitat.org]. Site visited on 9/3/2010.

URT (United Republic of Tanzania), (1982).Urban Authorities Act, Printed by the Government Printer, Dar es Salaam, Tanzania 59 pp.

URT (United Republic of Tanzania), (2006a).Tanzania census 2002 analytical report Volume X National Bureau of Statistics Ministry of Planning, Economy and Empowerment Dar es Salaam 211 pp. [http://www.nbs.go.tz /takwimu/references/2002popcensus.pdf]. Site visited on 9/3/2010.

URT (United Republic of Tanzania), (2006b). *National Livestock Policy*. Ministry of Livestock Development. December, 2006 79 pp, [http://www.mifugo.go.tz]. Site visited on 10/3/2010.

URT (United Republic of Tanzania), (2007). The Dairy Industry Regulations. The Government Printers Dar es Salaam Tanzania 48 pp.

URT (United Republic of Tanzania), (2008). The Animal Welfare Act. No. 19 of 2008. Ministry of Livestock Development 62 pp. [http://www.mifugo.go.tz]. Site visited on 9/3/2010.

URT (United Republic of Tanzania), (2011). Livestock sector development programme. Ministry of Livestock and Fisheries Development [http://www. mifugo.go.tz/documents_storage/Livestock%20Programepdf] Site visited on 9/3/2012.

URT (United Republic of Tanzania), (2013). *Tanzania census 2002 analytical report* Volume X National Bureau of Statistics. Ministry of Planning, Economy and Empowerment Dar es Salaam 211 pp. [http://www.nbs.go.tz/takwimu /references/2002popcensus.pdf]. Site visited on 12/4/2012.

URT (United Republic of Tanzania), (2014). *Basic Data for Livestock and Fisheries sectors 2013*. Ministry of Livestock and Fisheries Development, Dar es Salaam 135 pp.

Yifat, D., Kelay, B., Bekana, M., Lobago, F., Gustafsson, H. and Kindahl, H. (2009). Study on reproductive performance of crossbred dairy cattle under smallholder conditions in and around Zeway, Ethiopia.Livestock Research for Rural Development 21: 88. [http://www.lrrd.org/lrrd21/6/yifa21088. htm]. Site visited on 11/3/2013.

LIST OF PUBLISHED PAPERS

Paper I

Livestock Research for Rural Development 24 (11) 2012 | Guide for preparation of papers | LRRD Newsletter | Citation of this paper

Urban and peri urban dairy farming in East Africa: A review on production levels, constraints and opportunities

K A Gillah, G C Kifaro* and J Madsen**

Ministry of Livestock Development and Fisheries P.O. Box 9152, Dar es Salaam Tanzania
kagillah@yahoo.com
* Department of Animal Science and Production, Sokoine University of Agriculture, P.O. Box 3004, Morogoro Tanzania
** Department of Large Ruminants, University of Copenhagen, Denmark

Abstract

Urban and peri urban dairy production system is among the many forms of dairy production in the tropics and sub tropics. Both the number of dairy cattle and dairy farmers vary across urban and peri urban areas of East Africa. Generally, dairy cows are fed on moderate (6 – 6.8 CP percent) quality natural pastures. Milk production is low and ranges from 5.7 – 17.1 litres/cow/day. The mean lactation lengths in urban and peri urban dairy units vary between 8.8 to 9.7and 11.2 months respectively. In all cases, the lactation lengths were either shorter or longer than the standard length of 10 months. Some reports show that more milk yields (7- 14.7 litres/cow/day) are produced in urban dairy units compared to 6.2- 11.2 litres/cow/day produced by their counterparts in peri urban dairy units. The mean ages at first calving, calving to conception interval and calving interval were 29.7 to 46.0 months, 123 to 276 days, 406 to 562 days respectively. A large number of services per conception (2.3) were required when artificial insemination (AI) was used for mating cows compared to natural service that required a relatively small number (1.7). Some disparities in milk production and reproductive performance of cows between urban and peri urban dairy units have been reported. However, it is difficult to judge whether urban or peri-urban dairy cows performed better than the other. The major constraints hindering dairy production in urban and peri urban areas of East Africa differ between and within countries and production systems. The variations might be due to the methods employed during data collection, physical location, dairy breeds kept and season of the year. The constraints include seasonal availability and costs of feeds, poor milk marketing and low milk price, availability of land, problems of waste disposal and pollution, disease and shortage of capital. Despite having constrained by a number of factors, dairying in urban and peri urban areas creates employment opportunities and provides farmers chance to use land, labour and feed resources to generate regular income.

Key words: age at first calving, artificial insemination, lactation length, milk production, number of services per conception, calving interval

Introduction

Urban and peri urban dairy production system is among the forms of dairy production in the tropics and sub tropics. The system involves the production, processing and marketing of milk and milk products in the urban centres. Existence of the urban and peri-urban dairy farming is mainly motivated by availability of good market for animal products, need for creation of employment opportunities (Ayaga et al 2005, RLDC 2009, Prain et al 2010), financial constraints of urban dwellers (Ishagi et al 2002, Mlozi 2005). Dairying constitutes an important sub sector of agricultural production which contributes towards filling in the large demand-supply gap for milk and milk products in urban centres. Furthermore, urban dairying using improved dairy cattle is highly profitable. This is testified by Limbu (1999) in a study conducted in Dar es Salaam city Tanzania and reported that the gross margin per cow per year in urban dairy units was higher (US$1,000) than US$760 in intensive rural dairy systems. As a result of this, dairy cattle population keeps on increasing in most urban centres of East Africa.

More than 90 percent of the urban dairy farmers live in the medium and low density areas and use their residential units as places where dairying is carried out (Shiferaw et al 2003, Mlozi 2005). The dairy farmers in urban areas have little or no access to grazing land and they rely mainly on purchased feeds and communal grazing lands. This results into dairy cattle receiving sub optimal level of nutrition especially during the dry periods. Urban areas have limited space for dairying and due to small land holdings, zero grazing is common (Msangi et al 2005, Cole et al 2008). The level of milk production and reproduction of dairy cattle varies considerably within and between countries and between production systems. The variations are mainly due to ecological conditions, management factors and the way researchers report their findings especially daily milk production. This paper therefore, attempts to review the production and reproduction levels, constraints and opportunities of dairy cattle production kept in urban and peri urban areas of East African cities.

Benefits of urban and peri urban dairying

Dairying in East African cities is increasing substantially due to its associated benefits. The most important benefits are increased income, employment generation, food and nutrition, organic waste recycling and uplifting social status. Men and women view the benefits of dairying differently. According to Prain et al (2010) men and women ranked income and employment respectively as the first most important benefit. The informal raw milk marketing provides the urban dairy farmers with a regular daily source of income through sales of milk, milk products and manure. In view of this, Mlozi (2005) in Dar es Salaam city and Ayaga et al (2005) in Nairobi cities reported milk produced to generate a total sum of US$ 291,600 and Ksh 800 million annually respectively. Dairy farming improves the environment as it makes use of organic wastes from households, streets and agro industries as feed for the dairy cattle. Through marketing of milk valuable employment opportunities are created. For instance, it provides employment to more than 100,000 (RLDC 2009) and 28,000 (Ayaga et al 2005) milk hawkers in Dar es Salaam city and Nairobi respectively.

Dairy cattle breeds, herd size and other livestock species

East African urban and peri urban dairy farmers keep different breeds of dairy cattle. These breeds include Friesian, Jersey, Ayrshire, Guernsey and their crosses with local zebu. However, some non-descriptive crossbreds of dairy cattle are also found as a result of indiscriminate mating of cattle. The most common types of livestock kept differ from one town to the other. For example, studies carried out in Dar es Salaam (Mlozi 2005) and Kampala (Prain et al 2010) cities indicated dairy cattle as the first and second respectively most commonly kept livestock species. Likewise, in Nakuru and Nairobi towns in Kenya, dairy cattle were the second and third respectively most common types of livestock species (Guendel 2002). East African cities have experienced an increase in the relative growth rate of dairy cattle population. Dairy cattle increase was an attempt to lessen economic hardships that urban dwellers suffered (Mlozi 2005). Available data indicate that there are more dairy cattle in Kampala city followed by Addis Ababa city and Dar es Salaam city had the least number of dairy cattle (Table 1). Variations in the number of cattle between urban and peri urban areas were noted and the highest proportion of dairy cattle was found in urban than in the peri-urban dairy units (Richards and Godfrey 2003, Ayenew et al 2009). Access to the market for fresh milk has encouraged urban dairy farmers to keep more cross breed dairy cattle. Surprisingly, only 2 percent of the households in Kisumu municipality kept crossbred cattle claiming that they were capital and labour intensive and therefore undesirable to keep (Kagira and Kanyari 2010).

Apart from dairying, farmers keep different livestock species such as chickens, pigs, ducks, rabbits, sheep and goats. A Study carried out in Kampala (Prain et al 2010) indicated chickens (19 percent) to be number one livestock species commonly kept in the city. However, in the previous study carried out in Kampala city focusing on poor livestock keepers Ishagi et al (2002) found pigs as the most numerous livestock followed by cattle.

Table 1: Number of dairy cattle in urban and peri urban areas of East Africa

Country	City/Town	Number of dairy cattle	Reference
Tanzania	Dar es Salaam	11 571	Richards and Godfrey 2003
Ethiopia	Addis Ababa	40 000	Richards and Godfrey 2003
Kenya	Nakuru	25 000	Foeken and Owour 2000
	Nairobi	24 000	Ayaga et al 2005
Uganda	Kampala	50 000 - 168 000	Prain et al 2010

Dairy cattle herd size varies considerably between East African cities. Generally, a good number of households keep on average more than four head of cattle (Table 2). An exceptionally larger average herd size (21) was recorded in two cities of Bahir Dar and Gondar in Ethiopia (Ayenew et al 2009). According to Urban Authorities by laws, Act of 1982 No. 8 section 80, it is forbidden to keep more than four head of cattle in Tanzania. This means that the respondents in Dar es Salaam, Tanga and Morogoro municipality in Tanzania had contravened the town council by- laws which require them to keep not more than four head of cattle under zero grazing system. Despite the existing large herds of dairy cattle, some urban dairy farmers in Addis Ababa in Ethiopia have shown interest of increasing their cattle herds in order to capture the high market demand for milk in urban areas (Shiferaw et al 2003).

Table 2: Average herd size in urban and peri urban areas of East Africa

Country	City/Town	Average herd size	Reference
Tanzania	Dar es Salaam	8	Kivaria et al 2006
	Morogoro	6	Mlay et al 2001
	Tanga	6	Schooman et al 2011
Uganda	Kampala	4	Ishagi et al 2002
	Kampala	4	Prain et al 2010
	Jinja	5	Byarugaba et al 2008
Kenya	Nakuru	3	Prain et al 2010
	Kisumu	15	Kagira and Kanyari 2010
	Nairobi	5	Aleri et al 2011
Ethiopia	Addis Ababa	21	Ayenew et al 2009

Variations in the number of households keeping dairy cattle are noted across urban and peri urban areas of East Africa. With this regard, there are more households keeping dairy cattle in Mbeya Tanzania and Kisumu Kenya and few in Nakuru town of Kenya (Table 3). This can be speculated that possibly some town council by-laws that regulate and control urban dairying favour keeping of dairy cattle in some cities compared to others, or it could be that by-laws are not seriously enforced or there are no by-laws related to dairy farming.

Table 3: Number of households keeping dairy cattle in urban areas of East Africa

Country	City/Town	Sample size	Households keeping dairy cattle (%)	Reference
Tanzania	Mbeya	239	85	Foeken 2005
	Morogoro	114	54	Foeken 2005
Kenya	Nakuru	121	21	Foeken 2005
	Kisumu	573	77	Richards and Godfrey 2003
Ethiopia	Addis Ababa		45	Richards and Godfrey 2003
Uganda	Kampala		60	Richards and Godfrey 2003

Feeds, feeding systems and farm labour for dairy cattle

Urban dairying is more complex as a large proportion of the cattle diet has to be roughage. Usually, roughage for feeding dairy cattle is expensive to purchase and difficult to find in urban areas. This statement is confirmed by 53.7 (Shiferaw et al 2003) and 80 percent (Dayanandan 2011) of the respondents in Addis Ababa and Mekelle towns in Ethiopia respectively who indicated feed cost to be very expensive. High feed cost negatively affects the profitability of milk in the market and is felt more by the urban dairy farmers compared to the peri urban dairy farmers who benefit from grazing their cows in open areas.

The main sources of forage for dairy cattle are purchased fodder, crop residues, natural pasture and weeds. These are obtained from roadsides, public land and their own planted Napier grass or from farmers who do not have livestock. A good number (41 percent) of dairy farmers in Nakuru town obtained their fodder for cattle from their own urban farms and 30 percent were purchased from forage vendors (Prain et al 2010). Different observations were reported for urban dairy farmers in Addis Ababa (Guendel 2002) and Tanga (Schooman et al 2010) who used mostly (87 and 71 percent) respectively purchased hay and pasture from roadside. Seasonal variations in quantity and quality of

the forages are a major concern especially during the dry season. A study by Kavana and Msangi (2005) showed variations in feed availability in peri urban dairy units of Tanzania and dairy cows received less than 30 kg/cow/day of forages during the dry periods. As a result, lactating dairy cows were able to produce between 71 and 83 percent of their potential milk production. During the dry season, dairy cows are fed on moderate (6 – 6.8 CP percent) quality pastures (Epaphras et al 2004, Kavana and Msangi 2005, Ayenew et al 2009). The crude protein (CP) content of pastures is lower than the forage crude protein content of 7 percent which would cover the maintenance requirements of ruminants (McDonald et al 1995). Therefore, dairy cows depending on natural pastures during the dry season will not express their full genetic potential. However, in cross sectional studies in Bahir Dar and Gondar (Ayenew et al 2009) and Dare-Dawa (Mureda and Zeleke 2008) cities in Ethiopia, season of the year had no effect on milk yield at all stages of lactation. The reason behind this was that farmers in these cities conserve feeds that help to minimize variation in feed availability and therefore, the influence of climatic conditions was negligible. Deficiencies in nutritive value of natural pasture, stresses the importance of supplementation with energy and nitrogen especially during the dry season.

Urban and peri urban dairy farmers rarely feed concentrates at recommended levels and required quality. More often, dairy farmers feed concentrates to relax the cows when milking and not for increased milk production. Dairy farmers supplemented their lactating cows at the rate of 2-3 kg/cow/day at milking time without considering the actual physiological requirements of the animals (Richards and Godfrey 2003, Kivaria et al 2006). With exception of a few farmers (9 percent) in Kisumu Kenya (Kagira and Kanyari 2010) and (42 percent) in Nakuru (Richards and Godfrey 2003) who fed compounded concentrates to lactating cows, 45 and 83 percent of dairy farmers in Morogoro and Dar es Salaam cities respectively use maize bran as a major supplementary feed to lactating cows (Mlay et al 2001). Adequate concentrate supplementation improves performance to reach animal's genetic potential. Studies in peri urban dairy units of Nakuru in Kenya (Lanyasunya et al 2001) and Morogoro in Tanzania (Nkya et al 2008) indicated that in dairy units were concentrate feeding regime was introduced, milk production improved from 7 to over 24 litres/cow/day and from 6.7 to 8.0 litres/cow/day respectively. Inadequate dairy cattle husbandry skills and high cost of inputs prevent farmers from supplementing their dairy cattle.

Collection of forage from the sources requires transport. Different modes of transport are used to collect forage from the sources to the dairy units. These include the use of vehicles, animals, potters and bicycles and differ between urban and peri urban areas. According to Prain et al (2010), urban dairy farmers in Nakuru transported fodder using mostly (40 percent) bicycles, followed by humans/animals walking (38 percent). Meanwhile, almost a half (50.8 percent) of the dairy farmers in urban centre of Addis Ababa used donkeys while 46.7 percent of them used vehicles to bring in feed to the dairy units (Shiferaw et al 2003). The modes used to transport feed have an implication on the milk production costs and maintenance of high level of milk production throughout the year. Very unfortunately, milk price does not change for long time in accordance to seasonal availability of forages. The coping strategies and setting of milk price by dairy farmers especially during the dry seasons are not well known and documented.

Zero and free grazing are the two main types of feeding systems that have been identified across the cities in East Africa (Shiferaw et al 2003, Guendel 2006, Kagira and Kanyari 2010, Dayanandan 2011). Contrary to this, full-time zero grazing, partial grazing and full-

time grazing systems of dairy cows were reported in Tanga and Dar es Salaam peri urban dairy units of Tanzania (Nkya et al 2007). Free grazing system is not allowed and regarded as an offence in all East African cities. However, the system is most common in Kisumu Kenya (96 percent), followed by Nakuru in Kenya (46 percent), Dar es Salaam Tanzania (20 percent) and less common in Morogoro Tanzania (9 percent) (Table 4).

Table 4: Characteristics of urban dairy keeping by households

Country	City/Town	Sample size	Descriptions of dairy farming		Reference
			Free range (%)	Zero grazing (%)	
Kenya	Nakuru	121	46	48	Foeken 2005
Tanzania	Morogoro	114	9	91	Foeken 2005
	Mbeya	239	10	90	Foeken 2005
	Dar es Salaam	977	20	74	Kivaria et al 2006
	Dar es Salaam	132			Mlozi 2005
	Tanga	130	28	72	Schoolman et al 2010
Ethiopia	Addis Ababa	20	10	90	Richards and Godfrey 2003
	Dare –Dawa	33	9	72	Mureda and Zeleke 2008
	Makelle	168	10	90	Dayanandan 2011
Uganda	Kampala		17	60	Prain et al 2010
	Kisumu	34	94	6	Kagira and Kanyari 2010

Dairy cows require farm labour to perform various activities in the farm. In order to achieve this, both hired and family labours are employed in dairy activities and their intensities and types of the farm labour differ between cities. For instance, in urban dairy units of Dar es Salaam Tanzania (Kivaria et al 2006), Jimma town Ethiopia (Duguma et al 2011), Kisumu Kenya (Kagira and Kanyari 2010), Makelle town Ethiopia (Dayanandan 2011) and Tanga Tanzania (Schooman et al 2011) hired labour is used intensively in 97, 33, 76, 73 and 47 percent of households respectively. This implies that the owners of dairy cattle in those cities can afford to pay labour wages. Meanwhile, family members in Bishoftu town Ethiopia (54 percent) (Megersa et al 2011) and Kampala city (52 percent) (Ishagi et al 2000) family members carried out most of the management activities. This is an indication that dairy cattle management requires the attention of family members since they have high value.

Breeding systems of dairy cattle

Both natural and artificial insemination (AI) services are used to breed dairy cows. The intensity of using the two breeding systems varies and most dairy farmers use natural service than AI. This finding is supported by Megersa et al (2011) who reported more (46.4 percent) smallholder dairy farmers using natural service compared to 20.3 percent of them who use AI. This may imply that smallholder dairy farmers are not satisfied on the AI service. Various studies have shown more dairy farmers in urban areas who used AI than those in peri urban areas (Lobago et al 2007, Mureda et al 2008 and Sintayehu et al 2008). This is mainly due to easy availability of AI service and difficulties of feeding bulls in towns. On the other hand, the use of AI service has resulted into low conception rate when compared to natural service. Good examples are reported from urban dairy units in Tanga Tanzania (Msangi et al 2005) and Addis Ababa Ethiopia (Lemma and Kebede 2011) where 2.3 and 2.1 matings respectively were required for AI service compared to natural service that required a relatively small number of matings (1.7) per conception. This finding is supported by Kivaria et al (2006) who reported heifers that were served by

bull mating were six times more likely to become pregnant than heifers served by AI. Looking at the results, it can be said that the use of AI is a big challenge to dairy herd improvement.

Cattle shed design, hygiene and stocking density

A good shed for dairy cattle provides comfort to the animal, decreases wastage of feedstuff and ensures better environmental control. If these basic needs cannot be met in the animal shed, then health, welfare and production of the cattle will be compromised. Generally, the hygienic condition of urban and peri urban dairy units are not good. For instance, 28 (Omore 2003), 38.3 (Ayenew et al 2009), 42 (Megersa et al 2011) and 49 (Swai et al 2005a) percent of cattle sheds in peri urban dairy units of Kiambu Kenya, Addis Ababa Ethiopia, Tanga Tanzania and Bishoftu towns respectively had earthen floors. Earthen floors if not properly cleaned might be a predisposing factor to cattle diseases. Cattle designs such as kraals and traditional free stalls were very common in some peri urban areas of Dodoma (90 percent) (Mdegela et al 2005) and Dare-Dawa towns of Ethiopia (87.9 percent) (Mureda and Zeleke 2008). Overstocking of dairy cattle as a result of lack of sufficient space is one of the major concerns in urban and peri urban dairy units (Ishagi et al 2002). As a result of overstocking, cattle shed hygiene in Kampala (Prain et al 2010) and Dar es Salaam (Kivaria et al 2006) was poor at 38.4 and 60 percent respectively.

Performance in milk production

Milk production levels in urban and peri urban dairy units range from 5.7– 17 litres/cow/day (Table 5). Various factors contribute to variations in milk yield across the cities. These include feeding systems, breed, calving season, parity number, and effects of location (urban/rural). Others are body condition score at calving, herd size, source of labour, disease prevalence, lack of milk market, poor breeding and high cost of inputs (Epaphras 2004, Msangi et al 2005, Bee et al 2006). The types of feeding systems have an influence on daily milk yield. For example, a study conducted in urban and peri urban dairy units of Tanzania indicated that pasture grazed dairy cows had lower average daily milk yield (2299 kg/cow) compared to zero grazed dairy cows ((3150 kg/cow) (Nkya et al 1999). The low milk productions in pasture grazed cows is due to cows walking long distances in search of pasture and hence spend more energy which could otherwise be used for milk production. However, Lanyasunya et al (2001) and Bee et al (2006) did not find any difference in daily milk yield between pasture and zero grazed dairy cows in dairy units of Nakuru in Kenya, Kibaha and Korogwe in Tanzania.

Table 5: Daily milk yield in urban and peri urban areas of East Africa

Country	City/Town	Milk production (litres/cow/day)	Reference
Tanzania	Morogoro	6.3	Mlay et al 2001
	Korogwe	6.6	Bee et al 2006
	Tanga	5.7	Lyimo et al 2004
	Kibaha	*6.8*	Bee et al 2006
	Dar es Salaam	7.1	Epaphras et al 2004
	Dar es Salaam	8.0	Kivaria et al 2006
Kenya	Kiambu	7.2	Omore 2003
Ethiopia	Addis Ababa	7.8	Ayenew et al 2009
	Mekelle	8.7	Dayanandan 2011
Sudan	Khartoum	12.2	Gader et al 2007
	Khartoum	17	Idris et al 1999
Lesotho	Maseru	12.7	Gilles and Tawfik 2001
Uganda	Kampala	10	Prain et al 2010
	Jinja	12	Fonteh et al 2005

Variation in milk production has been noted in which crossbred dairy cows produce more (17 litres/day) milk than pure bred dairy cows (16.2 litre/day) (Idris et al 1999). This suggests that there may be no disadvantage in producing milk using crossbred dairy cows especially when pasture and climate are limiting factors. In principle, crossbred dairy cows are well adapted to the harsh environmental conditions and poor quality feeds available in most urban and peri urban areas. The proportion of exotic inheritance contributes to differences in lactation milk yield. A study conducted by Msanga et al (2000) reported crossbred dairy cows with 62 percent of Holstein inheritance produced higher lactation milk yield (2657 litres) than those with 50 percent (2370 litres) or 75 percent (2338litres) Holstein inheritance. Different results were reported by Bee et al (2006) in peri urban dairy units of Korogwe and Kibaha in Tanzania who found crossbred dairy cattle with 75 and 62 percent of exotic inheritance to produce similar milk yields of 7.0 and 6.8 litres/cow/day respectively.

Some authors in East Africa have reported disparities in the level of daily milk yield between urban and peri urban dairy units. Evidences show that more milk yield per day is produced in urban dairy units of Maseru in Lesotho (14.7 litres/cow/day) (Gilles and Tawfik 2001) and Holetta in Ethiopia (7 litres/cow/day) (Shiferaw et al 2003) than 11.2 and 6.2 litres/cow/day produced by their counterparts in peri urban dairy units. The relatively better management in urban dairy cows may be considered as a key factor for the better performance as compared to those in peri-urban areas. Contradictory findings were reported by Msanga et al (2000) who found higher lactation milk yield (2871 litres) in peri urban than in urban (2534 litres) located dairy units of Tanga in Tanzania.

Lactation length

In most dairy units, a lactation length of 305 days (10 months) is commonly accepted as a standard. However, such a standard lactation length might not work for dairy cows in the urban and peri urban areas of East Africa. Both Msanga et al (2000) in Tanga and Shiferaw et al (2003) in Addis Ababa reported shorter (8.8 to 9.7 months) and longer (11.1 months) lactation lengths in urban and peri urban dairy units respectively. However, Ayenew et al (2009) had different observations in which dairy cows in urban dairy units had longer (11.2 months) lactation lengths compared to cows kept in peri urban dairy units (7.5 months). An extended lactation period has practical implications to the dairy farmer

as it provides compensation for the extended calving interval (Lobago et al 2007). Nevertheless, the profitability of short or extended lactation length depends on lactation persistency.

Dry period

Dry period is the time between arresting of milk removal and the subsequent calving. This allows the mammary epithelial components to regress, proliferate, and differentiate with the ultimate goal of maximizing milk production during the subsequent lactation (Capuco et al 1997). Generally, 45 to 50 days is recommended and if less than 40 days, then milk yield in the next lactation will be decreased and longer dry periods produce dairy cows that succumb to metabolic conditions (Hurley 2009). Urban and peri urban dairy farmers rarely dry off cows at the recommended period. A study by Mellau et al (2009) in Dar es Salaam peri urban dairy units reported few (22.9 percent) farmers that dry off their cows for the recommended 60 days. Meanwhile, 52 percent of farmers dried off cows between 60 to 90 days and 21.4 percent dried off the cows for more than 90 days. Surprisingly, about 1.4 percent of them did not dry off cows at all.

Reproductive performance of crossbred dairy cows

Reproductive performance of dairy cows can be measured by considering parameters such as age at puberty, age at first calving (AFC), days open (DO), calving interval (CI) and number of services per conception (NSC). Management, environmental and physiological factors influence the reproductive performance of lactating dairy cows. Among the most important environmental factors that affect reproductive performance of dairy cows include nutritional status, suckling, milk yield, and season of the year.

Age at first calving (AFC)

Several studies carried out in East African cities revealed AFC to have ranged from 29.7 to 46.0 months (Table 6). Age at first calving is affected by factors such as breed, nutritional status and management differences of dairy cows. Pure exotic and crossbred cows attain AFC differently. For instance, pure exotic cows in peri urban dairy units of Khartoum (Gader et al 2007) and crossbred cows in Addis Ababa (Ayenew et al 2009) had lower (29.7 months) and higher (46.months) AFC respectively. This indicates that pure exotic heifers reach puberty earlier than crossbred cows. Since the results were reported from different cities then management and feeding differences could be the reasons. Farm size has been indicated to affect AFC in dairy animals. According to Lemma and Kebede (2011) small and large dairy farms in Addis Ababa had longer (34.2 months) and shorter (32.6 months) AFC respectively.

Table 6: Reproductive traits of crossbred dairy cows in urban and peri urban areas of East African cities/towns

Country	City/Town	Location	AFC (months)	CCI (days)	NSC	CI (days)	Reference
Ethiopia	Zeway	Urban	31.9	130	1.62	406	Yifat et al 2009
	Fitche	Urban		186	1.60		Lobago et al 2007
	Bahir Dar and Gondar	Urban	46.0		1.9 [b]	555	Ayenew et al 2009
		Peri urban	43.3		2.1 [b]	555	
	Addis Ababa	Peri urban		177	1.7	456	Goshu et al 2007
	Holleta	Urban	36.7	154	1.7	462	Shiferaw et al 2003
	Dare-Dawa	Peri urban	36.2	218	2.2	534	Mureda and Zeleke 2008
	Addis Ababa	Urban	33.2	176.8	2.0		Lemma and Kebede 2011
	Holeta, Stella	Urban/peri urban	39.2	148	1.8	446	Tadesse et al 2010
Tanzania	Tanga	Urban		276 [a]		562[a]	Msangi et al 2005
		Peri urban		153 [b]		436[b]	
	Tanga	Urban		123	1.8		Lyimo et al 2004
	Morogoro	Peri urban		152	2.6	477	Nkya et al 1999
	Dar es Salaam	Urban/peri urban	33			450	Kivaria et al 2006
Sudan	Khartoum	Peri urban	29.7	167.7		433	Gader et al 2007

AFC= Age at First Calving, NSC= Number of Service per Conception, CI= Calving Interval

[a b] Figures in same column and row/town having different superscripts are significantly different

Calving to conception interval

After calving, dairy cows remain open for long time before they conceive (Table 6). When comparing calving to conception interval (CCI) in Table 6 with the optimum CCI recommended (80-85 days) to achieve the target of 365 days of calving interval (Peters and Ball 1995) it can be pointed out that East African urban and peri urban dairy herds receive low level of management and feeding. The interval from calving to conception is influenced by factors such as source of labour (family, hired), types of mating systems (natural, AI), calving season and location (urban/peri urban). According to Msangi et al (2005) it took fewer days (223) for cows to conceive when family labour was employed compared to 239 days when hired labour was used. Likewise, dairy farms using natural service had CCI shorter (159 days) compared with farms using AI (179.7 days) (Lemma and Kebede 2011). Dairy cows calving during the dry season, when availability of forages was low, showed a negative correlation between body condition score at calving and CCI. This suggests that pre calving nutrition in the dry season has a great effect on fertility (Idris et al 1999).

Calving interval

Calving interval is an important factor in measuring the breeding efficiency and directly correlates with the economics of milk production. Reproduction in dairy cows with regular and shorter calving interval (365-420 days) is a key feature for the rapid multiplication of the breeding stocks. However, studies in urban and peri urban areas of East Africa have reported long calving intervals (406 to 562) for dairy cattle (Table 6). Long calving interval is a common problem in urban and peri urban areas and it is linked to poor body condition score and mineral deficiency especially inorganic phosphorus (Swai et al 2005b). The long mean calving intervals result into low calf crop and low level of production.

Number of services per conception

On average, crossbred dairy cows kept in urban and peri urban areas of East Africa conceive after 1.6 to 2.6 services/matings (Table 6). These values are higher than the minimum value of 1.3 numbers of services per conception (NSC) recommended in the tropics (Rahman, et al 1998). This is an indication of postpartum reproductive problems, poor heat detection skills, inefficiency of AI and/or poor body condition of the cows at mating. Number of services per conception was different between the mating systems with farms using natural service having lower values (1.7) compared with those that use AI (2.1). Higher value of NSC found in cows served by AI was a result of many technical and logistic hurdles contributing to the failure of the timely service of oestrous cows. On the hand, dairy farms using natural service have a better chance of detecting oestrus by using bulls and getting heifers or cows pregnant at the right time. Zero and pasture grazed cows have different reproduction performance in terms of NSC and zero grazed cows had better reproductive performance (NSC 1.8) than pasture grazed cows (NSC 2.3) (Mbugua et al 1999). On the contrary, Nkya et al (1999) showed that pasture grazed animals had better (NSC 1.8) reproductive performance. This statement is supported by Msangi et al

(2005). The reason given was that the cows were exposed to exercise and interacted with bulls in the grazing areas and therefore had greater chance of being served. Parity number affects number of services per conception and lower values were observed in cattle with three or more calvings (Yifat et al 2009). Nevertheless, Goshu et al (2007) reported the opposite and found number of services per conception to increase with parity number, even though the possible cause of the low number of services per conception for younger cows was not clear.

There have been different observations on reproductive performance of crossbred dairy cows in relation to location. Some authors (Ayenew et al 2009, Yifat et al 2009) have suggested better reproductive performance in urban than in peri urban dairy production system, while others (Msangi et al 2005) have reported the opposite (Table 6). Location of the dairy units may influence availability of feed supplements and breeding services. Therefore, having poor or better reproductive performance in the two locations implies that they may have different access to suppliers of services.

Constraints to dairy production in urban and peri urban units

The perceived relative importance of the major constraints hindering dairy production in urban and peri urban areas of East Africa differ between and within countries and production systems. The variations may be due to the methods employed during data collection, physical location which strongly influences the climate, livestock species and season of the year. Various researchers employed different methods to study constraints affecting dairy production in urban and peri urban areas. For example, Foeken and Owuor (2000) and Guendel (2006) used household surveys while Nkya et al (2007) used participatory tools to explore how livestock keepers prioritise the constraints associated with livestock keeping. A comprehensive list of major constraints limiting dairy production in urban and peri urban areas can be drawn using the two methods.

Seasonal availability and costs of feeds in the urban areas of East Africa were listed as the first constraints in Addis Ababa Ethiopia (Sintayehu et al 2008) and Kampala in Uganda (Richards and Godfrey 2003). Very interestingly, feed unavailability was ranked first and was significantly more severe in peri-urban (35 percent) than in urban (23 percent) areas of Tanga town in Tanzania (Swai et al 2005a). High feed costs limit supplementation levels and increased dairy cattle productivity.

Water is a very important nutrient for the dairy cow to maintain body functions and for milk production. However, this important resource is not adequate in most parts of East African cities. Moreover, water availability varies between location and dairy farms located in peri urban areas face acute shortage of water. As a result of water shortages during the dry season, free water intake of lactating dairy cows is reduced and limits milk production and reduce health status (Guendel 2006).

Poor milk marketing and low price were given the highest rank among the constraints affecting milk production in Tanga (Swai et al 2005a) and Addis Ababa (Ayenew et al 2009) peri urban dairy units. Normally, peri urban areas of East African countries have poor infrastructure and dairy farmers have difficulties in marketing their milk and milk

products. As a result of this, the proportion of milk sold is lower in the peri-urban dairy units while processed milk is significantly higher in urban dairy units. Generally, milk price has been low and for a long time has not changed in accordance to seasonal availability of forage.

Availability of land is one of the major obstacles limiting improved dairy cattle production in urban and peri urban dairy units. Even though, dairy farmers ranked the problems differently, According to Duguma et al (2011) in Jimma town Ethiopia shortage of land ranked first and the problem was reported by 50 percent of the dairy farmers. Likewise, in a study conducted in Addis Ababa Ethiopia lack of access to land ranked fifth and the problem was more severe in urban areas (92.4 percent) compared to peri urban areas (55.4 percent) of the city (Shiferaw et al 2003).Shortage of land forced most urban dairy farmers to keep their cattle within their own residential compounds in the medium and low density areas. Therefore, even if urban dairy producers are interested to expand their units, the land size cannot allow them to do so. Availability of land has direct implications on the quantity and quality of pasture dairy farmers can establish. Due to land scarcity most dairy farmers fail to establish pastures and this endangers the sustainability of urban and peri urban dairy production systems (Kavana and Msangi 2005, Ayenew et al 2009).

Urban areas of East Africa have increasing problems of waste disposal and pollution. The problem of waste disposal is exacerbated by rapid population growth, socio-cultural change, the absence of appropriate places to dispose off animal dung and resource-poor local governments (Prain et al 2010). Work carried out in Nakuru (Foeken 2005) and Dar es Salaam (Mlozi 2005) cities found 45 and 72 percent of livestock keepers respectively dump the animal dung along roadsides due to lack of land/space to dispose off wastes.

Environmental contamination with heavy metals from industries, improper handling of animal wastes and agrochemicals for controlling livestock ecto-parasites pose serious health hazards to urban consumers of animal products. Nevertheless, heavy metal contents in the soils of most cities in East Africa are not so high to cause acute toxic symptoms (van Veenhuizen and Danso 2007). The levels of Lead (3.5 mg/kg) and Copper (3.6 mg/kg) contamination in the blood of cattle in Morogoro municipality Tanzania have been reported even though it has not reached an alarming point (Mlay and Mgumia 2008). In another study aimed at examining the levels of heavy metals on the liver of cattle showed highest bioaccumulation of Lead (7.32 mg/kg) at the on-set of rainy season while Copper level was highest (2.2 mg/kg) during dry season (Nwude et al 2011). This implies that there is seasonal variation in environmental pollution by heavy metals. Application of acaricide for controlling ecto-parasite may cause health problems to consumers of animal products. However, available data from Jinja and Kampala cities in Uganda indicate that the level of acaricide in beef, milk and liver are still too low to pose a serious health risk to the consumers (Greenbelt Consult 2006).

Urban dairy units are often very close to high concentrations of people. These increase the chance of transfer of zoonotic diseases from animals to humans. About 61 percent of human infections are zoonotic (Prain et al 2010) and some of the important zoonotic diseases include bovine tuberculosis, brucellosis and anthrax. In the dairy sector, zoonotic pathogens are present in dairy animals, raw milk, milk products, meat and the farm

environment. The risk of acquiring zoonotic disease varies from one city to the other. For instance, a study conducted in Tanga town in Tanzania (Cole et al 2008), Kampala in Uganda (Prain et al 2010) and Nakuru in Kenya (Prain et al 2010) reported overall prevalence of brucellosis of 5.5, 3-33 and 3 percent respectively.

The most important dairy cattle diseases affecting the performance of urban and peri urban dairy units include reproductive disorders, mastitis, calf scour and pneumonia. Others are East Coast Fever (ECF), anaplasmosis and trypanosomiasis. However, among the most important diseases affecting dairy cattle, ECF present the biggest health problem in Tanga (Nkya et al 2007) and Kampala cities (Prain et al 2010). In other studies, Shiferaw et al (2003) in Addis Ababa, Kivaria et al (2006) in Dar es Salaam and Kagira and Kanyari (2010) in Kisumu cities respectively ranked mastitis (71.2 percent), anaplasmosis (21.8 percent) and lumpy skin disease (71 percent) as the major causes of dairy cattle health problems.

Studies on mastitis in urban and peri urban dairy herds have showed high prevalence of sub clinical than clinical mastitis and ranged from 25 (Mdegela et al 2005) to 95 percent (Almaw et al 2009). Location of the farm had an influence on the occurrences of clinical and sub clinical mastitis and according to Almaw et al (2009) there are more cases of mastitis in urban (75 percent) than peri urban (53.6 percent) dairy units. The higher prevalence of mastitis in urban compared to peri urban dairy units could be attributed to the increasing unfavourable production conditions. A different observation was made by Shem et al (2002) who reported lower sub clinical infection rate in the urban (40 percent) than peri urban dairy units which had infection rate of 60 percent. The reason given was that farmers in urban areas practiced better management techniques and had better cattle sheds than most dairy farmers in the peri urban areas.

Dairy cattle enterprises require high capital base which is missing to the most economically disadvantaged families in urban areas. Capital is required to purchase grade cattle, feeds and veterinary services. The cost of purchasing a grade heifer is high and they are not readily available (Dayanandan 2011). Owing to this, dairy farmers are unable to procure suitable dairy breeds and end up using any that comes in their way.

Opportunities to dairy production in peri urban environment

The principal opportunities for dairy development in East Africa cities include the growing market for dairy products, large cattle population and increasing recognition of the importance of urban dairying by donors, non-government organisations (NGOs) and municipal authorities (Guendel 2006, Sintayehu et al 2008). Dairying provides the opportunity for dairy farmers to use land, labour and feed resources to generate regular income. Moreover, it provides an opportunity to improve waste management practices through the use of technologies for animal waste disposal. In most cases, labour costs for dairying, are extremely cheap and Municipal authorities in East Africa are no longer harassing livestock keepers (Guendel 2006).

Conclusion

Milk production and reproduction parameters of dairy cattle are low despite the existing potential in urban and peri urban areas of East Africa. Inadequate forages both in terms of qualities and quantities, dairy marketing and processing problems and diseases constitute the major constraints to capturing the available opportunities to dairying. In order to improve the reproductive and productive performance of dairy cattle, sensible year round feeding, and herd health plan should be undertaken. Furthermore, there is a need for East African governments to set clear policies supporting and regulating urban dairying.

Acknowledgement

The authors would like to acknowledge the DANIDA peri urban livestock project for financial support for this research as part of the PhD study program of the first author.

References

Aleri J W, Nguhiu-Mwangi J and Mogoa E M 2011 Housing-design as a predisposing factor for injuries and poor welfare in cattle within smallholder units in per urban areas of Nairobi, Kenya. Livestock Research for Rural Development, Volume 23, Article #53.http://www.lrrd.org/lrrd23/3/aler23053.htm

Almaw G, Molla W and Melaku A 2009 Prevalence of bovine sub clinical mastitis in Gondar town and surrounding areas, Ethiopia. Livestock Research for Rural Development, Volume 21, Article #106 http://www.lrrd.org/lrrd21/7/alma 21106.htm

Ayaga G, Kibata G, Lee-Smith D, Njenga M and Rege J EO (edit) 2005 Prospects for urban and peri-urban agriculture in Kenya, Urban Harvest, International Potato Centre, Lima. pp. 27

Ayenew Y A, Wurzinger M, Tegegne A and Zollitsch W 2009 Handling, processing and marketing of milk in the North western Ethiopian highlands. Livestock Research for Rural Development, Volume 21, Article # 97 http://www.lrrd.org/lrrd21/7/ayen21097.htm

Bee J K A, Msanga Y N and Kavana P Y 2006 Lactation yield of crossbred dairy cattle under farmer management in Eastern coast of Tanzania. Livestock Research for Rural Development, Volume 18 article # 2http://www.lrrd.org/lrrd18/2/bee18023.htm

Byarugaba D K, Nakavuma J L, Vaarst M and Laker C 2008 Mastitis occurrence and constraints to mastitis control in smallholder dairy farming systems in Uganda. Livestock Research for Rural Development, Volume 20, Article #1. http://www.lrrd.org/lrrd20/1/byar20005.htm

Capuco A V, Akers R M and Smith J J 1997 Mammary growth in Holstein cows during the dry period: Quantification of nucleic acids and histology Journal of Dairy Science 80:477- 487

Cole D C, Lee-Smith D and Nasinyama G W (eds) 2008 Healthy city harvests: Generating evidence to guide policy on urban agriculture, CIP/Urban Harvest and Makerere University Press. Lima, Peru. pp. 282

Dayanandan R 2011 Production and marketing efficiency of dairy farms in highland of Ethiopia- an economic analysis International Journal of Enterprise Computing and Business Systems Volume 1 Issue 2 July 2011 http://www.ijecbs.com

Duguma B, Kechero Yand Janssens G P J 2011 Analysis of Constraints Facing Urban Dairy Farmers and Gender Responsibility in Animal Management in Jimma Town Jimma, Ethiopia. Libyan Agriculture Research Center Journal International 2 (4): 155-160

Epaphras A, Karimuribo E D and Msellem S N 2004 Effect of season and parity on lactation of crossbred Ayrshire cows reared under coastal tropical climate in Tanzania. Livestock Research for Rural Development, Volume 16 article # 42 http://www.cipav.org.co/lrrd/lrrd16/6/epap16042.htm

Foeken D W J 2005 Urban agriculture in East Africa as a tool for poverty reduction: A legal and policy dilemma? Working paper 65/2005 pp. 30 www.ascleiden.nl

Foeken D W J and Owuor S O 2000 Urban farmers in Nakuru, Kenya. Working Paper 45/2000 ASC, Leiden, The Netherlands pp.117 www.ascleiden.nl

Fonteh F A, Mubiru S, Tibayungwa F and Lammers W 2005 System analysis of peri-urban smallholder dairy farming in the Lake Crescent Region of Uganda. Livestock Research for Rural Development, Volume 17, Article #79 http://www.lrrd.org/lrrd17/7/font17079.htm

Gader A Z A, Ahmed M A, Musa L M and Peters K J 2007 Milk yield and reproductive performance of Friesian cows under Sudan tropical conditions Arch. Tierz, Dummerstorf 50 (2):155-164

Gilles P and Tawfik E S 2001 Urban and per urban dairy cattle farming in the Maseru District/Lesotho. University of Kassel, Steinstrasse Witzenhausen http.gwdg.de/pub/tropentag/proceedings/2001/11_23_Gilles1.pdf

Goshu G, Belihu K and Berihun A 2007 Effect of parity, season and year on reproductive performance and herd life of Friesian cows at Stella private dairy farm, Ethiopia. Livestock Research for Rural Development, Volume 19, Article # 98 http://www.lrrd.org/lrrd19/7/gosh19098.htm

Greenbelt Consult 2006 An Analysis of the Implications of Uganda's Livestock Policies for the competitiveness of its livestock and livestock products in the local and International markets, Uganda Programme for Trade Opportunities and Policy pp 70

Guendel S 2002 Peri-urban and urban livestock keeping in East Africa - a coping strategy for the poor? Scoping study July 2002 Natural Resources International Limited, Aylesford, UK. pp.31

Guendel S 2006 A synthesis of urban and peri-urban agriculture research commissioned by the Renewable Natural Resources Research Strategy programme, 1995–2006 Final report pp. 31 http//:www.cipotato.org/urbanharvest/ocuments/pdf/lpp_scoping.pdf

Hurley W L 2009 Dry period in dairy cattle. University of Illinois, Urbana-Champaign http://classes.ansci.illinois.edu/ansc438/lactation/dryperiod.html

Idris O F, Bari ME, Ahmed M, El Khedir O, Elbasheir H A, Elshadig A A and Abdel M TO 1999 Investigations into factors affecting reproductive efficiency of dairy cattle in the peri urban areas of Sudan. *In*: Proceedings of the Research Co-ordination Meeting of a Co-ordinated Research Project FAO/IAEA Vienna Austria, 7-11 Sept 1998 pp. 25-34

Ishagi N, Ossiya S, Aliguma L and Aisu C 2002 Urban and peri-urban livestock keeping among the poor in Kampala City. Ibaren Konsultants, Kampala, Uganda pp. \97

Kagira I J M, Kanyari P W N 2010 Questionnaire survey on urban and peri-urban livestock farming practices and disease control in Kisumu Municipality, Journal of the South African Veterinary Association Volume 81 no.2 Pretoria 2010

Kavana P Y and Msangi B S J 2005 On farm dairy cattle feeding experience in eastern zone of Tanzania Livestock Research for Rural Development Volume 17 Article # 6 http://www.lrrd.org/ lrrd17/6/kava17062.htm

Kivaria F M, Noordhuizenm J P T M and Msami H M 2006 Risk factors associated with the incidence rate of clinical mastitis in smallholder dairy cows in Dar es Salaam region of Tanzania. The Veterinary Journal 173 (3):623-629

Lanyasunya T P, Mukisira E A, Lokwaleput I K and Siamba D N 2001 Factors limiting optimization of smallholder peri urban dairy herd production in Kenya. Livestock Community and Environment.*In:* Proceedings of the 10th Conference of the Association of Institutions for Tropical Veterinary Medicine, Copenhagen, Denmark pp. 27-36

Lemma A and Kebede S 2011 The effect of mating systems and herd size on reproductive performance of dairy cows in market oriented urban dairy farming in and around Addis Ababa Revue Med Vet 162: 526-530

Limbu F 1999 Agricultural technology economic viability and poverty alleviation in Tanzania. Paper presented at The structural transformation policy workshop Organized by the ECAPAPA, Tegemeo Institute and Michigan State University 27-30 June 1999 Serena Hotel, Nairobi Kenya pp. 55

Lobago F, Bekana M, Gustafsson H and Kindahl H 2007 Longitudinal observation on reproductive and lactation performances of smallholder crossbred dairy cattle in Fitche, Oromia region, central Ethiopia, Tropical Animal Health and Production 39:395-403

Lyimo C, Nkya R, Schooman L and Van Eerdenbutg FJ 2004 Post-partum reproductive performance of crossbred dairy cattle on smallholder farms in sub humid coastal Tanzania. Tropical Animal Health and Production 36:269-279

Mbugua P N, Gachuiri C K, Wahome R G, Wanyoike M M, Abate A, Munyua S J M and Kamau J M Z 1999 Performance of dairy cattle under two different feeding systems as practiced in Kiambu and Nyandarua districts central Kenya. *In:* Proceedings of the final Research Co-ordination Meeting of a Co-ordinated Research Project FAO/IAEA Vienna, Austria, 7-11 September 1998 pp.119-126

McDonald P, Edwards R A and Greenhalgh J F D 1995 Animal Nutrition. Longman Singapore Publishers Pte Ltd, pp. 607

Mdegela R H, Karimuribo E, Kusiluka L J M, Kabula B, Manjurano A, Kapaga A M and Kambarage D M 2005 Mastitis in smallholder dairy and pastoral cattle herds in the urban and peri-urban areas of the Dodoma municipality in Central Tanzania. Livestock Research for Rural Development, Volume 17, Article # 123 \http://www.lrrd.org/lrrd17/11/mdeg17123.htm

Megersa M, Ashenafi F, Anteneh W and Tariku J 2011 Herd composition and characteristics of dairy production in Bishoftu town, Ethiopia Journal of Agricultural Extension and Rural Development 3 (6):113-117 http://academicjournals.org/JAERD

Mellau L S B, Sarimbo A P, Kimera S I and Phiri E C J 2009 Recumbence syndrome in cattle: A study of risk factors of milk fever in dairy units in Dar es Salaam, Tanzania. Tanzania Veterinary Journal 26 (2):56

Mlay P S, Madsen J, Pereka A E, Hvelplund T and Weisbjerb T M R 2001 Smallholder livestock production trends in urban and peri urban areas of Morogoro. Tanzania Veterinary Journal 21 (1):15-26

Mlay P S and Mgumia Y O 2008 Levels of lead and copper in plasma of dairy cows, pastures, soil and water from selected areas of Morogoro suburbs, Tanzania. Livestock Research for Rural Development, Volume 20, Article # 60 http://www.lrrd.org/lrrd20/4/mlay20060.htm

Mlozi M R S 2005 Urban animal agriculture: its palliativity and reasons for persistence in Tanzanian towns. RICS Foundation pp. 26 http//:www.rics-foundation.org

Msanga Y N, Bryant M J, Rutamu I B, Minja F N and Zylstra L 2000 Effect of environmental factors and the proportion of Holstein blood on milk yield and lactation length of crossbred dairy cattle on smallholder farms in northeast Tanzania. Tropical Animal Health and Production 32 (1):23–31

Msangi B S J, Bryant M J and Thorne P J 2005 Some factors affecting reproductive success in crossbred dairy cows on smallholder farms in coastal North-East Tanzania. Tropical Animal Health and Production 37 (5):413- 426

Mureda E and Zeleke M Z 2008 Characteristics and constraints of crossbred dairy cattle production in lowland areas of Eastern Ethiopia. Livestock Research for Rural Development Volume 20, Article #.57 http://www.lrrd.org/lrrd20/4/mure20057.htm

Nkya R., Aboud A A and Kessy B M 1999 Improving productivity of smallholder dairy cattle in peri urban Morogoro Tanzania. *In*: Proceedings of the final Research Co-ordination Meeting of a Co-ordinated Research Project FAO/IAEA Vienna, Austria, 7-11 September 1998 pp. 79-86

Nkya R, Kessy B M, Lyimo Z C, Msangi B S J, Turuka F and Mtenga K 2007 Constraints on smallholder market oriented dairy systems in the north eastern coastal region of Tanzania Tropical Animal Health and Production 39:627–636

Nkya R, Kessy B M, Ndossi D, Kanuya N L, Shem M N and Mwanga I E 2008 A review of interactions of nutrition and reproduction in dairy cattle with particular

emphasis to the situation in Tanzania. Tanzania Journal of Agricultural Sciences 9 (1):9-20

Nwude D O, Okoye PA C and Babayemi J O 2011 Assessment of heavy metal concentrations in the liver of cattle at slaughter during three different seasons. Research Journal of Environmental Science 5: 288-294

Omore A 2003 AGRIPPA Country Profile Livestock Production and Feed Resources in Kenya International Livestock Research Institute, Nairobi, Kenya pp.23 http://www.fao.org/DOCREP/ARTICLE/AGRIPPA/557_toc_en.htm

Peters A R, Ball P J H 1995 Reproduction in cattle 2nd edition, MA Blackwell Science Oxford Cambridge pp. 234

Prain G, Karanja N and Lee-Smith D (Eds) 2010 African Urban Harvest: Agriculture in the Cities of Cameroon, Kenya and Uganda. International Development Research Centre pp. 335

Rahman M M, Islam M N and Dev A 1998 A productive and reproductive performance of indigenous and crossbred cows under village management condition. Journal of Production Agriculture 2:95-99

Richards J I and Godfrey S H (Eds) 2003 Urban livestock keeping in sub-Saharan Africa: Report of a workshop held on 3-5 March 2003 in Nairobi, Kenya. Natural Resources International Ltd, Aylesford, Kent, UK. pp. 118

Rural Livelihood Development Company (RLDC) 2009 Dairy sub sector development strategy pp. 29

Shem M N, Mosha F A, Machang'u R, Kambarage D and Fujihara T 2002 Bovine mastitis in Zebu and crossbred cattle under the extensive management system in Tanzania. Asian-Australian Journal of Animal Science 15:751-756

Shiferaw Y, Tenhagn B A, Bekana M and Kassa T 2003 Reproductive performance of crossbred dairy cows in different production systems in the central Highlands of Ethiopia, Tropical Animal Health and Production 25:551-61

Sintayehu Y, Fekadu B, Azage T and Berhanu G 2008 Dairy production, processing and marketing systems of Shashemene–Dilla area, South Ethiopia. Project Working Paper 9, ILRI Nairobi, Kenya http://www.ilri.org/Infoserv/webpub/fulldocs/IPMS_WP9Dairy/ShashemeneIPMSWP9.pdf

Swai E S, Karimuribo E D, Schooman L, French N P, Fitzpatrick J, Kambarage D and Bryant M J 2005a Description, socio-economic characteristics, disease managements and mortality dynamics in smallholder's dairy production system in coastal humid region of Tanga Tanzania. Livestock Research for Rural Development, Volume 17 Article #4.http://www.lrrd.org/lrrd17/4/swa17041.htm

Swai E S, Bryant M J, Karimuribo E D, French N P, Ogden N H, Fitzpatrick J L and Kambarage D M 2005b A cross-sectional study of reproductive performance of smallholder dairy cows in coastal Tanzania. Tropical Animal Health and Production 37:513–525

Tadesse M, Thiengtham J, Pinyopummin A and Prasanpanich S 2010 Productive and reproductive performance of Holstein Friesian dairy cows in Ethiopia Livestock Research for Rural Development, Volume 22, Article #2

Van Veenhuizen R and Danso G 2007 Profitability and sustainability of urban and peri-urban agriculture. Agricultural Management, Marketing and Finance, FAO, Rome, Italy; Occasional Paper 19 pp. 95

Yifat D, Kelay B, Bekana M, Lobago F, Gustafsson H and Kindahl H 2009 Study on reproductive performance of crossbred dairy cattle under smallholder conditions in and around Zeway, Ethiopia.Livestock Research for Rural Development, Volume 21, Article #88.http://www.lrrd.org/lrrd21/6/yifa21088. htm

Received 20 July 2012; Accepted 3 October 2012; Published 6 November 2012

Paper II

Livestock Research for Rural Development 25 (9) 2013 | Guide for preparation of papers | LRRD Newsletter | Citation of this paper

Management and production levels of crossbred dairy cattle in Dar es Salaam and Morogoro urban and peri urban areas

K A Gillah, G C Kifaro* and J Madsen**

Ministry of Livestock Development and Fisheries P.O. Box 9152, Dar es Salaam Tanzania
kagillah@yahoo.com
* Department of Animal Science and Production, Sokoine University of Agriculture, P.O. Box 3004, Morogoro Tanzania
** Department of Large Ruminants, University of Copenhagen, Denmark

Abstract

A study was carried out to describe management and production levels of crossbred dairy cattle in urban and peri urban areas of Dar es Salaam city and Morogoro municipality in Tanzania. A cross sectional study design using a random sample of 153 dairy farmers was used to collect data on management and production levels of dairy cattle. Cattle sheds were measured to establish stocking densities. One third of farmers practised free grazing system. Poor quality forage and energy rich concentrate were the main feed resources. Farmers in Dar es Salaam and Morogoro covered 14.7±1.2 and 3.07±1.2 km/day, respectively in search of forages. Steaming up of dry cows was more common in Dar es Salaam than in Morogoro. Natural service was the predominant ($P \leq 0.05$) breeding method. Crossbred dairy cows in Dar es Salaam city produced significantly more (10.5±1.2 l/cow/day) milk than 6.2 ± 0.4l /cow/day produced by crossbred dairy cows in Morogoro municipality. Over half of cattle sheds had high stocking density and each shed accommodated 1.37 animals per 6.7m^2 standard space required per dairy cattle. Milk production in Dar es Salaam was higher than in Morogoro. One third of the farmers planned to decrease their cattle herds due to shortage of feeds. Therefore, addressing some of these management aspects should improve dairy cattle productivity.

Key words: *cattle shed, feed, free grazing, milk production, natural service, steaming up, stocking density*

Introduction

In Tanzania, dairying is one of the fast growing enterprises in the livestock sector contributing 30% of the livestock gross domestic product (GDP; URT 2012). Urban and peri-urban dairy farming has expanded considerably during the past decades as a result of inadequate milk marketing infrastructure, need for civil servants to supplement their income and the high price of raw milk in urban centres relative to the price in rural areas (Kurwijila 2001).People from different socio-economic and cultural groups are involved in dairying as a source of income, food and employment (Ishagi et al 2002, Mlozi 2005). However, the situation in Dar es Salaam is different whereby dairy cattle are kept exclusively by medium and high income people in peri urban and low density settlement areas (Jacobi et al 2000). Despite the enormous contribution of dairying in peri urban areas of Tanzania to GDP, the sub sector is constrained by factors such as genetic make-up of animals and management/ environmental factors.

Poor milk marketing is very common in Tanzania and was given the highest rank among the constraints affecting milk production in Tanga Tanzania (Swai et al 2005). Informal milk marketing dominates the marketing of milk in Tanzania and according to MoAC/SUA/ILRI (1998), over 90% of the milk marketed informally is sold as raw milk. Informal milk marketing poses health risks to consumers of raw milk as it contains appreciable number of bacteria. An example of health risks as a result of informal milk marketing was reported in Tanga Tanzania whereby 83% and 56% of all milk handled and marketed in informal markets respectively had higher coliform counts than the recommended values of less than 50000 cfu/ml and were Brucella milk ring test positive (Swai and Schoonman 2011).

Water is a very important nutrient for the dairy cows in order to perform proper physiological functions of the body. Clean and safe water is not readily available in urban and peri urban areas of Tanzania. For example, water supply service coverage in Dar es Salaam is 68% and the situation is worse in other urban areas (URT 2010). Shortage of water is critical especially during the dry season resulting into reduced milk production and health status of livestock (Guendel and Richards 2002).

Environmental contamination with heavy metals from industries and improper disposal of animal wastes poses serious health threats to urban consumers of animal products and by products. For instance, the levels of lead (3.5 mg/kg) and copper (3.6 mg/kg) contamination in the blood of cattle in Morogoro Tanzania have been reported even though the levels have not reached an alarming point (Mlay and Mgumia, 2008). Improper waste disposal has been reported in urban areas of Mbeya, Morogoro and Dar es Salaam and dumping of wastes was more common among elder household heads (22%) than among the young (9%) (Mlozi 2005). More recently, Lupindu et al (2012) in their study in Morogoro urban and peri urban areas revealed high risk of contracting zoonotic diseases as a result of improper handling of animal manure.

Farm and ranch land is inadequate in most peri urban areas of Tanzania and still more of it is turned into living quarters. In view of this, Dar es Salaam and Dodoma have

developed master plans showing agriculture as a land use, and Morogoro municipality has set aside land as a green belt. Shortage of land makes urban dairy producers face difficulties in disposing animal wastes and has forced them to keep their cattle within their own residential compounds. Keeping animals close to people increases the chances of transferring zoonotic diseases such as brucellosis and tuberculosis. Zoonotic diseases are a serious concern in urban and peri urban areas of Tanzania. For instance a study conducted in Tanga, Tanzania by Cole et al (2008) reported overall prevalence of brucellosis to be 5.5 percent. Likewise, scarcity of land in peri urban areas made most dairy farmers fail to establish pastures which in turn endangers the sustainability and the successful development of urban and peri urban dairy production systems (Kavana and Msangi 2005).

Natural pasture species in the communally owned land have been the main source of feed for dairy cattle (Orodho 2006), although smallholder dairy farmers do not have full control of it. Availability of forage in terms of quantity and quality, especially in the dry season, is a major concern for dairy production in Tanzania. During the dry season, the quality of the forage is very poor and leads to low milk production (Kavana and Msangi 2005).

Studies on milk demand in Tanzania indicated higher levels of per capita milk consumption in urban centres (44 l/annum) than in rural areas (30 l/annum) and that consumption of milk is higher in lower age groups (8 years and below) than other age groups (MoAC/SUA/ILRI 1998). Higher milk demand in urban centres provides an opportunity for the dairy sub sector to expand. Unfortunately, demand for milk and milk products are much higher than actual milk production.

The above challenges have led to the development of crossbred dairy cows in Tanzania to produce milk of about 1800 l/cow/annum below the genetically possible potential yields of 2500 l/cow/annum (Msangi et al 2005, Swai et al 2005). Smallholder dairy farmers in rural areas of Tanzania manage their animals differently depending on the challenges they face and available resource bases they have. However, such management information is very limited in urban and peri-urban areas of Tanzania (Guendel and Richards 2002). Knowledge on the current management and production levels of dairy cattle may assist in improving their production through formulation of policies and enforcement of urban by - laws related to keeping of animals.

In order to inform efforts to improve dairy cattle productivity in urban and peri urban areas of Tanzania, it was ideal to collect important information on farmer's perception on the major challenges to high dairy cattle performance and characterise management practices in the study areas. Therefore, for comparative purposes, smallholder dairy farms in urban and peri urban areas of Dar es Salaam and Morogoro were randomly selected as an input to the on-going study on reproductive and productive performance of crossbred dairy cattle in urban and peri urban areas of Tanzania. The objective of this study was to describe the management and production levels of crossbred dairy cattle in Dar es Salaam and Morogoro.

Materials and methods

Study areas and animals

This study was carried out in urban and peri-urban areas of Dar es Salaam and Morogoro, both located within the same agro Ecological Zone 2 with rainfall between 500-1000 mm (URT 2007b). According to UN-Habitat (2009), Dar es Salaam is the most urbanized region in Tanzania with 93.9% of its population being urban while Morogoro is the third region in the country to have large proportion of its urban population (27.0%) above the national figure (23%) of urbanization. Dar es Salaam is located between longitudes $37^{0}10$" to $39^{0}30$"E and latitudes $06^{0}15$" to $07^{0}40$"S. Morogoro region is located between latitudes 5º 58"and 10º 0"S and longitudes 35º 25"and 35º 30"E (URT 2007b). Dar es Salaam has three Municipalities, namely Kinondoni, Ilala and Temeke but, only Kinondoni and Ilala were studied. All wards keeping cattle in Morogoro municipality were selected for the study.

In this study, an urban area is defined as part of town up to 10 km away from the town centre with high density areas (plots are not more than 200m²), while a peri urban area is part of town 10 km up to 30 km from town centre. This part of town has low density areas (plot sizes range between 1,200m² and 2,000m²) and some basic social services such as piped water and electricity may be missing. Both urban and peri urban areas are within the jurisdiction of a Local Government Authority (Urban Authorities Act 1982). According to urban authority bylaws, keeping of animals in urban areas of Tanzania is allowed provided they are kept under zero grazing condition and not more than four head per household (URT 2007b).The choice of the two research sites was based on the fact that they had similar agro ecological zones and have fast growing human and cattle populations.

Dairy cattle considered in this study were crossbreds between *Bos taurus* (Friesian, Ayrshire and Jersey) and zebu (*Bos indicus*) breeds. All lactating cows were hand milked two times a day. Dairy cattle were either zero grazed (stall fed) where forages are cut and carried to cattle to be fed under confinement, semi zero or free grazed. Natural pasture formed the major source of feeds while concentrate was used to supplement lactating cows during milking time.

Study design and data collection

A cross sectional study design was conducted between April and August 2010 using a random sample of 71 and 82 smallholder dairy farmers from Dar es Salaam and Morogoro, respectively. For the purpose of this study, a smallholder farm was defined as the one having $1<n<50$ dairy cattle of all ages and sexes. However, for easy discussion, farmers were subdivided into three sub groups according to herd sizes namely: 1-10, 11-20 and 21-50 animals. Interviews with dairy cattle farmers using semi-structured questionnaires, focus group discussions with livestock stakeholders and personal observations using a check list were the main tools used to gather information on farmers' demographic characteristics, types of farm labour, land size, livestock inventory/herd

structure, dairy cattle feeding, milk production, processing and marketing, grazing systems and breeding methods. The hygienic condition of cattle sheds was visually observed and assessed as good/clean or poor/dirty. Cattle sheds which were cleaned with water regularly and removed manure by scrubbing only were assessed as being in good/clean and poor/dirty sheds, respectively. Cattle sheds measurements were taken by using a tape measure to get total cattle shed area in square metres. The stocking density was determined by computing the number of cows kept per cattle shade area.

Data analysis

Microsoft Excel was used to store and draw graphs. Descriptive statistics of General Linear Models (GLM) procedures of SAS version 9.1 (2002) was used to describe herd size and composition, milk yield, land size and amount of milk processed. Differences in sample size among continuous variables were determined by using GLM procedures (sum of squares type III). Separation of the least square means (LSMeans) was performed by using PDIFF procedure. Chi-square test (PROC FREQ) of SAS (2002) was used to analyse associations between possible combinations of categorical variables (demographic characteristics, types of farm labour, sources of capital) and values of $P \leq 0.05$ were considered as significant.

Results and discussion

Demographic characteristics of dairy farmers

On average for both locations, nearly half of the dairy farmers were self-employed while retired officers and government employees were few (Table 1). By contrast, government employees were the most numerous in Morogoro municipality compared to Dar es Salaam. Similar proportions of dairy farmers with college and secondary education were observed in both study areas (Table 1). Farmers had similar levels of education although Dar es Salaam had fewer and more farmers with primary and college education, respectively, compared to Morogoro. Involvement of dairy farmers with different social economic and cultural backgrounds was reported from different studies in urban and peri urban areas of East African cities (Gillah et al 2012).

Table 1: Employment status and education levels of dairy farmers interviewed in Morogoro and Dar es Salaam

Variable	Area				Total	Chi (X^2)	*p*
Employment status		Retired officers	Government employee (n) %	Self-employees		17.3	0.002
	Morogoro	(26) 14.8	(34) 19.4	(30) 17.1	(90) 51.4		
	Dar es Salaam	(12) 6.9	(18) 10.3	(55) 31.	(85) 48.6		
	Total	(38) 21.7	(52) 29.7	(85) 48.6	(175) 100		
Education levels		Primary	Secondary	College	Total	3.48	0.175
	Morogoro	(24) 13.7	(36) 20.6	(30) 17.1	(90) 51.4		
	Dar es Salaam	(15) 8.6	(31) 17.7	(39) 22.3	(85) 48.6		
	Total	(39) 22.3	(67) 38.3	(69) 39.4	175 (100)		

Figures in brackets (n) are number of respondents p=probability

Dairy farmers had various sources of funds/capital for establishing and running dairy enterprises. However, the main and least sources of funding were own capital and in-kind assistance (heifer in trust) from Heifer Project International, respectively (Figure 1). Dairy farmers who applied for loans comprised of 15.4% of the total in Dar es Salaam and very few (2.8%) in Morogoro. There was a positive relationship between herd size and desire of the farmer to apply for loan; 9.7% of dairy farmers with small herd sizes (1-10) applied for loans while 4.0% (n=7) of dairy farmers with herd sizes of 21-50 cattle applied for loan. Most dairy farmers use their own capital for establishing and running dairy cattle enterprises. This practice has also been reported in Dar es Salaam (Lupala 2002) and Addis Ababa (Kassa 2003; Shiferaw et al 2003). Availability of credit services for dairy related activities is difficult. For instance, Lupala (2002) in Dar es Salaam and Ayenew et al (2009) in Bahir Dar, Ethiopia reported 4% and 16% of dairy farmers respectively to have received credit services for dairy related activities. In view of this, Baltenweck and Staal (2000) pointed out that access to credit cannot be excluded as a reason for delaying adoption of dairy cow related innovations.

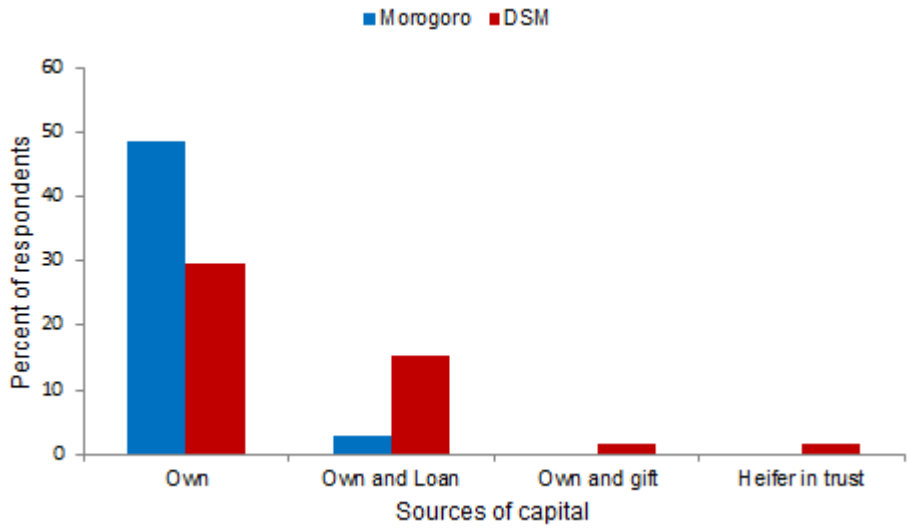

Figure 1. Percentage of the farmers who used different sources of capital for establishing dairy enterprises in Dar es Salaam (DSM) and Morogoro

Feeds, feeding, breeding methods and sources of dairy farm labour

Dairy farmers depended mostly on natural pasture as feed source obtained from open spaces/communal grazing land. Forage vending is very common in urban areas where young boys cut forage from open areas/fallow land and sell it to dairy farmers. Most of the forage transactions were made along the highways. The naturally occurring green feeds in the study areas were of moderate quality, having only 6.8% crude protein and 55.6% of digestible organic matter in dry matter according to Kavana and Msangi (2005). According to NRC (1989), the available feed resources are unable to meet the crude protein requirements of a dairy cow (12% CP) producing at least 10 litres of milk per day. Kavana and Msangi (2005) reported that the feeding regime practiced by smallholder dairy farmers in peri urban areas of Kibaha and Morogoro enabled exploitation of less than 83% of the animals' potential for milk production. Contrary to this, a good number (78.5%) of dairy farmers in Tanga municipality obtained animal feeds from farm established fodder units (Swai et al 2005). This was made possible because for quite a long time, Dutch funded dairy project in Tanga gave dairy farmers training in dairy husbandry and in calf heifers on conditions that they have to establish pasture/fodder and construct cattle sheds.

Natural pasture was collected from various sources using different means of transport. Generally, dairy farmers in the study areas used mainly vehicles and bicycles/bikes/ walking on foot to collect forage from the sources to their respective dairy units. Nevertheless, a few dairy farmers freely grazed their cattle (Figure 2). Similar results were reported by Prain et al (2010) in Nakuru, Kenya where urban dairy farmers transported their fodder using mostly bicycles. Contrary to this observation, more than

half of the dairy farmers in the urban centre of Addis Ababa used donkeys to bring feeds to their farms (Shiferaw et al 2003). It is worth to note that donkey transport is a most important occupation and primary income source of urban household heads in Addis Ababa (Guendel and Richards 2002).

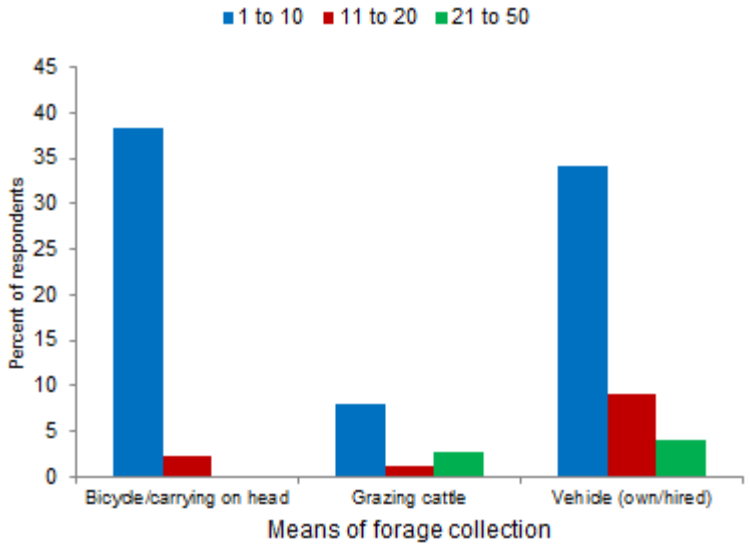

Figure 2. Percentage of the farmers who used different means to collect forage in Dar es Salaam (DSM) and Morogoro

Dar es Salaam dairy farmers covered longer distance in search of forages relative to Morogoro (Table 2), hence it was logical for them to use mostly vehicles (hired/own) to collect animal feeds. This situation may explain the high cost of milk production (188 Tsh per kg of milk) in Kibaha (closer to Dar es Salaam city) relative to 171 Tsh per kg of milk (1 USD=1, 600 Tsh) calculated in Morogoro municipality (Kavana and Msangi 2005). Generally, transport costs are too high for smallholder farmers to access feed resources and also limit selling of manure to peri urban areas for crop production (Guendel and Richards 2002).

Availability of land for dairy activities was a major concern in urban and peri urban areas, although the size differs both within and between towns/cities (Table 2). Generally, peri urban areas had large plot/farm size compared to urban settings. However, the finding that peri urban areas had larger plots than urban areas was different to Swai et al (2005) who reported larger plot/farm sizes in urban (5 ha) than in peri urban (4.2 ha) dairy units of Tanga, Tanzania. Small land availability limits dairy farmers to expand their dairy units and face difficulties in disposing animal wastes (Lupindu et al 2012).

Very few dairy farmers in Dar es Salaam and Morogoro peri urban areas allocated land for cultivated pasture production and/or set aside grazing area (Table 2). Nevertheless, peri urban Dar es Salaam dairy farmers set aside comparatively larger land for pasture production/grazing area than farmers in Morogoro. Failure to establish pasture in peri

urban dairy units was reported in Addis Ababa city (Ayenew et al 2009) but different in Tanga (Swai et al 2005). Availability of alternative sources of pasture, land scarcity, lack of pasture seeds and technical know-how on pasture establishment could be the possible reasons for not allocating land for pasture (Kavana and Msangi 2005, Mtengeti et al 2008).

Table 2: Average land size, pasture plots and distance to forage sources in Morogoro municipality

Variable (n=153)	**Study area**		**Overall**	***P* value**
	Morogoro	**Dar es Salaam**		
Land holding owned by dairy farmers, ha	1.5±0.6	5.0±0.6	3.2	**<0.01**
Land allocated to pasture/grazing land (mean± SE), ha	0.1±0.3	1.6±0.3	0.8	**<0.05**
Distance to forage sources, km	3.07±1.2	14.7±1.2		**<0.01**
Proportion of land allocated to pasture, %	6.3	5.6		**NS**

NS=non-significant

Energy rich concentrate was used to supplement lactating dairy cows during milking sessions (Figure 3). According to Mtengeti et al (2008), lack of protein supplement could be due to scarcity and/or high price. The practice of giving extra concentrate to dry cows in the last trimester was more common in Dar es Salaam city than in Morogoro municipality. Furthermore, steaming up of dry cows was more common with small herd sizes (1-10 animals) than in large herds (21-50 animals). The fact that dairy farmers rarely supplement dry and early postpartum cows is in agreement with other researches in urban and peri urban areas of East African cities (Mellau et al 2009; Gillah et al 2012).

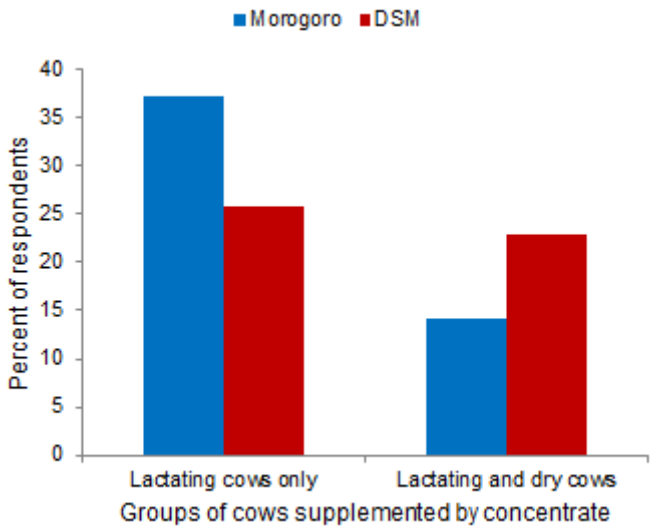

Figure 3. Status of farmers in supplementing concentrates to cows in Dar es Salaam (DSM) and Morogoro

About one third of dairy farmers still practice a combination of semi zero and free grazing systems in communal grazing land. The two grazing systems were predominant in the urban and peri urban areas of Dar es Salaam city compared to Morogoro municipality

(Table 3). The communal lands are public-owned lands that include river banks, dam edges, flood plains and fallow lands and these form the major source of dairy animals' feed in urban and peri urban areas of Tanzania. Semi zero and free grazing systems are very common practices in most peri urban areas of African cities (Gillah et al 2012). In semi zero grazing system, animals are allowed to graze on open spaces for some hours and confined during the night where they are given supplementary feeds. The fact that semi zero and free grazing systems are dominant in peri urban areas is supported by Ngigi (2005) and Mustafa et al (2011). Free grazing of livestock in Tanzanian towns is not allowed and contravenes the Municipal council by-laws which require all livestock to be kept under zero grazing system. Therefore, allowing free grazing of dairy cattle implies that possibly town council by-laws are not seriously enforced (Mlozi 2005).

Table 3: Percentage of dairy farmers using different grazing systems and breeding methods in Morogoro and Dar es Salaam

Variable	**Area**				**Total**	**Chi (X^2)**	***P* value**
Grazing systems		Zero grazing	Semi zero grazing (n) %	Free grazing		10.6	0.004
	Morogoro	(72) 41.1	(16) 9.1	(2) 1.1	(90) 51.4		
	Dar es Salaam	(50) 28.6	(26) 14.9	(9) 5.2	(85) 48.6		
	Total	(122) 69.7	(42) 24.0	(11) 6.3	(175) 100		
Breeding methods		Natural/ bull AI		Natural and AI	Total	23.2	0.001
	Morogoro	(57) 32.5	(10) 5.8	(23) 13.1	(90) 51.4		
	Dar es Salaam	(25) 14.4	(30) 17.1	(30) 17.1	(85) 48.6		
	Total	(82) `46.9	(40) 22.9	(53) 30.2	175 (100)		

Figures in brackets (n) are number of respondents, AI=artificial insemination

Herd size influenced the choice of transport used to collect forage from outside sources. Dairy farmers with small herds used mostly bicycle/head whereas farmers with larger herds had two alternatives, either grazing or used vehicles for collecting forage (Figure 4).

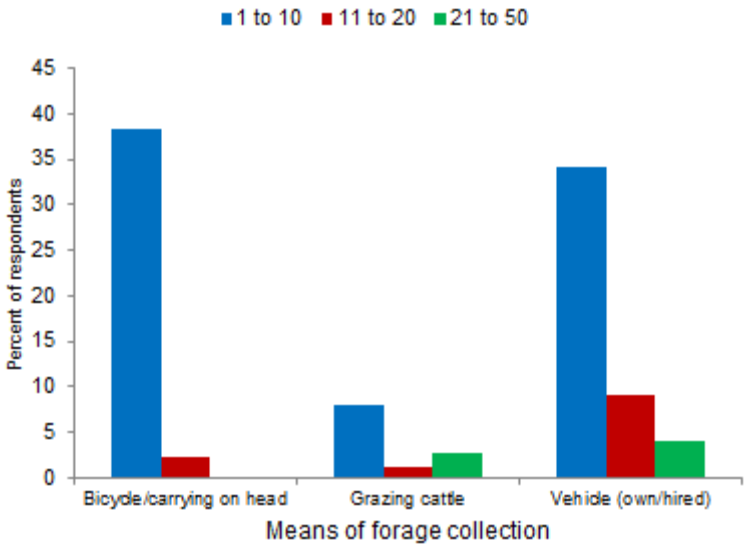

Figure 4. Percentage of farmers who used different means to collect forage according to the size of herd

The methods used to breed dairy cattle varied and most dairy farmers used natural service rather than artificial insemination (Table 3). The proportion of dairy farmers in urban and peri urban areas who used artificial insemination was less in Morogoro municipality than in Dar es Salaam city. Fewer dairy farmers used a combination of both natural and artificial insemination in Morogoro compared to Dar es Salaam. Dairy farmers preferred natural service as opposed to artificial insemination service as earlier reported in most urban and peri urban dairy units of East Africa (Gillah et al 2012). Unreliable artificial insemination services, lower conception rates and high cost of the service scared most smallholder dairy farmers from using the service (Msangi et al 2005). Contrary to this observation, 69.7% of urban smallholder dairy farmers of Dire Dawa, Ethiopia used artificial insemination service. Possible reasons for depending on artificial insemination service in some urban areas were lack of space to keep bulls and shortage of feed (Mureda and Zeleke 2008). Nevertheless, the decision on the types of breeding methods a dairy farmer should use was not based on herd size and had no relationship with levels of education.

On average for both areas, dairy farmers depended largely on hired labour followed by a combination of hired and family labour; few farmers depended on family labour alone. A combination of hired and family labour and hired labour was more used in Dar es Salaam and Morogoro, respectively to perform most of the work in the dairy units. The types of farm labour had a bearing on the herd size, whereby small herd sizes were managed mostly by hired labour, but larger herd sizes were cared for by a combination of hired and family labour (Figure 5). According to Lupala (2002), 56% of livestock keepers in Dar es Salaam employed hired labour. The use of hired labour in performing dairy activities is common in urban cities of East Africa (Gillah et al 2012). This implies that dairy farming in urban and peri urban areas is a viable enterprise, creates employment opportunities to

urban dwellers and owners of dairy cattle in those cities can afford to pay labour wages (Nugent 2000, Mlozi 2005, Orodho 2006).

The involvement of hired labour in urban dairy units was probably linked to the fact that some dairy unit owners were government employees (Table 1) and others run small businesses (Mlozi 2005). However, Salem et al (2006) gave caution on the reliance of hired labour with less dairying skills and not motivated by pointing out that it may result in mismanagement practices of the dairy unit operations. Meanwhile, family labour was more pronounced in Bishoftu, Ethiopia (Megersa et al 2011) and Kampala (Ishagi et al 2002) and accounted for 54 and 52%, respectively of the households keeping dairy cattle. This shows that some urban dairy owners cannot afford to pay labour wages since they keep cattle on a subsistence basis (Ishagi et al 2002).

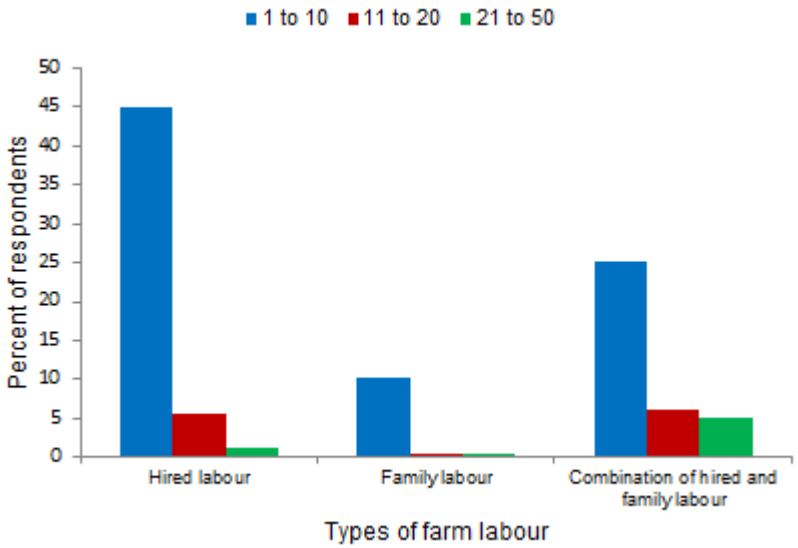

Figure 5. Percentage of the farmers who used different types of farm labour according to herd size in Dar es Salaam and Morogoro

Cattle shed hygienic condition and conformity to standard design

Averaged for both locations, most cattle sheds were in good condition and there was no difference in hygienic condition between the two study areas (Table 4). Similar observations were made in several urban and peri urban dairy units of East Africa (Gillah et al 2012). Shortage of water especially during the dry season and keeping a large number of animals per unit area were some of the factors which contributed to poor hygiene of cattle sheds. Shortage of water was a common problem in most urban and peri urban areas of Tanzania (Lupala 2002, URT 2010). The majority of the cattle sheds at both locations had concrete floors; very few had earthen floors. The types of floor observed in Dar es Salaam were similar to the ones found in Morogoro. Herd size was related to hygienic condition of the cattle sheds whereby in small herds, which were

mainly zero grazed, the sheds were in poorer hygienic condition when herd sizes were larger (semi and free grazed cattle).

Table 4: Types of cattle shed floor and hygienic condition in Dar es Salaam city and Morogoro municipality

Variable	Area				Total	Chi (X^2)	*P* value
Types of cattle sheds floor		Stone paved	Concrete	Earthen		1.60	0.448
			(n) %				
	Morogoro	(16) 7.1	(72) 41.2	(2) 1.1	(90).51.4		
	Dar es Salaam	(10) 5.7	(74) 42.2	(1) 0.7	(85) 48.6		
	Total	(26) 14.8	(146) 83.4	(3) 1.8	(175) 100		
Hygienic condition of cattle sheds		Satisfactory	Good		Total	0.13	0.713
	Morogoro	(8) 6.1	(55) 42.3		(63) 48.4		
	Dar es Salaam	(10) 7.7	(57) 43.9		(67) 51.6		
	Total	(18) 13.8	(112) 86.2		130 (100)		

Figures in brackets (n) are number of respondents

Cattle shed design was similar at both locations and the majority of them did not conform to recommended standards (FAO 1998). For both locations, the majority of cattle sheds did not have provision for separate sleeping and walking/feeding spaces. This observation is supported by other research findings in urban and peri urban dairy units of East Africa cities (Gillah et al 2012). Poor cattle shed design decreases the productivity of the dairy cows (Kassa 2003) and predisposes them to body injuries and diseases (Aleri et al 2011). The poorly designed cattle sheds implies that they were constructed without taking into consideration the space requirement per animal as stipulated in the Tanzania Animal Welfare Act (URT 2008). The few cattle sheds that conformed to standard design were a result of a donor-funded dairy project (Heifer Project International) which required the dairy farmer to construct a standard cattle shed before starting the project. Generally, cattle sheds in smallholder dairy units were small structures made of cement blocks, burnt bricks or pieces of timber off-cuts. They are normally covered by corrugated metal sheets or thatched with grasses. The floors were made of stones or concrete.

Stocking density, herd size and structure

More than half of cattle sheds had high stocking density (Table 5) than the recommended space requirement of one animal in 6.7m^2 (FAO 1998). However, the stocking densities in the study areas were not different. High stocking density was a problem in urban dairy units of Tanga Tanzania (Shirima and Msanga 2004) and Nairobi, Kenya (Aleri et al 2011). High stocking density affects animal performance, and according to Moore (2010) dairy cows should not be housed at a stocking density of more than 1.17 cows per stall, since the lactating cows may produce low milk yield and have poor conception rates. Therefore, dairy farmers should be trained and sensitized to have cattle sheds that

conform to standard design in order to avoid the negative effects of having smaller cattle shed per animal.

The current average dairy herd size (Table 5) in Dar es Salaam is larger than has been reported in the previous studies in urban and peri urban areas of Tanzanian towns/cities (Gillah et al 2012). The two study areas had more than the recommended herd size of keeping not more than four animals per farmer (Urban Authorities Act 1982). For long time, farmers in urban areas of Tanzania have not reduced their herd sizes despite the by-laws enacted in all urban centres concerning keeping livestock in towns. The need for more income (Gillah et al 2012) and inefficiency in by-laws enforcement mechanisms (Mlozi 2005) could possibly led to many dairy farmers to contravene the urban by laws.

Table 5: Average (mean± SE)stocking density, herd size and herd structure in Dar es Salaam and Morogoro municipality

Variable (N=153)	**Study areas**		
	Morogoro	**Dar es Salaam**	***P* value**
Stocking density (number/6.7m^2 standard space per cattle	1.27±0.09	1.48±0.09	NS
Herd size	5.5 ± 0.5	11.1±1.1	**
Milking cows	1.93 ±0.2	2.2±0.3	NS
Dry cows	0.9 ±0.2	4.2±0.3	*
Heifers	0.6±0.1	2.4±0.2	*
Calves	1.7±0.2	1.4±0.2	NS
Bulls	0.4 ±0.1	0.3±0.1	NS

*NS=non significant different, * =significant different at P<0.05, ** = significant different at P<0.001*

Milk production and processing

The average milk yields in the study areas were different (Table 6), but within the range obtained from other earlier studies in urban and peri urban dairy units of East African cities (Gillah et al 2012). The difference in milk yield between the two study areas could possibly be explained by the fact that dairy farmers in Dar es Salaam used more artificial insemination (Table 3) and steamed up dry cows in the last trimester (Figure 3) than dairy farmers in Morogoro municipality. Moreover, greater prices paid for a litre of milk (Table 6) in Dar es Salaam compared to Morogoro municipality gave them an incentive to intensify management to produce more milk. Nevertheless, the average milk production in the two study areas (8.3 litre/cow/day) was lower for dairy cows with genetic potential of producing at least 15 litres of milk per day (Msanga and Kavana 2002). Such low milk production could be due to poor nutritive value of feeds and improper feeding of lactating and dry cows which do not meet animals' physiological requirements (Kavana and Msangi 2005).

Table 6: Average (Mean ± SE) milk production, amount of milk processed and distance to milk market places

Variable (N=153)	Study areas		
	Morogoro	Dar es Salaam	*p* value
Milk production, liters/cow/day	6.2 ± 0.4	10.5±1.2	<0.01
Milk produced per household, liters/day	12.4 ±0.8	29.13 ±5.0	<0.01
Milk processed, liters/household/day	0.0 ±0.0	16.0±13.8	<0.01
Distance to market place, km	2.3±2.1	6.6±4.1	<0.05
Milk price per liter, Tsh	686	1,050	<0.05

Tanzania shillings (Tsh) 1600= 1USD, NS=non-significant different, 1

Almost all dairy farmers sold raw milk directly to consumers and very little was processed into fermented milk products (Table 6). One of the reasons contributing to low milk processing was a small amount of milk produced per household per day relative to the demand for raw milk (Table 6). This finding concurs with Shiferaw et al (2003) who reported 61.8% of dairy farmers did not process milk because of low milk output. Selling and drinking of raw milk may transmit milk borne diseases to humans (Makita et al 2010) and illegal in Tanzania (URT 2007a). It is worth noting that the dairy inspectors in Tanzania who are charged with such duties and given powers in the performance of their functions are not performing their responsibilities.

Milk collection centres were not available and dairy farmers in Dar es Salaam were forced to cover longer distance to milk market places compared to Morogoro (Table 6). Longer distance to milk market places may have a bearing on the profit margin realized from sale of milk as well as the keeping quality of the milk (IDF, 1990).

Future plans in dairying

A slightly greater proportion of farmers preferred to increase their cattle herd size than maintaining or decreasing it (Table 7). Similar observations were made in studies carried out in urban and peri urban dairy units of Dar es Salaam (Nugent 2000) and Hue City in Vietnam (Schiere 2001).

Table 7: Percentage responses of farmers on future plans in dairying in Dar es Salaam and Morogoro municipality(n (%))

Area	Increase cattle herd	Maintain cattle herd	Decrease cattle herd	Total	Chi (X^2)	*P value*
Morogoro	(58) 33.1	(4) 2.3	(28) 16.0	(90).51.4	10.0	0.006
Dar es Salaam	(45) 25.7	(17) 9.7	(23) 13.2	(85) 48.6		
Total	(103) 58.8	(21) 12.0	(51) 29.2	(175) 100		

Various reasons induced dairy farmers to make decisions on either to increase, maintain or decrease their cattle herd and differed between the two study areas (Figure 6). Shortage of feed and/or grazing land and prohibitive urban by-laws that required each dairy farmer to have not more than 4 head at a time were the first and second reasons for wanting to decrease cattle herd. Availability of feeds in terms of quality and quantity has been an

important constraint in urban and peri urban areas of Addis Ababa in Ethiopia (Shiferaw et al 2003, Mureda and Zeleke 2008), Kampala in Uganda (Atukunda et al 2003) and Tanga in Tanzania (Swai et al., 2005). Due to inadequate feeding, the production potential of most crossbred cows has not been reached (Kavana and Msangi 2005). The fact that dairy farmers wanted to decrease cattle herd as a result of by-laws, implies that some farmers are becoming aware of the rules and regulations regarding dairying in urban and peri urban areas. The urge to decrease cattle herd due to external forces such as market fluctuations, lack of capital, diseases and problems of manure disposal has also been reported in Hue in Vietnam (Schiere 2001).

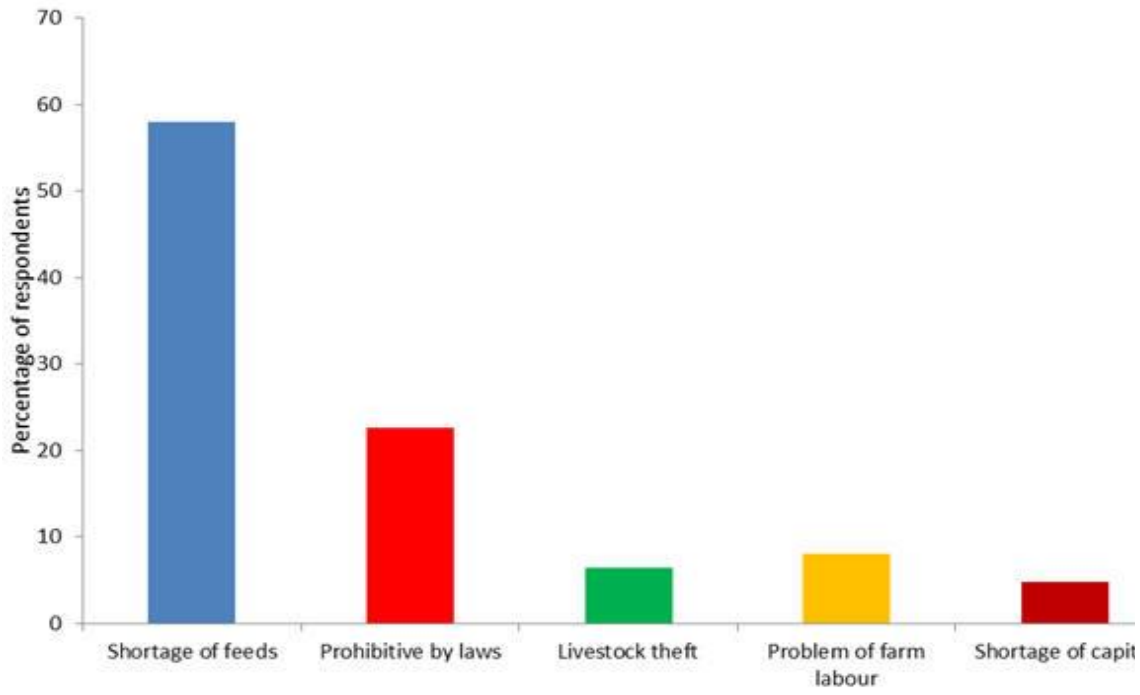

Figure 6. Percentage responses of farmers on reasons for wanting to decease cattle herd in Dar es Salaam and Morogoro municipality

Conclusions

Dairying in Dar es Salaam differs significantly to Morogoro and crossbred cows produced milk below their production potential. Dairy farmers depended mainly on poor quality natural pastures. Artificial insemination service was rarely used in urban and peri urban areas of the study areas. Dairy cattle were confined in poorly designed sheds at high stocking densities which are against animal rights stipulated in Tanzania Animal Welfare Act. Some dairy farmers were forced to decrease their cattle herds mainly due to shortage of feed/forage and prohibitive urban by laws. In order to offset the seasonal variations in

feed availability, dairy farmers should adopt strategic supplementation of dairy cows using protein rich concentrates.

Acknowledgements

The authors would like to acknowledge the DANIDA peri urban livestock farming project for financial support to this research as part of the PhD study program of the first author. We also thank the dairy farmers and ward extension staff in Morogoro and Dar es Salaam urban and peri urban areas for co-operation and provision of valuable information for this study.

References

Aleri JW, Nguhiu-Mwangi J and Mogoa E M 2011 Housing-design as a predisposing factor for injuries and poor welfare in cattle within smallholder units in peri urban areas of Nairobi, Kenya.Livestock Research for Rural Development.Volume 23, Article # 53.http://www.lrrd.org/lrrd23/3/aler23053.htm.

Atukunda G, Baseke F, David S, Jagwe J, Kalyebara M, Kaweesa M, Miiro R, Musoke P, Nabulo G, Namagembe A, Niringiye C, Nyapendi R, Odongo B, Owori C, Azuba,S M and Tumwegamire S 2003 .Farming in the city: Participatory appraisal of urban and peri-urban agriculture in Kampala, Uganda. CIAT Africa Occasional Publications Series, No. 42.CIAT, Kampala, Uganda.44 pp.

Ayenew YA, Wurzinger M, Tegegne A and Zollitsch W 2009 Handling, processing and marketing of milk in the North western Ethiopian highlands. Livestock Research for Rural Development.Volume 21, Article # 97.http://www.lrrd.org/lrrd21/7/ayen21097.htm.

Baltenweck I. and Staal SJ 2000 Determinants of adoption of dairy cattle technology in the Kenyan highlands: a spatial and dynamic approach. Paper presented at the International Association of Agricultural Economics (IAAE) Meetings, Berlin, August 2000.

Cole DC, Lee-Smith, D and Nasinyama GW (eds) 2008 Healthy city harvests: Generating evidence to guide policy on urban agriculture, CIP/Urban Harvest, and Makerere University Press, Lima, Peru 259 pp.

FAO 1998 Farm structure in tropical climates: A Textbook for structural engineering and design Bengtsson, L.P. and Whitaker, J.H. (Editors). FAO/SIDA Cooperative Programme. Rural Structures in East and South-East Africa 167 pp. http://www.fao.org/docrep/s1250e/S1250E00.htm#Contents

Gillah K A, Kifaro G C and Madsen J 2012 Urban and peri urban dairy farming in East Africa: A review on production levels, constraints and opportunities. Livestock Research for Rural Development.Volume 24, Article #198.http://www.lrrd.org/lrrd24/11/gill24198.htm.

Guendel S and Richards W 2002 Peri -urban and urban livestock keeping in East Africa - a coping strategy for the poor? Scoping study commissioned by the Livestock Production Programme (LPP) July 2002. NRI Limited, Aylesford. 29 pp http://www.tropentag.de/2003/proceedings/ node148.html**.**

IDF ternational Dairy Federation 1990 Handbook on Milk collection in warm developing countries IDF, Brussels, Belgium 148 pp.

Ishagi N, Ossiya S, Aliguma L and Aisu C 2002 Urban and peri-urban livestock keeping among the poor in Kampala City. Ibaren Konsultants, Kampala, Uganda 97 pp.

Jacobi PA Mend J and Kiango S 2000 Urban agriculture in Dar es Salaam: providing for an indispensable part of the diet. In N. Bakker, M. Dubbeling, S. Guendel, U. Sabel Koschella and H. de Zeeuw eds. 2000. Growing cities, growing food, urban agriculture on the policy pp 257-283 agenda,http://www.ruaf.org/sites/default/files/DaresSalaam.PDF

Kassa TM 2003 A study on urban agriculture: the case of small-scale urban dairy farming in selected areas of Addis Ababa. A thesis presented to the school of graduate studies of the Addis Ababa University in partial fulfilment of the requirements for the degree of Master of Arts in Geography 175 pp

Kavana PY and Msangi BSJ 2005 On farm dairy cattle feeding experience in eastern zone of Tanzania Livestock Research for Rural Development Volume 17 Article # 6 http://www.lrrd.org/lrrd17/6/kava17062.htm

Kurwijila LR 2001 Evolution of dairy policies for smallholder production and marketing in Tanzania In: Rangnekar D. and Thorpe W. (eds). 2002. Smallholder dairy production and marketing, Opportunities and constraints. In: Proceedings of a South-South workshop held at NDDB, Anand, India, 13-16 March 2001. NDDB, Anand, India, and ILRI, Nairobi, Kenya.538 pp.

Lupala A 2002 Scoping study on urban and peri-urban livestock keepers in Dar es Salaam City.University College of Lands and Architectural Studies (UCLAS), Dar es Salaam, Tanzania 71 pp.

Lupindu AM, Ngowi HA, Dalsgaard A, Olsen JE and Msoffe PLM 2012 Current manure management practices and hygiene aspects of urban and peri-urban livestock farming in Tanzania, Livestock Research for Rural Development 24 (9) 2012 http://www.lrrd.org/lrrd24/9/lupi24167.htm

Makita K, Fèvre EM, Waiswa C, Eisler MC, Welburn SC 2010 How human Brucellosis incidence in urban Kampala can be reduced most efficiently? A stochastic risk assessment of informally-marketed milkPLoS ONE 5 (12): e14188.doi:10.1371/journal.pone.0014188.

Megersa M, Ashenafi F, Anteneh W and Tariku J 2011 Herd composition and characteristics of dairy production in Bishoftu town, Ethiopia Journal of Agricultural Extension and Rural Development 3 (6):113-117.

Mellau LSB, Sarimbo AP, Kimera SI and Phiri ECJ 2009 Recumbence syndrome in cattle: A study of risk factors of milk fever in dairy units in Dar es Salaam, Tanzania Tanzania Veterinary Journal Vol. 26 (2): 56-63.

Mlay PS and Mgumia Y O 2008 Levels of lead and copper in plasma of dairy cows, pastures, soil and water from selected areas of Morogoro suburbs, Tanzania.Livestock Research for Rural Development.Volume 20, Article #60.http://www.lrrd.org/lrrd20/4/mlay20060.htm.

Mlozi MRS 2005 Urban animal agriculture: its palliativity and reasons for persistence in Tanzanian towns. RICS Foundation pp. 26 http://www.rics-foundation.org

MoAC/SUA/ILRI 1998 Rapid appraisal of the Tanzania dairy subsector: Executive summary. Volume 1.ILRI, Nairobi, Kenya.

Moore DA 2010 Stocking density: How much? Western Dairy News 10 (11):167-168. http://animalscience-extension.tamu.edu/dairy/wdn.html.

Msanga YN., and Kavana PY 2002 Performance of F1 Frisian x Boran crossbred bulls and their off-springs to Tanzanian shorthorn Zebu managed under the extensive traditional system. In E. K. Batamuzi, & A. J. P. Tarimo (Eds.), In: Proceedings of the First Collaborative Research Workshop on Food Security May 2003. TARP II SUA Project pp 196-200.

Msangi BSJ, Bryant MJ and Thorne PJ 2005 Some factors affecting variation in milk yield in crossbred dairy cows on smallholder farms in North-east Tanzania. Tropical Animal Health and Production, 37:403-412.

Mtengeti EJ, Phiri ECJH, Urio NA, Mhando DG, Mvena Z, Ryoba R, Mdegela R, Singh BR, Mo M, Wetlesen A, Lørken T and Reksen O 2008. Forage availability and its quality in the dry season on smallholder dairy farms in Tanzania, Acta Agriculturae Scandinavica, 58: (4):196-204.

Mureda E and Zeleke Z 2008 Characteristics and constraints of crossbred dairy cattle production in lowland areas of Eastern Ethiopia.Livestock Research for Rural Development.Volume 20, Article #57 http://www.lrrd.org/lrrd20/4/mure20057.htm.

Mustafa E, Murtada EE, Omer A and Amir S 2011 The contribution of dairying to household welfare of the small commercial dairy keepers in Khartoum north province (KNP), Sudan, Research opinions in Animal and Veterinary Sciences, 1(1):55-59.

Ngigi M 2005 The Case of Smallholder Dairying in Eastern Africa International Food Policy Research Institute EPT Discussion Paper 131, 93 pp.

NRC (National Research Council) 1989 Nutrient Requirements of Dairy Cattle 6th edition.National Academy Press, Washington D.C., USA.

Nugent R 2000 The impact of urban agriculture on the household and local economies. In: N. Bakker, M. Dubelling, S. Gundel, V. Sabel-Koschella, and A. Zeeuw (eds.), Growing Cities, Growing Food: Urban Agriculture on the Policy Agenda. Feldafing, Germany: Food and Agriculture Development Centre (ZEL).

Orodho AB 2006 Intensive forage production for smallholder dairying in East Africa. In: Grasslands: Developments Opportunities Perspectives by (Reynolds & Frame eds) chapter 18 http://www.fao.org/ag/AGP/AGPC/doc/Newpub/napier/eastafrica_orodho.htm

Prain G, Karanja N and Lee-Smith D (Editors) 2010 African urban harvest: Agriculture in the cities of Cameroon, Kenya and Uganda. IDRC, 335 pp.

Salem MB, Djemali M, Kayouli C and Majdoub A 2006 A review of environmental and management factors affecting the reproductive performance of Holstein-Friesian dairy herds in Tunisia. http://www.lrrnd.org/lrrd18/4.htm Livestock Research for Rural Development 18 (4) 2006

SAS (Statistical Analysis System) 2002 User Installation Guide for the SAS system version 9.1, SAS Institute Inc., Cary, North Carolina, USA 221 pp.

Schiere H 2001 Livestock production in urban conditions, problems and opportunities, concepts and methodologies. In: Proceedings of the 10th International Conference of the Association of Institutions for Tropical Veterinary Medicine "Livestock Community and the Environment", 20-23 August 2001 Copenhagen, Denmark.

Shiferaw Y, Tenhagn BA, Bekana M and Kassa T 2003 Reproductive performance of crossbred Dairy cows in different production systems in the central Hhighlands of Ethiopia. Tropical Animal Health and Production 25:551-61.

Shirima EJM and Msanga YN 2004 The state of livestock welfare in Tanzania: An overview. In: Proceedings of the 31st Scientific Conference of TSAP held at Kilimanjaro Crane Hotel Moshi 5th–7th 2004, 31:137-146.

Swai ES, Karimuribo ED, Schoonman L, French NP, Fitzpatrick J, Kambarage D and Bryant MJ 2005 Description, socio-economic characteristics, disease managements and mortality dynamics in smallholder's dairy production system in coastal humid region of Tanga. Tanzania. Livestock Research for Rural Development 17 Article #4 16 pp.

Swai ES, Schoonman, 1. 2011 Microbial quality and associated health risks of raw milk marketed in the Tanga region of Tanzania Asian Pacific Journal of Tropical Biomedicine pp 217-222. http://www.elsevier.com/locate/apjtb.

UN-Habitat 2009 Tanzania: Morogoro profile Tanzania United Nations Human Settlements Programme Regional and Technical cooperation Division 32 pp. http://www.unhabitat.org

Urban Authorities Act 1982 Printed by the Government Printer, Dar es Salaam, Tanzania 59 pp.

URT (United Republic of Tanzania) 2007a The Dairy Industry Regulations. The Government Printers Dar es Salaam Tanzania 48 pp.

URT (United Republic of Tanzania) 2007b Morogoro regional socio economic profile,122 pp. http://www.tzonline.org/pdf/Morogoro.pdf

URT (United Republic of Tanzania) 2008 The Animal Welfare Act. No. 19 of 2008 Ministry of Livestock Development 62 pp. http://www.mifugo.go.tz

URT (United Republic of Tanzania) 2010 Water sector status report ministry of water and Irrigation 127 pp. http://www.maji.go.tz

URT (United Republic of Tanzania) 2012 National Sample Census of Agriculture, Small holder agriculture Volume III: Livestock Sector. The National Bureau of Statistics and the Office of the Chief Government Statistician, Zanzibar 187 pp.

Received 15 July 2013; accepted 9 August 2013; Published 4 September 2013

Paper III

Cattle sheds design, management and its legal implications in urban and peri urban areas of Dar es Salaam city and Morogoro municipality, Tanzania

K A Gillah, G C Kifaro* and J Madsen**
Department of Research Training and Extension, Ministry of Livestock Development and Fisheries, P.O. Box 9152, Dar es Salaam Tanzania,
***** Department of Animal Science and Production, Sokoine University of Agriculture**,** P.O. Box 3004, Morogoro Tanzania
**Department of Large Animal Sciences University of Copenhagen, Groennegardsvej 2, DK-1870 Frederiksberg C. Denmark

Corresponding author: kagillah@yahoo.com

Abstract

This study was carried out in urban and peri-urban areas of Dar es Salaam and Morogoro, Tanzania and involved 153 smallholder dairy units. A semi structured questionnaire and observational study were used to collect information on herd size, manure cleaning and handling, shed design and construction materials used. The hygienic condition of the cattle sheds was assessed as good for cattle sheds that were cleaned with water regularly or poor for the one that manure was removed by scribing. The stocking density was classified in reference to the recommended floor space of 6.7m^2 per one cattle. General Linear Models procedures of SAS was used to analyse data. The average herd size was 7.9 animals per farmer and significantly ($p<0.05$) varied between the study areas. The cattle sheds had significantly ($p<0.05$) higher stocking density and more than half (53.6%) of all the cattle sheds accommodated more than one cattle per standard area. The design of the cattle sheds significantly ($p<0.05$) influenced the herd size where by timber off cuts and open sheds had accommodated 32.0±4.7 and 13.6±2.7 animals in Dar es Salaam city and Morogoro municipality, respectively. Timber off cuts and tin roofed cattle sheds were the most numerous (58.8%) followed by cement block and tin roofed sheds (33.3%). The inclusion of cubicles in the cattle sheds was not a common feature (15.7%) and the construction was not done (89.54%) according to the prescribed designs. Nearly, all cattle sheds (94.8%) were covered by corrugated iron sheets. Location of the study area significantly ($p<0.05$) influenced the way cow manure was disposed. About 13.8% of all the cattle sheds were in poor hygiene. It may be concluded that the management of cattle sheds was improperly executed and were against various laws and regulations guiding dairy farming in urban and peri urban areas.

Key words: Hygiene, by-laws, regulation, stocking density

Introduction

The population of Tanzanians is estimated at 42 million people of which the urban population has increased from 22.6 percent in 2002 to 29.1 percent in 2012 (Wenban-Smith, 2014). Dar es Salaam city and Morogoro municipality were among the fastest growing cities/urban centres in Tanzania with annual population growth rate of 4.4 and 2.6 percent, respectively (UN-Habitat, 2009). Migration of people from the rural areas to cities/towns to look for work was reported as one of the reasons that contribute to increased population in urban areas (Foeken et al., 2004). As long as social services continue to be lacking in rural areas, more people will flood into cities and towns. The rate of urbanization in East African Cities/towns has exerted pressure on food supply and the situation has made some of the urban dwellers to go for dairying in order to supplement food supply and income (Tegegne et al., 2000; Cheruiyot et al., 2014).

Urban agriculture (UA) in Tanzania was first recognised in 1979 as a survival strategy to urban residents following poor economy of the country in the 1970s and 1980s. In response to the economic hardship, the government of Tanzania issued policies to encourage people to undertake UA in order to attain food self-sufficiency and offset inflation. Three policies that had direct impact in the operation of UA were formulated to address not only the key issues of their respective sectors but also to guide the orderly conduct of UA. The policies include the National Land Policy, (URT, 1995) which was intended to deal with issues related to land management and administration, the Agricultural and Livestock policy (URT, 1997) was intended to regulate the conduct of UA to ensure that it does not disrupt the planned urban development, while the National Human Settlements Development Policy, (URT, 2000) was intended to provide the orderly planning, management and regulation of human settlements developments.

On the other hand, the Town and Country Planning (Urban Farming) Regulations, explicitly dealt with the conduct of Urban farming in Tanzania (URT, 1992). At the regional level, a local government authority made by laws for effective enforcement of the laws in area of jurisdiction. Within this context, urban and peri urban farming in Tanzania is permitted but it has to be undertaken with certain conditions. Nevertheless, in the early 1980s the government policies that encouraged UA, especially livestock keeping, started to have a negative effect on the environment and that called for revision of the existing municipal by-laws regarding urban farming. The by-laws for regulating urban farming (crops and livestock keeping) in all Municipalities of Tanzania were reviewed anticipating proper and ethical handling of the animals (Foeken et al., 2004).

According to the Town and Country Planning (Urban Farming) Regulations, No. 2, keeping animal in urban areas of Tanzania is permitted provided the animals are zero grazed (URT, 1992) In due respect, there was a good number of dairy farmers who have adopted zero grazing system in urban and peri urban areas of Tanzania (Gillah, et al., 2012). One of the pre requisites of the zero grazing system is for a dairy farmer to have a cattle shed. More important, the cattle shed should be well planned and designed in order to provide the cattle with freedom from discomfort, injury, disease, fear and improve efficiency of managing the animals (Aleri et al., 2012).

Regular cleaning and sanitation of the dairy cattle shed is necessary in order to remove dirt materials and micro-organisms, respectively. Barbari et al. (2006) pointed out that a dairy cow living in a dirt shed cannot be comfortable and its level of milk production will be affected. Dairy cows require correct stocking density for resting/sleeping and walking. Overstocking of lactating cows causes aggressive interactions (Fregonesi et al., 2007), decrease milk butter fat content (Hill et al., 2007) and tends to increase the somatic cell counts (Krawczel, 2013).This study was, therefore, undertaken to characterize cattle shed designs/types, management and its legal implication in urban and peri-urban areas of Dar res Salaam city and Morogoro municipality in Tanzania. Such information is important in improving the welfare of the animals and to inform policy makers and other livestock stakeholders.

Materials and methods

Study areas

This article is based on a cross-sectional study carried out in urban and peri-urban areas of Dar es Salaam and Morogoro, Tanzania. The two sites are located within the same agro ecological zone two (2) and receive about 500 -1000 mm of rainfall per annum (URT, 2007). Dar es Salaam city and Morogoro municipality are among the fastest growing cities and municipalities in Tanzania and have 93.9 and 27 percent respectively, of its population found in urban areas (UN-Habitat, 2009). Dar es Salaam city is located between longitudes $37^0$10" and $39^0$30"E and latitudes $06^0$15" and $07^0$40"S while the Latitude and Longitude of Morogoro Municipality Council is 6.8 S and 37.6 E, respectively. Kinondoni and Ilala municipalities in Dar es Salaam city and wards keeping dairy cattle in Morogoro municipal were selected for this study. The term urban and peri urban area has been defined in the previous study by Gillah et al. (2013).

Study design and data collection

A total of 153 smallholder dairy units were visited, interviewed and their cattle sheds measured. For the purpose of this study, a smallholder dairy unit was defined as one with $1<n<50$ dairy cattle of all ages and sexes. Dairy farmers were subdivided into three sub groups according to herd sizes namely: 1-10, 11-20 and 21-50 dairy cattle. A semi structured questionnaire and observational study were used to collect information from dairy farmers on herd, manure cleaning and handling, shed design and construction materials. The parameters related to cattle shed design which were assessed included presence of roof, types of walls and floors, presence/absence of cubicles and area of the floor space which was assessed by taking actual measurements to get total cattle shed area in square metres.

The hygienic condition of the cattle sheds was assessed as good for cattle sheds that were cleaned with water regularly or poor for the ones that manure was removed by scrubbing. The types of cattle sheds were categorised as cement block tin roofed (CBTR), burnt brick tin roofed (BBTR), timber/poles off cuts tin roofed (TOTR) and timber/poles off cuts open (TOO). The floor types were classified as concrete, stone paved and earthen floors. The stocking density was classified in reference to the recommended floor space of $6.7m^2$ per one cattle (FAO, 1998). Therefore, the stocking rates were < 1 animal in $6.7m^2$, 1 animal in $6.7m^2$ and > 1 animal in $6.7m^2$ which were considered to be low, normal and high stocking rates, respectively.

Data analysis
Descriptive statistics of General Linear Models (GLM) procedures of SAS (2002) version 9.1 was used to describe herd size, composition and management variables. Separation of the least squares means (LSMeans) was performed by using PDIFF procedure. Chi-square test (PROC FREQ) of SAS (2002) was used to analyse associations between possible combinations of categorical variables and values of $p \leq 0.05$ were considered significant.

Results and discussion

Herd size
The average herd size in the two study areas is larger than the maximum number (4 animals) permitted in urban and peri urban areas (Table 1). Dairy herd categorization into smaller groups had shown considerable variations between the two study areas and Dar es Salaam city had fairly many dairy farmers than in Morogoro municipality who kept 11-50 dairy cattle (Table 1). Nevertheless, the majority of the smallholder dairy farmers kept 1-10 dairy cattle and very few had 21-50 dairy cattle.

The average dairy herd size (7.9 cattle per farmer) observed in the two study areas was comparable to 7.4 cattle per farmer reported in smallholder dairy farms of Debremarkos city (Yayeh et al., 2014) but was larger than the average of 4 cattle per farmer found in dairy units of Debre-Zeit town in Ethiopia (Mekonnen et al., 2006).

The average herd size was larger than the recommended 4 cattle per farmer that should be kept at a time (The Morogoro Municipal Council by-laws, 1999). This implied that the two study areas contravened the Town and Country Planning (Urban Farming) Regulations (URT, 1992). The existence of large herds of cattle in urban areas could possibly due to conflict of interest since some of the law enforcers keep livestock (Foeken et al., 2004), weak enforcement of by-laws (Foeken et al., 2004; Cheruiyot et al., 2014) and high economic benefit obtained from keeping dairy cows in urban and peri urban areas (Gillah et al., 2012). Due to this Foeken et al. (2004) commented that it is impracticable for a junior officer to punish his or her boss who is found violating the law.

Stocking density
Results on stocking density are shown in Table 1. The cattle sheds had high stocking density and more than half of all the cattle sheds accommodated more than one cattle in a standard area required by one animal. However, both study areas had higher and similar stocking density.

High stocking density was a common phenomenon in peri urban dairy units (Shirima and Msanga, 2004; Mekonnen et al., 2006; Aleri et al., 2012). Normally, high stocking density increases the risk of laminitis, lameness and restrict the animals from freely expressing their behaviour and enjoying free movement (Aleri et al., 2012). Moreover, overstocking of livestock violates the Tanzania Animal Welfare Regulations (URT, 2010). Unavailability of land on one hand and ignorance of the farmers on the other side may have contributed to the shocking high stocking densities that are seen in urban and peri urban areas of Tanzania.

Table 1: Average herd size (LSMeans), herd categories and the influence of cattle shed designs/types on herd size in Dar es Salaam city and Morogoro municipality

Variable (n=153)	Category	Study area		Total n (%)	*p* value
		Dar es Salaam n (%)	Morogoro n (%)		
Herd size		11.1±1.1	5.5 ± 0.5	7.9	0.001
Herd size category					0.0005
	1-10 cattle	49 (32.0)	76 (49.7)	125 (81.7)	
	11-20 cattle	13 (8.5)	5 (3.3)	18 (11.8)	
	21- 50 cattle	9 (5.9)	1 (0.65)	10 (6.5)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Stocking density					
	LSMeans (number/6.7m^2 standard space per cattle	1.27±0.09	1.48±0.09		0.9496
	<1cows/6.7m^2)	21 (13.7)	26 (17.0)	47 (30.7)	
	1 cows/6.7m^2)	11 (7.2)	13 (8.5)	24 (15.7)	
	>1cows/6.7m^2)	39 (25.5)	43 (28.1)	82 (53.6)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Influence of shed design on herd size					
	BBTR	0	4.1±2.4		0.0001
	CBTR	12.1±1.1	5.2±2.0		0.0041
	TOTR	7.7±1.2	5.0±0.8		0.0754
	TOO	32.0±4.7	13.6±2.7		0.0012

BBTR= Burnt Brick tin roofed, CBTR=Cement block tin roofed, TOTR=Timber off cuts tin roofed, ,TOO=Timber off cuts open, n-number of respondents

Cattle shed types/designs

Table 2 shows results on cattle shed types/designs**.** Four types/designs of cattle sheds namely: bricks tin roofed (BTR), cement blocks tin roofed (CBTR), timber/poles off cuts tin roofed (TOTR) and timber off cuts open (TOO) were found and differed significantly in the two study areas. Timber/poles off cuts tin roofed cattle sheds were the most numerous while timber off cuts open cattle sheds were few. Cement blocks tin roofed and timber off cuts tin roofed cattle sheds were the majority in Dar es Salaam city and Morogoro municipality, respectively.

The type/design of the cattle shed significantly influenced the size of the dairy cattle herd. Dairy farmers in Dar es Salaam city who had timber off cuts open (TOO) and cement blocks tin roofed (CBTR) types of cattle sheds had accommodated the first (32.0±4.7) and second (12.1±1.1) highest herd sizes, respectively.

Cubicles were not included in most cattle sheds and contravened the FAO (1998) guidelines on cattle shed design. Similar observations were reported from urban and peri urban smallholder dairy farms in Ethiopia (Mureda and Zeleke, 2008. As opposed to Cities/towns in Tanzania and Ethiopia, Nairobi City in Kenya had a large proportion (83.8%, n=8) of cattle sheds having cubicles (Aleri et al., 2012). The inclusion of cubicles in the cattle shed is very important since cows housed in such sheds are less likely to be dirty since the cubicles have guarding poles that restrict the animal from defecating in the sleeping/resting area (Barbari et al., 2006) and have minimal chances of contracting diseases and get body injuries (Aleri et al., 2012). On the other hand, improper design and

planning of cattle sheds was reported to be the cause of bad odour and air pollution (Cheruiyot et al., 2014). Poorly designed cattle sheds restrict the cattle from exhibiting its five (5) freedoms as stipulated in the Tanzania Animal Welfare Act (URT, 2008).

Different types and designs of cattle sheds were observed and there were no standardised design. However, according to the Tanzania Animal Welfare Regulations (URT, 2010), the Minister for Agriculture Livestock and Fisheries was required to prescribe the minimum standards for appropriate housing systems of animals. The respective Municipal Councils in Tanzania were supposed to approve such structures. The minimum and standard cattle sheds have never been established. Lack of guidelines for keeping livestock in urban and peri urban areas of Tanzania could possibly contribute to the existence of substandard cattle shed designs and contravened Tanzania Animal Welfare Act (URT, 2008).

Location of the dairy unit had a significant relationship with the type of cattle shed, in which Dar es Salaam city had the highest number of dairy farmers who had cement blocks and tin roofed cattle shed. This type of cattle shed is expensive to construct but it is durable and offers good security against livestock thieves, a practice that is so common in peri urban dairy units of Tanzania (Lupala, 2002; Gillah et al., 2012). Farmer's decision on the type of the cattle shed that he/she could construct depends on the economic ability and access to information on housing techniques. The results therefore, revealed that farmers in Dar es Salaam city and Morogoro municipality have different economic status (Lupala, 2002) and lack information on how to construct good cattle sheds (Angelo, et al., 2016).

Construction materials

The materials used for constructing floors and roofs of the cattle sheds were similar in the two study areas (Table 2). However, the materials used for constructing the shed walls were significantly different between the two study areas. Very few cattle sheds had earthen floor and almost all of them were covered by corrugated iron sheets. Timber off cuts and burnt bricks were the most and least, respectively preferred construction materials for the walls of the cattle. Timber/pole off cuts were the most popular constructing materials of the cattle sheds. The reason could possibly due to the fact that in Tanzania timber off cuts are comparatively cheaper, readily available and most dairy farmers may afford to purchase. However, this kind of shed type needs regular repair and are not durable especially when timbers are not treated. Dairy farmers would incur less cost to construct a shed using timber off cuts especially when the herd size is big. Only few dairy farmers afforded to have cement blocks tin roofed type of cattle sheds. High cost of purchasing the materials hindered most farmers from having such kind of cattle sheds. Nearly all the cattle sheds were covered by corrugated iron sheets, such a practice was common in urban and peri urban areas of East African cities (Schooman et al., 2011; Aleri et al., 2012). Earthen floor was rarely seen in the cattle sheds in the two study areas. Contrary to this, 69.7 percent; and 37.7% (n=49) of the cattle sheds had earthen floor in Ethiopia and Tanga Tanzania, respectively peri urban smallholder dairy units (Mureda and Zeleke, 2008; Schooman et al., 2011). Earthen floor is difficult to clean and this contributed to 92% (n=24) of the cattle sheds in Tanga municipality, Tanzania to be slightly dirty to very dirty (Schooman et al., 2011).

Table 2: Designs and materials used for constructing cattle sheds in Dar es Salaam city and Morogoro municipality

Factor		Study area, n (%)		Total	*p* value
		Dar es Salaam	Morogoro		
Shed type/design					0.0001
	CBTR	38 (24.8)	13 (8.5)	51(33.3)	
	BTR	1 (0.7)	6 (3.9)	7 (4.6)	
	TOTR	32 (20.9)	58 (37.9)	90 (58.8)	
	TOO	0 (0)	5 (3.3)	5 (3.3)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Presence of cubicles					0.0652
	Present	7 (4.6)	17 (11.1)	24 (15.7)	
	Not present	64 (41.8)	65 (42.5)	129 (84.3)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Building part	Building materials				
Floor					0.7581
	Concrete	61 (39.9)	67 (43.8)	128 (83.7)	
	Stones paved	9 (5.9)	13 (8.5)	22 (14.4)	
	Earthen	1 (0.6)	2 (1.3)	3 (1.9)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Wall					<.0001
	Cement blocks	39 (25.5)	14 (9.1)	53 (34.6)	
	Burnt bricks	1 (0.6)	6 (3.9)	7 (4.5)	
	Timber/poles off cuts	31 (20.3)	62 (40.6)	93 (60.9)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Roofing					0.2124
	Covered	69 (45.1)	76 (49.7)	145 (94.8)	
	Open	2 (1.3)	6 (3.9)	8 (5.2)	
	Total	71 (46.4)	82 (53.6)	153 (100)	

CBTR= cement block tin roofed, BTR=brick tin roofed, TOTR=Timber/poles off cuts tin roofed, TOO=Timber/poles off cuts open, n-number of respondents

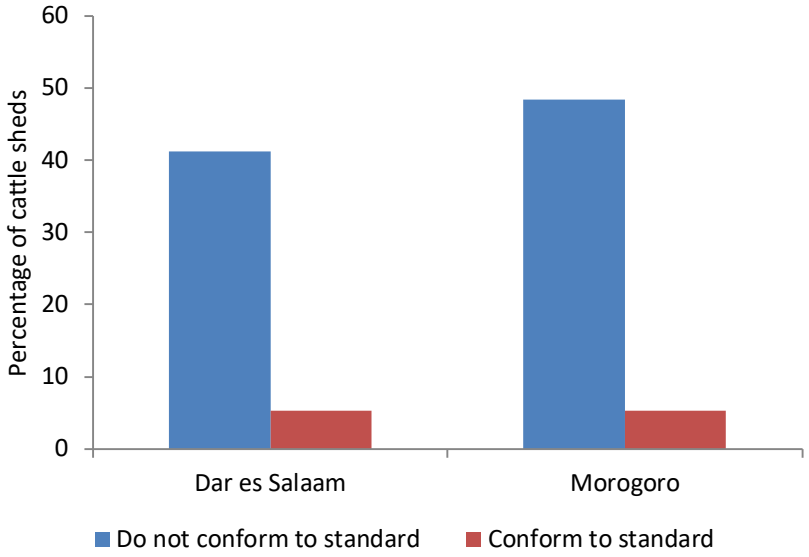

Figure 1: Percentage of cattle sheds that conformed and not conformed to standard cattle shed design in Dar es Salaam and Morogoro municipality

Manure disposal and hygienic condition of cattle sheds

More than three quarters of dairy farmers preferred to either pile up or spread manure directly on the farm plots/gardens close to their homesteads. However, there were some few dairy farmers who had no specific places to dispose of manure (Table 3). Location of the study area significantly influenced the way cow manure was disposed. A good number of cattle sheds were in good hygienic condition and there were no significant difference in hygienic condition between Dar es Salaam city and Morogoro municipality.

Heaping of manure for some time before being removed to other places was preferred by a good number of dairy farmers. The practice contradicts the Morogoro Municipal by-laws No. **6** that require compulsory and regular removal of manure, liquid waste material and other animal waste (The Morogoro Municipal Council by-laws, 1999). Heaping of manure and leaving it for sometimes before being disposed off made it to decompose and produce an unpleasant odour and create a good breeding ground for harmful bacteria (Foeken et al., 2004; Cheruiyot et al., 2014). Production of unpleasant odour from manure was a source of conflict between livestock and non-livestock residents in urban and peri urban areas of Dar es Salaam city Tanzania (Lupala, 2002) and Kampala city Uganda (Ishagi et al., 2002).

Dairy farmers in Dar es Salaam city and Morogoro municipality differed in the way cow manure was disposed. The reason could possibly due to differences in the levels of awareness on the potential damaging impact of livestock activities on the environment. According to Foeken et al. (2004), the degree of awareness on the environmental impact of manure was greater in high-income areas than in the low-income. Almost one fifth of the cattle sheds were in a poor hygienic condition. Differing to this study, Mekonnen et al. (2006) and Schooman et al. (2011) reported nearly half (48 percent) and more than two thirds (71.9%, n=75) of the cattle sheds in Addis Ababa, Ethiopia and Tanga

municipality Tanzania, respectively to have poor hygienic condition. Poor hygienic condition of cattle sheds was reported to be one of the main risk factors of contracting zoonotic diseases such as cryptosporidiosis (Kang'ethe, 2012) and contributed to the occurrence of mastitis in peri urban dairy units (Mekonnen et al.; 2006). Poor hygienic condition of the cattle sheds is a reflection that the Medical Officers in urban areas of Tanzania were not doing their work as stipulated in Local Government (Urban Authorities), by- laws No.7. (URT, 1992) Negative attitude of dairy farmers towards regular cleaning of cattle sheds (Aleri et al., 2012) and keeping animals in high stocking density (Lupala, 2002; Gillah et al., 2013) in most peri urban dairy units could possibly contribute to the poor hygienic conditions of some cattle sheds. Despite poor hygienic condition of the cattle sheds, they are not inspected by the Tanzania Food and Drug Authority (TFDA) and Municipal Medical Officers as suggested in section 106 (1) (b) of the TFDA Act (URT, 2003) and by-laws No. 7, respectively. Failure to carry out regular inspections of the cattle sheds has caused the culprits not to be reprimanded as pointed out in the by-laws No. 16 of the Morogoro Municipal Council by-laws (1999). Weak enforcement of the by-laws that regulate urban dairying was also reported in other East African Cities (Cheruiyot et al., 2014).

Table 3: Cattle shed stocking density and manure handling in Dar es Salaam city and Morogoro municipality

Parameters		Study area			
		Dar es Salaam n (%)	Morogoro n (%)	Total n (%)	*p* value
Manure disposal					0.0339
	Pilled close to the shed	33 (21.6)	28 (18.3)	61 (39.9)	
	Spread directly on farm	32 (20.9)	33 (21.6)	65 (42.5)	
	Dumped somewhere	6 (3.9)	20 (11.7)	26 (16.9)	
	Left on kraal for some time	0 (0)	1 (0.7)	1 (0.7)	
	Total	71 (46.4)	82 (53.6)	153 (100)	
Hygienic condition of cattle sheds					0.713
	Satisfactory	12 (7.7)	9 (6.1)	21 (13.8)	
	Good	67 (43.9)	65 (42.3)	132 (86.2)	
	Total	79 (51.6)	74 (48.4)	153 (100)	

n= n-number of respondents

Conclusion

The management of cattle sheds in urban and peri urban smallholder production systems of Tanzania was improperly executed and against various laws and regulations guiding dairy farming. The cattle shed designs had no cubicles that lead to low sanitation condition and exhibit various sub standards which are contrary to the Tanzania Animal Welfare Act (2008). Dairy sub sector in Tanzania is regulated by various regulatory authorities. Nevertheless, there is no clear division of responsibilities and coordination between the inspecting authorities, leading to duplication of activities and efforts in regulating the sector. It is therefore recommended that dairy farmers should be sensitized and trained on the importance of having good cattle sheds that conform to standards. On the other hand, the existing by-laws should be put into operation and the offenders charged accordingly.

Acknowledgments

The authors highly acknowledge the financial assistance given by the DANIDA Peri urban Livestock farming project. We are grateful to all participating dairy farmers and Livestock field officers in Dar es Salaam city (Kinondoni and Ilala) and Morogoro municipality.

References

Aleri, J .W., Nguhiu-Mwangi, J., Mogoa, E. M. and Mulei. C. M. (2012). Welfare of dairy cattle in the smallholder (zero-grazing) production systems in Nairobi and its environs. *Livestock Research for Rural Development.* Volume 24, Article #159. http://www.lrrd.org/lrrd24/9/aler24159.htm.

Angello, C.; Msuya, J. and Matovelo, D. (2016). Assessing the Information Needs and Information Sources of Urban and Peri-urban Livestock Keepers in Kinondoni and Morogoro Urban Districts, Tanzania. *Library Philosophy and Practice (e-journal).* Paper No. 1363. http://digitalcommons.unl.edu/libphilprac/1363

Barbari M., Ferrari, P. and Rossi, P. (2006). Hygienic conditions of milking cows in loose housing systems with different lying areas. *In: Proceedings of the World Congress CIGR, Enraging, VDI, FAO, Agricultural Engineering for a Better World, Bonn*, 03-07 September, pp 549-550.

FAO, (1998). *Farm structure in tropical climates*: A Textbook for structural engineering and design. Bengtsson, L.P. and Whitaker, J.H. (Editors). FAO/SIDA Cooperative Programme. Rural Structures in East and South-East Africa pp 167. http://www.fao.org/docrep/s1250e/S1250E00.htm#Contents.

Foeken, D., Sofer, M. and Mlozi, M. (2004). Urban agriculture in Tanzania: Issues of sustainability. African Studies Centre Research Report 75 / 2004 195 pp https://openaccess.leidenuniv.nl/bitstream/handle/1887/4678/ASC-1241504-003.pdf?sequence=1.

Fregonesi, J. A., Tucker, C. B. and Weary. D. M. (2007). Overstocking reduces lying time in dairy cows. *Journal of Dairy Science* 90:3349-3354.

Gillah, K .A., Kifaro, G .C. and Madsen, J. (2012). Productive and reproductive performance of dairy cattle kept in Urban and peri urban areas: *Livestock Research for Rural Development*. Volume 24, Article #198. http://www.lrrd.org/lrrd24/11/gill24198.htm..

Gillah, K .A., Kifaro, G .C. and Madsen, J. (2013). Management and production levels of cross-bred dairy cattle in Dar es Salaam and Morogoro urban and peri urban areas. *Livestock Research for Rural Development.* Volume 25, Article #165. http://www.lrrd.org/lrrd25/9/gill25165.htm.

Hill, C.T., Krawczel, P.D., Dann, H. M., Ballard, C.S., Hovey, R.C. and Grant, R. J. (2007). Effect of stocking density on the short-term behaviour of dairy cows. *Journal of Dairy Science* 90 (1):244. http://www.journalofdairyscience.org/article/S0022-0302(06)72472-9/fulltext.

Ishagi, N., Ossiya, S., Aliguma, L. and Aisu, C. (2002). *Urban and Peri-Urban Livestock Keeping Among the Poor in Kampla City*, Ibaren Konsultants, Kampala, Uganda, 48 pp. http://r4d.dfid.gov.uk/PDF/Outputs/ZC0201e.pdf (August 15, 2014).

Kang'ethe, E. (2012). *Urban Agriculture and Zoonoses in Nairobi Kenya ILRI*. Fact sheet http://www.ilri.org 4 pp.

Krawczel, P. (2013). Effects of cow comfort on milk quality, productivity and behaviour *America's Research based Learning Network* http://www.extension.org/pages/70107/effects-of-cow-comfort-on-milk-quality-productivity-and-behavior.

Lupala, A. (2002). Scoping study on urban and peri-urban livestock keepers in Dar es Salaam City. University College of Lands and Architectural Studies (UCLAS), Dar es Salaam, Tanzania 71 pp.

Mekonnen, H.M., Asmamaw, K., Courreau, J. F. (2006). Husbandry practices and health in smallholder dairy farms near Addis Ababa, Ethiopia, *Preventive Veterinary Medicine* 74: 99–107. http://www.elsevier.com/locate/prevetmed.

Cheruiyot, M. K., Kurgat, B.K., Moturi, W. N. and Kosgey, I.S. (2014). Environmental Effects of Urban Cattle Keeping in Nakuru Municipality, Kenya. *Journal of Natural Sciences Research* , Vol.4, No.18, 2014.

Mureda, E. and Zeleke, M. Z. (2008). Characteristics and constraints of crossbred dairy cattle production in lowland areas of Eastern Ethiopia. *Livestock Research for Rural Development.* Volume 20, Article #57. http://www.lrrd.org/lrrd20/4/mure20057.htm.

SAS (Statistical Analysis System) (2002). *User Installation Guide for the SAS system,* Version 9.1, SAS Institute Inc., Cary, North Carolina, USA 221 pp.

Schooman, L., Swai, E .S. and Daborn, C. J. (2011). Differences in socio-economic demography, herd parameters and hygienic management practices amongst livestock keepers in two contrasting production systems of Tanga region, Tanzania. *Livestock Research for Rural Development.* Volume 23, Article #237. www.lrrd.org/lrrd23/11/scho23237.htm

Shirima, E.J.M. and Msanga, Y.N. (2004). The state of livestock welfare in Tanzania: An overview. *In*: *Proceedings of the 31st Scientific Conference of TSAP* held at Kilimanjaro Crane Hotel Moshi 5th–7th 2004, 31:137-146.

Tegegne, A., Tadesse, M., Yami, A., and Mekasha, Y. (2000). *Market-oriented urban and peri-urban dairy systems*, Urban Agriculture Magazine, 1 (2), 23-24. https://cgspace.cgiar.org/handle/10568/29817.

The Morogoro Municipal Council (1999) .Animals in Urban Area by-laws. *Morogoro by laws on urban livestock keeping*, 2 pp.

UN-Habitat (2009). *Tanzania: Morogoro profile United Nations Human Settlements Programme* Regional and technical cooperation division 32 pp. unhabitat.org/books/tanzania-morogoro-urban-profile/tanzania-morogoro-urban-profile/

URT (United Republic of Tanzania) (1992). *The Town and Country Planning (Urban Farming) Regulations*, 1992,p 9-10 http://faolex.fao.org/cgi-bin/faolex.exe.rec_id=005242.

URT (United Republic of Tanzania) (1995). *The National Land Policy, 1995*, http:/www.tanzania.go.tz

URT (United Republic of Tanzania), (1997).*Agricultural and Livestock Policy, 1997*, pp 62 http:/www.tanzania.go.tz

URT (United Republic of Tanzania) (2000). *National Human Settlements Development Policy, 2000*, http:/www.tanzania.go.tz

URT (United Republic of Tanzania) (2003). *The Tanzania Food, Drug Authority Act. No. 1 of 2003*. Printed by the Government Printer, Dar es Salaam –Tanzania 90 pp.
URT (United Republic of Tanzania) (2007). *Morogoro regional socio economic profile*, 122 pp. http://www.tzonline.org/pdf/Morogoro.pdf.

URT (United Republic of Tanzania) (2008). *The Animal Welfare Act. No. 19 of 2008* Ministry of Livestock Development 26 pp http://www.mifugo.go.tz.

Wenban-Smith, H. (2014). Population growth, internal migration and Urbanisation in Tanzania, 1967-2012: A census based regional analysis, Working paper www.theigc.org/newsletter

Yayeh, Z, Hailemariam M., Belhu K. and Asmare B. (2014). Characterization of dairy cattle production systems in Debremarkos district, Amhara Regional State, Ethiopia. *Pacesetter Journal of Agricultural Science Research* Vol. 2 (4), pp. 42-51. http://www.pacesetteronlinepublishers.org/pjar

Has been ACCEPTED with Journal of Natural Sciences Research, ISSN (Paper)2224-

3186 ISSN (Online)2225-0921.

Paper IV

Paper V

Effects of pre partum supplementation on milk yield, reproduction and milk quality of crossbred dairy cows raised in a peri urban farm of Morogoro municipality Tanzania

K A Gillah, G C Kifaro* and J Madsen**

Ministry of Livestock Development and Fisheries P.O. Box 9152, Dar es Salaam Tanzania
kagillah@yahoo.com
* Department of Animal Science and Production, Sokoine University of Agriculture, P.O. Box 3004, Morogoro Tanzania
** Department of Large Ruminants, University of Copenhagen, Denmark

Livestock Research for Rural Development 26 (1) 2014 | Guide for preparation of papers | LRRD Newsletter | Citation of this paper

Abstract
An experiment was carried out to evaluate the effects of pre and post-partum concentrate supplementation on milk yield, milk composition and reproductive performance of crossbred dairy cows. Forty eight cows were involved in the study, and were divided into three groups according to concentrate supplementation. The first treatment (HMR-PPP) was fed 4 kg/day home-made ration during pre-and post-partum period. Treatment HMR-PP and MB-PP were fed 4 kg/day home-made ration and maize bran, respectively during the first 24 weeks of lactation. Pasture samples were collected from the grazing area for chemical and digestibility tests. A total of 288 milk samples were collected at monthly intervals and analysed for butter fat, solids not fat and total solid. Days from calving to first insemination (CFSI), calving to conception interval (CCI), number of services per conception (NSC) and calving interval (CI) were calculated based on farm records. General Linear Models were used to analyse the data. The overall crude protein (CP), *in vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD0 percentages of the pasture were 5.7±0.30, 41.9±0.22 and 44.4±0.27, respectively and varied between seasons. The overall mean milk yield was 6.5±0.10 litres/day. Cows supplemented with home-made ration during pre and post-partum had the highest (p<0.05) milk yield followed by post-partum supplemented cows with home-made ration. The overall mean CFSI, CCI, NSC and CI were 96.1±0.02 days,. 129.8±6.92 days, 1.74 ±0.01and 410.2±0.00 days, respectively. Concentrate supplementation before calving increased milk yield but did not affect milk composition and reproductive performance of lactating cows.

Key words: *concentrate supplementation, milk quality, peri urban*

Introduction

In Tanzania dairying is one of the fast growing enterprises in the livestock sector (URT 2006) and is expanding rapidly around urban and peri urban centres. People from different socio-economic and cultural groups are involved in urban and peri urban dairy farming as it provides regular income and food (Kassa 2003) and employment opportunities (Mlozi 2005).

The urban population in Tanzania is increasing fast and the proportion of people living in urban areas in 2012 was 27 percent (URT 2013). The increase in population creates demand for milk and milk products (Kurwijila 2001). Despite the high demand, good marketing opportunities and high price for milk and milk products, milk yield from crossbred dairy cows is low (Mlozi 2005, Gillah et al 2012). Various factors contribute to the low performance of the dairy cattle in urban and peri urban areas of Tanzania. Among the management factors, poor quality feeds and feeding are the most important limiting factors to dairy cattle production (Urassa et al 1999, Mlay et al 2001). Dairy farmers in urban and peri urban areas depend mostly on natural pasture which has low crude protein and digestibility and cannot meet the minimum requirements for maintenance and milk production (Kavana and Msangi 2005, Mlay et al 2005). Therefore, for dairy cattle dependent on natural pastures, supplementary feeding with additional protein sources is essential especially during the dry season. Supplementary concentrates like cereal brans and oil seed cakes are easily available in urban and peri urban areas of Tanzania (Mlay et al 2005). These can be used to alleviate the problem of inadequate nutrition and boost the productivity of dairy cattle.

Some attempts have been made in Tanzania to improve milk production and reproduction performance of dairy cows and some authors came up with different findings. For example, Msangi et al (2004) concluded by saying that short-term increases in post-partum supplementation were unlikely to be an attractive means of reducing calving intervals, while Urassa et al (1999) and Mlay et al (2005) had shown non-significant effect of post-partum concentrate supplementation on reproduction but caused considerable improvement in milk yield.

Proper nutrition in the late stage of pregnancy is very crucial since nutrient demands for foetal growth, body reserve replenishment and initiation of milk synthesis are increased. However, improvement of the late pregnancy feeding is seldom practiced in most production systems in tropical Africa (Sidibé-Anago 2008, Gillah et al 2013). For instance, a study carried out by Mellau et al (2009) in peri urban dairy units of Dar es Salaam reported few (22.9 percent) dairy farmers who dried off their cows at the recommended 60 days but none supplemented dry cows with concentrates in the late stage of pregnancy. Furthermore, dairy farmers hardly use plant protein sources (oil seed cakes) and energy concentrates at the recommended levels (Mlay et al 2005, Gillah et al 2012) because of fearing high prices (Urassa et al 1999). Information on farm feed supplementation during the late stage of pregnancy on milk yield, milk chemical composition, reproduction performance and its cost implication is scarce in Tanzania. Therefore, the present study was conducted to evaluate the effect of feeding a formulated concentrate to crossbred dairy cows during the late stage of pregnancy on milk production, reproduction and milk quality.

Materials and methods

Location of the study and herd management

The study was conducted at Kingolwira dairy farm located 20 km east of Morogoro municipality. The dairy farm is one of the medium scale units raising crossbred dairy cows between Zebu and Friesian and Ayrshire. The area receives bimodal rainfall: March –May (wet), July-Oct (dry) and November –February (wet). Artificial insemination service was mostly used for mating and to a lesser extent breeding bulls. Animals were grazed on 5500 ha grazing land of natural pasture and supplemented with hay or maize stovers especially during the dry season. Lactating cows were hand milked twice a day and were given maize bran 4 kg per day during milking time. Farm records were kept and the majority of pregnant cows were dried at two months before calving but were never steamed up.

Experimental animals and treatments

Dairy cows were pregnancy tested and forty eight pregnant crossbred (*Bos taurus x Bos indicus*) cows with seven months of pregnancy were used in the study. The cows were equally divided into three treatments and randomly allocated after being balanced for parity and breed. The first treatment (Home Made ration-Pre-Partum Period, HMR-PPP) was fed 4.0 kg of home-made ration (HMR) per cow per day for an average of 56 days pre partum and the same amount during 24 weeks postpartum. The second group of cows (Home Made Ration - Post Partum, HMR-PP) was given 4 kg/day HMR after calving (postpartum) for 24 weeks. The home-made ration was composed of maize bran (72.5%), sunflower seed cake (14.5%), cotton seed cake (12.0%), bone meal (0.5%), lime (0.5%) and supplied 150g/kg CP. The third group (Maize Bran - Post Partum, MB-PP) was a control group fed 4 kg/day of maize bran for 24 weeks postpartum which supplied 91.9g/kg CP. The control group simulated the farm's concentrate feeding practice. During pre-partum period, cows in HMR-PPP were given HMR individually, once per day, during the morning before grazing. All experimental cows were identified for ease of record keeping. Apart from supplementation, the experimental animals received similar management practices as the rest of the cows.

Sample collection, laboratory analysis and derived reproductive performance

Monthly representative pasture samples were collected from the grazing area for chemical and digestibility tests. Milk yield was recorded (litres/cow) in milk record book every day. A total of 288 milk samples (200 ml each) were collected in bottles on monthly intervals for 24 week period, kept in the cool box and thereafter deep frozen in the laboratory at the Animal Science Department of Sokoine University of Agriculture (SUA). Milk samples were analysed for butter fat (BF), solids not fat SNF) and total solids (TS) contents. Milk butterfat percent was determined by Gerber method and Total solids were calculated by using a standard formula (TS =CLR/4+ (1.22 x BF %) + 0.72), (O'Mahony 1988) whereby CLR is the corrected lactometer reading and BF is the butter fat content. The SNF content was estimated by subtracting BF from TS percentages. Pasture and concentrate feed samples were analysed for dry matter, crude protein, *in vitro*

dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD). *In vitro* digestibility was conducted according to Tilley and Terry (1963). Days from calving to first insemination/service (CFSI), calving to conception interval (CCI), number of services per conception (NSC) and calving interval (CI) were calculated based on records kept by the farm.

Cost of concentrate supplementation

The cost and income as a result of concentrate supplementation of using either maize bran alone or home-made formulated ration were analysed. No attempt was made to estimate the overall profitability of the dairy enterprises.

Data analysis

Data on milk yield, reproductive parameters and milk qualities as a result of pre-and postpartum supplementations of dairy cows were analysed by General Linear Models procedure (SAS 2002). The dependent variables were weekly average milk production for 24 weeks, reproductive parameters (CFSI, CCI, NSC and CI) and milk qualities (BF, SNF, TS) while the fixed variables were breed, parity and supplementation levels (treatments). The initial milk yield during the first week of lactation was used as a covariate. The cost of the supplementary feeds consumed by the cows throughout the feeding trial was computed in order to quantify the net income of the feeding interventions.

Results

Chemical composition and digestibility of the pasture

Table 1 shows the results on chemical composition and *in vitro* dry matter digestibility of the grazing pasture. The overall crude protein content and digestibility of the pasture were low and varied significantly between wet and dry seasons. Monthly variations in crude protein, *in vitro* dry matter digestibility and in *vitro* organic matter digestibility were observed, where by the highest and minimum percentages were found in March and June, respectively (Figure 1).

Table 1: Chemical composition and in *vitro* digestibility of the pasture

Parameter	n	LSMean (mean ± SE)		*p*
		Wet season	Dry season	
DM	8	43.2± 3.33	73.7±4.30	0.0014
CP	8	6.7 ± 0.27	4.1± 0.35	0.0009
INVIDMD	8	46.3 ±1.42	34.5± 1.84	0.0002
INVIOMD	8	49.4 ± 1.77	35.9 ± 2.28	0.0035

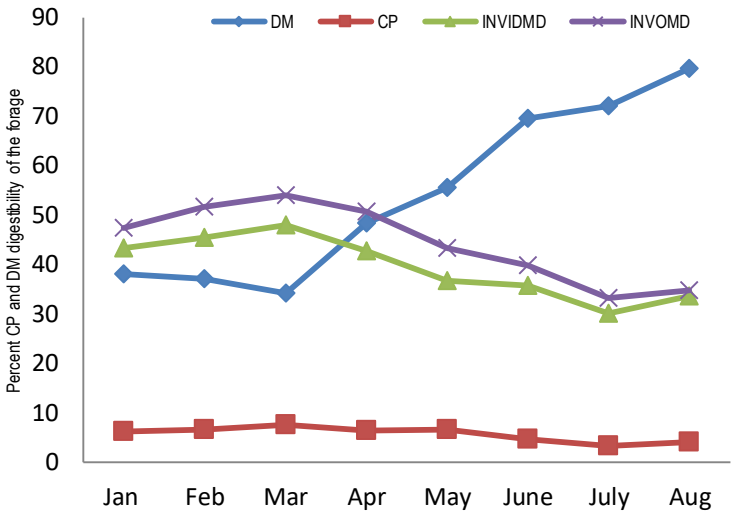

Figure 1: Seasonal variations in chemical composition and digestibility of the grazing pasture in 2012

Average daily milk yield

Results on the effects of concentrate supplementation, breed and parity on daily milk yields are presented in Table 2. Pre-partum supplementation significantly (p<0.05) increased milk yields by 2.3 kg/day as compared to those which received home-made ration during post-partum period and by 4.0 kg/day compared to the control group.

Breed of cows had no effect on milk yield but there was a tendency for the Friesian crossbreeds to consistently produce more daily milk yield over the entire experimental period and displayed a slightly better lactation curve than Ayrshire crossbred (Figure 2). Cows in the third parity produced more (p<0.05) daily milk yield while cows in second parity produced similar daily milk yield as those in parity four and five.

Table 2:Mean daily milk yield (litres) (LSMean ± SE) of crossbred dairy cows fed varying levels of concentrate supplement for 24 weeks

Category	N	LSMean
Supplementation		
HMR-PPP	384	8.5[a]
HMR-PP	384	6.2[b]
MB-PP	384	4.5[c]
SEM		0.33
p value		<0.0001
Breed		
Ayrshire crosses	600	6.2
Friesian crosses	552	6.6
SEM		0.27
p value		0.2425
Parity		
2	288	6.1[a]
3	336	7.7[b]
4	288	6.3[a]
5	240	5.4[a]
SEM		0.37
p value		0.0014

n =number of observations HMR-PPP=Home-made ration pre and post-partum, HMR-PP= Home-made ration postpartum, MB-PP=Maize bran postpartum, SEM=Standard Error of Means, [abc]Means without common superscripts within the same category are different at P<0.05

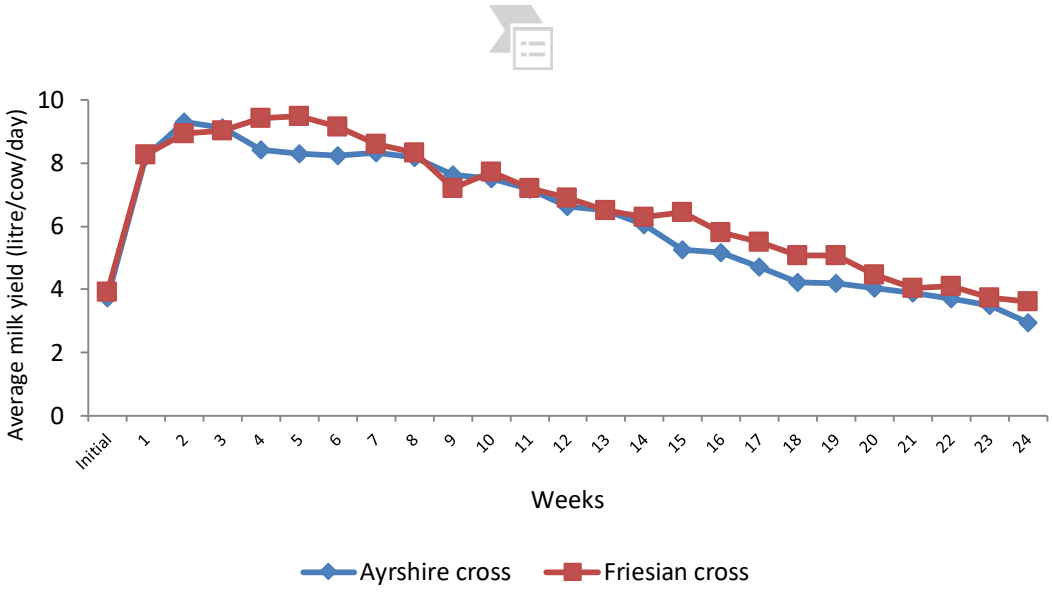

Figure 2: Mean weekly milk yield of Friesian and Ayrshire crossbred dairy cows for 24 weeks

Milk composition

Supplementation with home-made ration during pre-partum (T1) or post-partum (T2) had similar but higher total solids (TS) than post-partum supplementation with maize bran (T3). There were no significant differences in butter fat and total solids not-fat contents between treatments (Table 3).

Ayrshire crossbred cows had higher butter fat (p=0.013) and total solids contents (p=0.045) than Friesian crossbred cows. Effect of parity was significant (p=0.044) on total solids but had no effect on butter fat and solids non-fat. Total solids decreased from parity 1 up to parity 4 and then increased in parity 5. Butter fat and solids not-fat contents were similar in the different parities.

Table 3: LS means of milk composition (% of whole milk) for different forms of feed supplementation, breeds and parity

Sources	N	BF	TS	SNF
Supplementation				
HMR-PPP	96	3.8	12.2[a]	8.4
HMR-PP	96	3.9	12.1[a]	8.2
MB-PP	96	3.7	11.8[b]	8.1
SEM		0.09	0.12	0.05
p value		0.32	0.041	0.29
Breed				
Ayrshire cross	138	4.0	12.2	8.2
Friesian cross	150	3.7	11.9	8.1
SEM		0.08	0.10	0.04
p value		0.013	0.045	0.27
Parity				
2	72	4.0	12.2[a]	8.2
3	84	3.8	11.8[b]	8.1
4	72	3.6	11.8[b]	8.1
5	60	3.9	12.2[a]	8.2
SEM		0.12	0.14	0.06
p value		0.1348	0.044	0.57

n=number of observations, BF=butter fat, TS= total solids, SNF=solids not-fat

[ab]Means without common superscripts within the same category are different at P<0.05, SEM=Standard Error of Means, HMR-PPP=Home-made ration pre and post-partum, HMR-PP= Home-made ration postpartum, MB-PP=Maize bran postpartum

Reproductive performance

Results shown in Table 4 indicate that reproduction parameters of crossbred cows were not influenced by concentrate supplementation and breeds. However, cows in T2 had a relatively better reproductive performance (except for CI) than cows in T1and T3.

Table 4: Reproductive criteria in lactating crossbred dairy cows fed different levels of concentrates

Effects		CFSI (days)	CCI (days)	NSC (days)	CI (days)
Treatment					
	HMR-PPP	94.3	132	1.85	413.
	HMR-PP	93.7	126±	1.62	409
	MB-PP	99.5	131	1.72	408
	SEM		12.85	0.17	12.70
	p value	0.79	0.95	0.64	0.95
Breeds					
	Ayrshire	93.2	127.9	1.78	409
	Friesian	98.5	131.6	1.68	412
	SEM	5.3	10.49	0.14	10.30
	p value	0.48	0.80	0.63	0.83

n=number of observations, p=probability level, CFSI= calving to first service interval, CCI=calving to conception interval, NSC=number of services per conception, CI=calving interval, SEM=Standard Error of Means, HMR-PPP=Home-made ration pre and post-partum, HMR-PP= Home-made ration postpartum, MB-PP=Maize bran postpartum

Supplementary feed cost

The cost of home-made formulated ration and maize bran was estimated to be 295.25 and 170.00Tsh/kg, respectively. The additional cost to the farmers for feeding 4 kg of either home-made ration or maize bran per cow per day was calculated to be 1,181.00 and 680.00Tsh, respectively (Table 5).

Table 5: Cost of individual ingredients and overall cost of preparing 100 kg (as fed basis) of home-made ration and maize bran supplements

Ingredients	Price/kg	Amount, kg		Cost of ingredients	
		HMR	MB	HMR	MB
Maize bran	170	72.5	100	12,325	17000
Sunflower seed cake	500	14.5	0	7,250	0
Cotton seed cake	800	12.0	0	600	0
Bone meal	300	0.5	0	150	0
Lime	400	0.5	0	200	0
Total		100	100	29,525	17,000
Cost/kg, Tsh				295	170
Cost/cow/day, Tsh				1,181	680

HMR=Home-made ration, MB=maize bran, USD 1=1,600 Tsh

Table 6 shows the estimated income from milk sales from cows in the three treatment groups. The net income as a result of pre partum home-made ration supplementation of cows in T1 relative to control group (951,497.23 - 506,446.00 = 445,051.23 Tsh) was higher than post-partum supplementation relative to control group (667,945.02 - 506,446.00= 161,499.02 Tsh).

Table 6: Mean values of milk yield (litres), feed costs and income of different treatments for 24 weeks of lactation

	n	Milk yield	Cost of feed (Tsh)			Income (Tsh)	Income-Feed (Tsh)
			Pre-partum	Post-partum	Total		
HMR-PPP	16	1506	67,002.07	198,408	265,410	1,216,907	951,497
HMR-PP	16	1080	0	198,408	198, 408	866,353	667,945
MB-PP	16	759	0	114,240	114,240	620,686	506,446

n =number of observations, USD 1.00=1,600 Tsh, HMR-PPP=Home-made ration pre and post-partum, HMR-PP= Home-made ration postpartum, MB-PP=Maize bran postpartum

Discussion

The overall crude protein content of the grazing natural pasture was lower than the minimum of 7% CP required for maintenance and milk production. This also, tends to lower feed intake. On overall, the digestibility of the pasture was poor as it has digestible organic matter less than 55% (Meissner et al 2000). The lower digestibility of the natural pasture was due to increasing proportion of stem in respect to the leaves as the plants mature. The implication of the results is that concentrate supplementation of lactating dairy cows that rely on natural pasture as basal diet is necessary for realization of optimum milk yields. The current results on CP, IVDMD and IVOMD were similar to 6.5, 43.0 and 44.1 percent, respectively reported in Tanga peri urban areas of Tanzania (Kavana et al 2007). The similarities could possibly be due to the fact that the two sites are located in the same agro ecological zone. However, the result on pasture CP content was higher than 5.4% CP reported in Dodoma municipal Tanzania communal grazing land (Njau et al 2013).

The overall mean daily milk yield of 6.5±0.10 litres/day obtained from this study was comparable to 6.54 ± 0.15 litres/day reported for crossbred cows in large scale dairy farm at Debre Zeit dairy herd Ethiopia (Tadesse and Dessie 2003). But, the overall mean milk yield was lower and higher than 8.45±1.23 litres/day (Duguma et al 2011) and 5.7±2.21 litres/day (Lyimo et al 2004), reported in Jimma town Ethiopia and Tanga municipality in Tanzania, respectively. Lactating dairy cows which received home-made concentrate supplementation during pre-and post-partum periods produced more milk yield than those which were fed during lactation period. This is a reflection that dairy cows had accumulated enough body reserves to mobilize for synthesis of milk (Soto et al 2001). The finding is in agreement with Sidibé-Anago (2008). However, according to Keady et al (2001) concentrates supplementation in the late stage of gestation did not alter milk yield. The fact that supplementation with home-made ration during pre or post-partum increased milk yield than supplementation with maize bran alone means that the former had caused higher ammonia levels in the rumen that was available to rumen microbes which in turn were digested in the small intestines for milk production.

Dairy breed had no effect on milk yield, although Friesian crossbred produced consistently more daily milk yield than Ayrshire crosses. Lack of significant difference in milk yield between the two crossbreds could possibly be caused by having similar blood levels (Mlay et al 2001). The dairy farm had no controlled breeding programme as it used both artificial insemination and bulls. Availability and supply semen of a particular breed

is erratic and hence the inseminator might be tempted to use whatever type of semen available to inseminate any cow regardless of its breed. This non-significant effect of breed on milk yield was also reported in Korogwe, Tanga and Kibaha peri urban dairy farms in Tanzania (Bee et al 2006). Contrary to this observation, Tadesse and Dessie (2003) reported breed differences in daily milk yield in which crossbred Friesian x Barca had higher (7.15±0.28 litres/day) milk yield than 6.92 ±0.25 litres/day observed in Friesian x Boran. The significant effect of parity on milk yield observed could partly be due to increase in body size, which results in larger mass of digestive system and mammary glands for synthesis of milk (Bath et al 1985). The result is supported by earlier findings by Tadesse and Dessie (2003) and Tadesse et al (2007) who conducted studies in large scale urban and peri urban dairy farms in Addis Ababa.

The non-significant effect of supplementation on SNF agrees with Mushtaq and Qureshi (2009) who stated that the quality of the ration changes the SNF content of milk to a lesser extent. The fact that milk composition (butter fat and solids not-fat) did not vary with the current levels of concentrate supplementation is supported by Sidibé-Anago (2008). The current result on non-significant effect of supplementation on butter fat content differed to Keady et al (2001) who defended their results by stating that the higher milk fat concentration in cows fed concentrate in late stage of gestation was probably due to greater fat mobilization, as they had a higher condition score. Furthermore, the variations in butter fat content could be attributed to the fact Keady et al (2001) fed their dairy cows higher levels of crude protein of 174g/kg and 218g/kg during pre-and post-partum periods, respectively compared to 150 g/kg CP used in this study. The significant differences in BF and TS contents with breed confirmed the finding that Ayrshire breed produces more concentrated milk than Friesian (O'Mahony 1988). Effect of parity was not significant on butter fat and solids not-fat with exception of total solids (p=0.0437). In the same way, Gurmessa and Melaku (2012) and Mushtaq and Qureshi (2009) did not observe the effect of parity on various milk constituents.

Pre partum supplementation and breed of dairy cows had no effect on reproductive traits studied. The non-significant effect of breed on reproductive traits is supported by Ahmed (2006) and Hassan and Khan (2013). On the other hand, Keady et al (2001), Soto et al (2001), Msangi et al (2004) supported the findings that pre partum supplementation had no effect on reproductive performance of cows.

The overall mean calving to first service interval of 96.1±0.02 obtained in this study was slightly higher than the ideal interval of 85.6±5.6 days and 87±8.6 days for crossbred dairy cows reported in Asella Ethiopia peri urban dairy farms (Dinka et al 2012) and Tanga Tanzania peri urban dairy units (Lyimo et al 2004), respectively. Nonetheless, the current interval was shorter than the range of 115 - 170 days reported earlier for crossbred dairy cows in Ethiopia (Tadesse et al 2007) and Tanzania (Mwatawala and Kifaro 2009). The relatively lower calving to first service interval in the present study could be attributed to the smaller negative energy balance (Butler and Smith 1989).

The overall mean calving to conception interval of 129.8±6.9 days is similar to 120 and 123±11 days reported for crossbred dairy cows in Ethiopia (Yifat et al 2009) and Tanga Tanzania (Lyimo et al 2004), respectively. Nevertheless, the interval was shorter than the range of 148±1.72 - 218.5 days reported from various dairy units in East African

countries (Tadesse et al 2007, Mwatawala and Kifaro 2009, Lemma and Kebede 2011, Nuraddis et al 2011). The relatively lower calving to conception interval in this study could partly be attributed to fair management and feeding of the lactating dairy cows.

The overall mean number of services per conception of 1.7 is within the range of 1.6 to 2.6 services per conception reported for crossbred dairy cows kept in urban and peri urban areas of East African cities (Gillah et al 2012). The number of services per conception depends in most cases on the breeding system used (Mwatawala and Kifaro 2009, Lemma and Kebede 2011) and a mean higher than 2 should be considered as poor (Dinka 2012). Taking into consideration the value of 2 services per conception as a bench mark, the results in the present study suggests relatively good insemination services of the herd during the period of study. Nevertheless, Nuraddis et al (2011) reported a value of 1.29 services per conception, less than the minimum value of 1.3 numbers of services per conception (Rahman et al 1998) for crossbred cows in peri urban areas of Gondar town in Ethiopia.

The overall mean calving interval of 410.2±0.01 days is lower than 433 – 562 days reported for crossbred dairy cows kept in various dairy units in urban and peri urban areas of East African cities (Gillah et al 2012). Likewise, the value is within 365-420 days required for dairy cows to calve down regularly. The relatively short calving interval could be attributed to fairly better management practices especially during the study period.

The net income obtained as a result of pre-partum home-made ration supplementation was higher than post-partum supplementation with either home-made ration or maize bran. However, the impact of feeding extra days on net income is felt more when the cost of protein sources (seed cakes) is relatively higher. Similarly, some studies reported post-partum supplementation with home-made ration to be cost effective (Mlay et al 2005). Nevertheless, Mlay et al (2005) gave caution that in case the cost of protein sources is a limiting factor then careful consideration should be done to minimize feed cost at the same time maintaining nutrient and feed intake levels that will support an optimum level of production.

Conclusion

Feed supplementation with maize bran after calving is common, but the present experiment shows that milk production can be increased and that it is economical to substitute or supplement the maize bran with better concentrate. This of course depends on the prevailing prices. The change in supplementation regime had no effect on reproduction or the composition of the milk. Supplementation of a smaller amount of concentrate distributed both pre- and post-partum increased milk production significantly more than supplementing all the concentrate post-partum. In most situations the prices of concentrate is low compared to the price on milk and supplementation can be advised. When the prices are high it is recommended to distribute the allocation both pre-and post-partum.

Acknowledgement

We thank the Danish International Development Agency (DANIDA) for funding this study, and the Department of Animal Science and Production of the Sokoine University of Agriculture (SUA) Morogoro for analyzing feed and milk samples. The cooperation rendered to us by Kingolwira dairy farm management team particularly, Mr. Leonard Marandu (Farm manager) and Mr. Nicostratus Magori (Assistant farm manager) is highly appreciated. We also acknowledge the technical support provided by Mr. Yahaya Watuta, Mr. Dominic Alute and A. Haji of the Department of Animal Science and Production laboratory, SUA Morogoro.

References

Ahmed T U 2006 Studies on nutritional status of dairy cows of Bangladesh and improvement of their productive and reproductive performance in Baghabarighat area through nutritional manipulation. PhD Thesis, Department of Animal Nutrition, Faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh.

Ali T, Lemma A and Yilma T 2013 Reproductive performance of dairy cows under artificial insemination in south and northwest part of Ethiopia. *Livestock Research for Rural Development. Volume 25, Article #191.* http://www.lrrd.org/lrrd25/11/ali25191.htm

AOAC (Association of Official Analytical Chemists) 1995 *Official Methods of Analysis*, 16th edition, Washington DC 62 pp.

Bath D L, Dickinson F N, Tucker H A and Appleman R D 1985 *Dairy Cattle: Principle, Practices, Problems, Profits*. 3rd ed. Lea and Febiger, Washington Square, Philadelphia.

Bee J K A, Msanga Y N and Kavana P Y 2006 Lactation yield of crossbred dairy cattle under farmer management in Eastern coast of Tanzania. *Livestock Research for Rural Development* 18 (2) 2006 http://www.lrrd.org/lrrd18/2/bee18023.htm.

Butler W R and Smith R D 1989 Interrelationship between energy balance and postpartum reproductive function in dairy cattle. *Journal of Dairy Science* 72: 767-783, http://jds.fass.org/cgi/reprint/72/3/767.

Dinka H 2012 Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia International *Journal of Livestock Production* 3 (3): pp. 25-28, http://www.academicjournals.org/IJLP.

Duguma B, Kechero Y and Janssens G P J 2011 Analysis of constraints facing urban dairy farmers and gender responsibility in animal management in Jimma Town Jimma, *Ethiopia. Libyan Agriculture Research Centre Journal International* 2 (4): 155-160.

Gillah K A, Kifaro G C and Madsen J 2012 Urban and peri urban dairy farming in East Africa: A review on production levels, constraints and opportunities. *Livestock Research for Rural Development.* Volume 24, Article #198. http://www.lrrd.org/lrrd24/11/gill24198.htm.

Gillah K A, Kifaro G C and Madsen J 2013 Management and production levels of cross-bred dairy cattle in Dar es Salaam and Morogoro urban and peri urban areas. *Livestock Research for Rural Development Volume 25, Article #165.* http://www.lrrd.org/lrrd25/9/gill25165.html.

Gurmessa J and Melaku A 2012 Effect of lactation stage, pregnancy, parity and Age on yield and major components of raw milk in crossbred Holstein Friesian cows, *World Journal of Dairy and Food Sciences* 7 (2):146-149.

Hassan F and Khan M S 2013 Performance of crossbred dairy cattle at military dairy farms in Pakistan, *The Journal of Animal and Plant Sciences* 23 (3):705-714.

Kassa T M 2003 A study on urban agriculture: the case of small-scale urban dairy farming in selected areas of Addis Ababa, A Thesis presented to the School of Graduate Studies of the Addis Ababa University in Partial Fulfilment of the Requirements for the Degree of Master of Arts in Geography 166 pp.

Kavana P Y and Msangi B S J 2005 On farm dairy cattle feeding experience in eastern zone of Tanzania. *Livestock Research for Rural Development* 17 (6) http://www.lrrd.org/lrrd17/6/kava17062.htm.

Kavana P Y, Kizima J B, Msanga Y N, Kilongozi N B, Msangi B S J, Kadeng'uka L A, Mngulu S and Shimba P K 2007 Potential of pasture and forage for ruminant production in Eastern zone of Tanzania. *Livestock Research for Rural Development Volume 17, Article #144*, http://www.lrrd.org/lrrd17/12/kava17144.htm.

Keady T W J, Mayne C S, Fitzpatrick D A and McCoy M A 2001 Effect of concentrate feed level in late gestation on subsequent milk yield, milk composition, and fertility of dairy cows. *Journal of Dairy Science* 84: 1468-1479.

Kurwijila L R 2001 An overview of dairy development in Tanzania In: Rangnekar D. and Thorpe W. (eds). 2002. Smallholder dairy production and marketing, Opportunities and constraints. *In:* Proceedings of a South-South workshop held at NDDB, Anand, India, 13-16 March 2001. NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya. 538 pp.

Lemma A and Kebede S 2011 The effect of mating system and herd size on reproductive performance of dairy cows in market oriented urban dairy farms in and around Addis Ababa *Revue Méd. Vét*. 162 (11): 526-530.

Lyimo C, Nkya R, Schoolman,L and Van Eerdenbutg F J 2004 Post-partum reproductive performance of crossbred dairy cattle on smallholder farms in sub humid coastal Tanzania. *Tropical Animal Health and Production* 36: 269-279.

O'Mahony F 1988 *Rural Dairy Technology; Experiences in Ethiopia*, ILCA Manual No. 4, International Livestock Centre for Africa, Addis Ababa 64 pp.

Meissner H H, Zacharias P J K and O'Reagain P J 2000 *Forage quality* (Feed Value). In (Editor:Neil Tainton) Pasture Management in South Africa. University of Natal Press, pp 66 - 88.

Mellau L S B; Sarimbo A P; Kimera S I and Phiri E C J 2009 Recumbence syndrome in cattle: A study of risk factors of milk fever in dairy units in Dar es Salaam *Tanzania Veterinary Journal* 26 (2):56.

Mlay P S, Madsen J, Pereka A E, Hvelplund T and Weisberg M R 2001 Smallholder livestock production trends in urban and peri urban areas of Morogoro. *Tanzania Veterinary Journal* Volume 21(1) 15-26.

Mlay P S; Pereka A E; Balthazary S T, Phiri E C J; Hvelplund T, Weisbjerg M R and Madsen J 2005 The effect of maize bran or maize bran mixed with sunflower cake on the performance of smallholder dairy cows in urban and peri-urban area in Morogoro, Tanzania. *Livestock Research for Rural Development* Volume 17 (2) http://www.lrrd.org/lrrd17/1/mlay17002.htm.

Mlozi M R S 2005 Urban animal agriculture: its palliativity and reasons for persistence in Tanzanian towns. RICS Foundation. http//www.rics-foundation.org 26 pp.

Msangi B S J, Bryant M J, Nkya R and Thorne P J 2004 The effects of short term increase in supplementation on reproduction performance of lactating crossbred dairy cows. *Tropical Animal Health and Production* 36:775-787.

Mushtaq A and Qureshi M S 2009 Variation in milk composition and its relationship with physiological states and management in crossbred cattle under tropical conditions 23 pp. http://en.engormix.com/MA-dairy-cattle/articles/variation-milk-composition-its-t1447/p0.htm.

Mwatawala H W and Kifaro G C 2009 Reproductive performance of artificially and naturally bred Boran heifers and cows under ranch conditions in Tanzania. *Journal of Animal and Plant Sciences* 4 (1): 267 - 275. http://www.biosciences.elewa.org/JAPS.

Njau F B C, Lwelamira J and Hyandye C 2013 Ruminant livestock production and quality of pastures in the communal grazing land of semi-arid central Tanzania. *Livestock*

Research for Rural Development Volume 25, Article #146 http://www.lrrd.org/lrrd25/8/Njau25146.html.

Nuraddis I, Shebir A and Shiferaw M 2011 Assessment of reproductive performance of crossbred cattle (Holstein Friesian X Zebu) in Gondar Town. *Global Veterinarian* 6 (6): 561-566.

Omore A J, Cheng'ole Mulindo Fakhrul Islam S M, Nurah G, Khan M I, Staal S J and Dugdill B T 2001 Employment generation through small-scale dairy marketing and processing: Experiences from Kenya, Bangladesh and Ghana. FAO/ILRI Joint Report. FAO, Rome. 57 pp.

Rahman M M, Islam M N and Dev A 1998 A productive and reproductive performances of indigenous and crossbred cows under village management condition. *Journal of Production Agriculture* 2:95-99.

SAS (Statistical Analysis System) 2002 *User Installation Guide for the SAS system* version 9.1, SAS Institute Inc., Cary, North Carolina, USA 221 pp.

Sidibé-Anago A G, Ouedraogo G A and Ledin I 2008 Effect of season and supplementation during late pregnancy and early lactation on the performance of Zebu cows and calves African *Journal of Agricultural Research* 3 (9):640-646. http://www.academicjournals.org/AJAR.

Soto R, Rubio I, Galina C S, Castillo E and Rojas S 2001 Effect of pre and post-partum feed supplementation on the productive and reproductive performance of grazing primiparous Brahman cows. *Tropical Animal Health and Production* 33: 253-264.

Tadesse M and Dessie T 2003 Milk production performance of Zebu, Holstein Friesian and their crosses in Ethiopia. *Livestock Research for Rural Development* (15) 3. http://www.lrrd.org/lrrd15/3/Tade153.htm.

Tadesse M, Thiengtham J, Pinyopummin A and Prasanpanich S 2007 Productive and reproductive performance of Holstein Friesian dairy cows in Ethiopia. *Livestock Research for Rural Development* 22 (2) 2010.

Tilley J M A and Terry R A 1963 A two stage technique for the in vitro digestion of forages. *Journal of the British Grassland Society* 18**:**104-111.

Urassa A, Kurwijila L R and Aboud A A 1999 Feeding practices of smallholder dairy farmers and effect of improved supplementation on milk yield of dairy cattle in Tanga,

Muheza and Lushoto districts. *In: Proceedings of the 26th scientific conference held in LITI, Tengeru, Arusha, Tanzania.* TSAP Conference Series, Volume 26 pp 11-56.

URT (United Republic of Tanzania) 2006 *National Livestock Policy*. Ministry of Livestock Development. December, 2006 79 pp, http://www.mifugo.go.tz.

URT (United Republic of Tanzania) 2013 *Tanzania census 2002 analytical report* Volume X National Bureau of Statistics Ministry of Planning, Economy and Empowerment Dar es Salaam 211 pp. http://www.nbs.go.tz/takwimu/references/2002popcensus.pdf.

Yifat D, Kelay B, Bekana M, Lobago F, Gustafsson H and Kindahl H 2009 Study on reproductive performance of crossbred dairy cattle under smallholder conditions in and around Zeway, Ethiopia. *Livestock Research for Rural Development* Volume 21, Article #88. http://www.lrrd.org/lrrd21/6/yifa21088.htm.

Received 22 November 2013; Accepted 7 December 2013; Published 1 January 2014

APPENDICES

Appendix 1: Declaration: Feeding cities in the Horn of Africa

DECLARATION

Feeding Cities in the Horn of Africa

We the ministers, mayors, city managers, representatives of governments, cities and local authorities in the Horn of Africa, meeting together with participants from international and nongovernmental organizations, at the sub-regional workshop on "Feeding Cities in the Horn of Africa", organized by the Addis Ababa City Administration in conjunction with the Food and Agriculture Organization of the United Nations in Addis Ababa on 7 – 9 May 2002,

recognize:

- the right of access to adequate and healthy food for all in our rapidly growing cities;
- that cities and local authorities play a key role in enhancing access to food for vulnerable groups;
- that food supply and distribution involves many actors whose responsibilities are currently fragmented and uncoordinated and suffer numerous constraints;
- that partnerships and networking with and among stakeholders at the local, national and international levels offer significant opportunities for the transfer of knowledge and technologies for improved urban food security;

further acknowledge the need to:

- enhance food security in our cities;
- provide an enabling environment for sustainable livelihoods in our cities;
- give greater priority to urban food security in regional, metropolitan and urban planning;
- gain information on food supply and distribution activities in our cities, including the role of women, youth and neighborhood associations;
- develop multi-sectoral policies, strategies and programmes for urban food security;
- involve the private sector and other actors in the design and implementation of urban food security policies;
- review and revise laws, by-laws and regulations to promote effective food supply and distribution activities;
- increase and encourage effective public and private investments to promote access to safe and adequate food;
- encourage income-generating opportunities to increase the incomes of the urban poor;
- monitor environmental and health risks related to food production, marketing and processing and take appropriate action to reduce them;
- engage in effective collaboration and partnerships with all concerned institutions and actors, including inter-city exchanges;
- ensure that urban food security is adopted as part of the agenda of international fora, particularly the forthcoming "World Food Summit – five years later". Addis Ababa, Ethiopia, 10 May 2002.

Name Title Signature

Source: http://www.ruaf.org/sites/default/files/Declaration%20Horn%20of%20Africa%20FINAL.pdf

Appendix 2: Harare declaration on urban and peri urban agriculture in Southern and Eastern countries

The Harare Declaration on Urban and Peri-Urban Agriculture in Eastern and Southern Africa

We, the Ministers responsible for Local Governments from Kenya, Malawi, Swaziland, Tanzania and Zimbabwe, at our meeting in Harare on Urban and Peri-urban Agriculture (UPA) in Eastern and Southern Africa organized by the Ministry of Local Government, Public Works and National Housing of the Government of Zimbabwe and the Municipal Development Partnership for Eastern and Southern Africa, in collaboration with UNDP, UNICEF, FAO-SAFR, FANRPAN, RUAFS and IDRC held on 28 and 29 August, 2003;

Acknowledging,
The presence of local government practitioners and representatives of non-governmental organizations and community based organizations;

Acknowledging further that:

- UPA is a widely practised activity in and around towns and cities within the region on parcels of land with alternative competing uses;
- UPA has generally been practised informally without appropriate policy, legislative and institutional frameworks;
- UPA plays, and will continue to play, a significant role in promoting food security, employment creation and income generation, health and nutrition and improving the economies of urban areas;
- Some governments in the region have made significant progress in incorporating UPA in their urban development plans, and that others are now beginning to rise to the challenge,

Recognizing,
The existence and increasing practice of UPA and also noting the many challenges that it faces, including:

- Absence, inadequacy and or inconsistency in the policies, legislation and institutional arrangements for regulating the sector
- Limited availability of and access to resources
- Limited research, documentation and information-sharing nationally and regionally
- The need for environmental sustainability

Accepting,
That the foregoing challenges require immediate and prudent reform of policies, legislative and institutional arrangements in order to effectively integrate UPA into our urban economies,

We therefore,
Call for the promotion of a shared vision of UPA that takes into account the specific needs and conditions in the region, and accordingly commit ourselves to developing policies and appropriate instruments that will create an enabling environment for integrating UPA into our urban economies.

Thus done at Harare on 29th Day of August, 2003

Signed

Millicah W. Thairu
For the Government of Kenya

Signed

Honourable Henry Midiani
For the Government of Malawi

Signed

For the Government of Swaziland

Signed

For the Government of Tanzania

Honourable Ignatius Chombo
For the Government of Zimbabwe

Sign

Honourable Albert Shabaneu

Honourable Mizengo Pinda

Background to The Harare Declaration on Urban Agriculture

It is acknowledged that urbanization is one of the major challenges for mankind today. Urbanization rates in the Eastern and Southern Africa region have been given at between 3 and 8 % per annum. Cities in sub-Saharan Africa are growing at an exceptional rate of about 5% annually. It is estimated that by the year 2020, half of the population in the region will be urban. As the urban expansion continues the overall cost of supplying, distributing and accessing food is likely to increase with the number of urban households that are food-insecure also increasing. The challenge of feeding cities therefore lies in enhancing consumer access to food by ensuring that the required investments for increasing food production, processing and distribution are accessible under affordable, good quality, hygienic and environmentally sound conditions.

The SADC Ministers of Agriculture meeting in Harare in September 2001 identified huge food deficits, with only one country, South Africa, reporting a cereal surplus. The role of urban and peri-urban agriculture in the food supply for cities and towns, as a compliment to rural agriculture, is therefore becoming an important issue in the Eastern and Southern Africa region economy. There is evidence that urban agriculture has been expanding in many urban areas especially Zimbabwe, Zambia and Tanzania.

The Harare Declaration on Urban Agriculture is a result of a Minister's Conference on Urban Agriculture - Opportunities for Food Security and UA held 28-29 August 2003 in Harare. The conference was co-organized by MDPESA and the Ministry of Local Government, Public construction and National Housing of Zimbabwe and was sponsored by UNDP, UNICEF and IDRC. It was attended by sixty-nine participants, with ministers and delegations from Malawi, Tanzania, Swaziland, Kenya and the hosts Zimbabwe. Other stakeholders like the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), FAO and UNDP also attended. The main workshop objectives were:

1. To facilitate the sharing of experiences on the issues of urban & peri-urban agriculture in the sub-region.

2. To come up with strategies to enhance urban food security, nutrition and local economic growth and development through intensive high value (peri) urban agriculture development.

3. To come up with strategies for improving the nutritional status of HIV/AIDS sufferers through urban agriculture.

4. Identify key policy issues for urban agriculture in the region.

5. To formulate a regional development programme on (peri) urban agriculture focusing on the technical, financial and legal institutional aspects and supports

The Harare Declaration on Urban Agriculture was adopted by the heads of delegations present on the 29 of August 2003.

Contact Information:

Mr. George Matovu Mubvami gmatovu@mdpafrica.org.zw

Mr. Shingirayi Mushamba smushamba@mdpafrica.org.zw

Mr. Takawir mubvami@mdpafrica.org.zw

Mailing Address

Municipal Development Partnership
7th Floor, Hurudza House
14-16 Nelson Mandela Avenue
Harare, Zimbabwe
Tel. 263-4-774385
Fax. 263-4-774387

Source: http://www.ruaf.org/sites/default/files/Harare_0.pdf

Appendix 3: Academic paper acceptance letter with journal of Natural Sciences Research