SOCIO-ECONOMIC VALUES AND GENETIC DIVERSITY OF INDIGENOUS CATTLE IN MARA REGION, TANZANIA

BY

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ABSTRACT

A field survey was carried out on Tarime zebu cattle (TZC) in Tarime district (Mara region) in order to describe farmers' traditional knowledge practices of cattle preferences, productive, reproductive, breed-specific management constraints, desired policy interventions and phenotypic characteristics of TZC. Information from structured questionnaire of 120 farmers, twenty key informants, field measurements such as heart girth, height at withers and body length of 17 males, 23 castrates and 53 females were utilised to carry out an on-farm phenotypic characterisation and description of the breed. The majority of the farmers (86%) still prefer to keep TZC. Average age at first calving was 4.2 years. Average calving interval was 17.5 months and lactation length was 8.2 months. Farmers ranked with highest score draught power, dowry and the role of cattle in home consumed milk as the most important preferences of keeping TZC. The TZC breed is recognized by farmers to have adaptive resistance to diseases and parasites and ability to cope with feed shortages during the long dry periods are favourably rated by the majority of farmers. Farmers desired to have regular extension services (48%), reliable market for livestock and milk (28%) and veterinary services (22%) as well as improving of water sources through construction of dams and cattle dips (18%) to reduce water shortage and tick-borne diseases, respectively. TZC have an average body weight of 292kg, 249kg and 319 ± 36kg and average height at withers of 111cm, 107cm and 116cm for males, females and castrates. The heart girth, height at wither, body length and rump width predicted body

weight with the highest accuracy (R^2 = 0.98) of statistical significance ($p<0.05$).The study concluded that the farming communities in the study area prefer their local and highly adapted cattle breed for their survival; and the breed trends (TZC) are attributed mainly to the decrease in grazing land and the increase in human population.

DECLARATION

I, EDWIN ESTOMII NGOWI, do hereby declare to the SENATE of Sokoine University of Agriculture that this dissertation is my own original work and has never been submitted nor concurrently being submitted for any degree award in any other University.

_____ _____

EDWIN ESTOMII NGOWI Date
M. A. (Rural Development)

The above declaration is confirmed

_____ _____

PROF. GWAKISA, P. S. Date
Supervisor

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DEDICATION

With love and appreciation,
I dedicate this dissertation to dad,
Mr. Estomii Ngowi
and my late mum,
Getrude Wallace Mputa

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
AGR	Animal Genetic Resources
BL	Body length
BW	Body Weight
CaAnGR	Cattle Animal Genetic Resources
CaGR	Cattle Genetic Resources
CBMAnGR	Community-based Management of Animal Genetic Resources
CBNRM	Community-based Natural Resource Management
CFAGRF	Canadian Farm Animal Genetic Resources conservation
Cm	Centimetre
DAD-IS	Domestic Animal Diversity – Information System
DAGRIS	Domestic Animal Genetic Resources Information System
DASIP	District Agricultural Sector Investment Project
DSI	Development Studies Institute
EASHZ	East African Short Horned Zebu
ECA	Eastern and Central Africa
EL	Ear Length
EW	Ear Width
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
HG	Heart Girth
HL	Horn Length
HW	Height at wither
ILRI	International Livestock Research Institute
Kg	Kilogramme
LFO's	Livestock Field Officers
MFEC	Mogabiri Farmers Extension Centre
MWLD	Ministry of Water and Livestock Development
Ne	Effective Population Size
NSGRP	National Strategy for Growth and Reduction of Poverty
PR	Principal Researcher
R^2	Coefficient of determination
RW	Rump width
SD	Standard Deviation
SE	Standard Error
SEAZ	Small East African Zebu
SPSS	Statistical Package for Social Science
SZC	Sukuma Zebu Cattle
SSA	Sub-Saharan Africa
TSHZ	Tanzania Short Horned Zebu
TZC	Tarime Zebu Cattle
URT	United Republic of Tanzania
VEO	Village Executive Officer
WTP	Willingness to Pay
X^2	Chi-square

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Tanzania is rich in indigenous cattle animal genetic resources (CaAnGR). In cattle numbers it ranks third in Africa after Ethiopia and Sudan; making the country important in terms of breed diversity. The most important classes of livestock to the economy are 17 million cattle, 10.7 million goats, 3.5 million sheep and 27 million chickens (MWLD, 2004; Msechu, 2000). Most of the CaAnGR in Tanzania are in the traditional sector, in which indigenous breeds and types predominate. The potential of the livestock sub-sector to contribute to the economy is great as it has been depicted in the national statistics (Ministry of Agriculture, 2000). The contribution of livestock sector to the GDP in Tanzania is 6.1 per cent (MWLD, 2004). The livestock sub-sector accounts for 30 per cent of the contribution of the agricultural sector to the gross domestic product (GDP), which is in turn estimated to be about 60 per cent of the total national GDP. In Tanzania most livestock are kept under the agro-pastoral farming system, in the 'traditional sector' where the farming community may be described as "crop/livestock owners" and accounts for over 90 per cent of the national herd of domesticated ruminants thriving principally on communal grazing. Currently, cattle production tends to focus on only one or a few breeds, a trend that is unsuitable for the future of the sector. In addition, the tendency is particularly inimical which is generally characterized by low-input production systems.

The traditional sector is the main source of livestock products in Tanzania (Msechu, 2000). Tanzania Short Horned Zebu (TSHZ) breeds are the major type of CaAnGR. The TSHZ breed is comprised by a number of strains (genetic diversity), which includes Iringa Red, Maasai, Mkalama Dun, Singida White, Mbulu, Gogo, Chaga and Pare (Das and Mkonyi, 2003). Despite this apparent clear classification, the genetic distinctiveness of these breeds is unknown. The general trend in Africa has been that cattle like most livestock populations, have names of tribes/communities which keep them, or areas where they are found. Consequently, it is possible that some “breeds” could be identical or similar genetically. On the other hand, some of the breeds currently known by the same name may be genetically different. Examples of such breeds are the Boran cattle of Ethiopia, Somalia and Kenya; and strains of the Ankole of Uganda, Rwanda, Burundi, Eastern Congo and North Western Tanzania.

CaAnGR are resources for future food production and environmental and socio-economic stability. An estimated 1.96 billion people in the world rely on livestock to supply part, or their entire daily needs. The world's domestic animal breeds represent an important resource for socio-economic development and livelihood security (Anderson, 2003). Indigenous cattle are well adapted to environmental and diseases stress prevailing in the tropics and are suitably raised under low-input smallholder systems. They are potential source of food and income, especially in rural areas with low agricultural potential and they provide manure for crop production and convert roughages and crop residues of no value into protein of high quality (Rege and Gibson, 2003). Despite their ecological and socio-economical importance, little research efforts have been put to understand the characteristics and develop the TSHZ cattle. This is disadvantageous because when

indigenous populations are lost there is a consequent loss of their genetic attributes, particularly the adaptive traits (Henson, 1992). Likewise, local traditional knowledge, farmers' preferences and experience has been disregarded or underestimated (Kohler-Rollefson, 2000).

The wide distribution of indigenous cattle reflects their adaptation to a wide range of environments, but there are limited research efforts and scanty information on the uniqueness of the various cattle strains forming TSHZ group such as Tarime zebu cattle. These unique attributes of the indigenous cattle not withstanding, the perceptions and breed choice of the various communities keeping indigenous cattle have not been adequately determined and documented. This information will be useful in contributing to their genetic phenotypic characterization into distinct breeds or strains and the development of innovative utilization of the genetic resources.

1.2 Problem statement

Some of the constraints in livestock development in Tanzania are insufficient description of the CaAnGR regarding their phenotypic and genetic performance in production, reproduction and adaptation. Regular performance recording under field conditions is rare, but it is essential for improving and preserving farm animal genetic resources, which are important components of the prevailing crop-livestock production system (Mizeck, 2000). This apparent lack of breeding goals and strategies threatens not only the indigenous animal population, but also the diversity of animal genetic resources.

In Tarime District, the indigenous cattle populations are being threatened by a number of factors, including: crossbreeding with, and/or replacement by specialized and exotic breeds; and intensification of settlement in pastoral areas due to increasing human population. The trend has led to reduction of land available for human settlement. Changes in traditional farming systems also threaten the security of some of the least studied indigenous breeds/strains.

Although there is a large literature about the economic benefits of improved breeds in intensive commercial agriculture, the importance of indigenous breeds of cattle and trait values in the subsistence production systems typical of Tarime District have inadequately been studied. The potential contribution of socio-economic valuation in ensuring equitable sharing of benefits derived from indigenous animal genetic resources (CaAnGR) should be known (Smith, 1988). This prompts a need to conduct research to describe the socio-economic values and genetic diversity of indigenous cattle that would result in efficient utilization and conservation of Tarime zebu cattle (TZC).

1.3 Justification

A systematic description of the indigenous cattle genetic resources under the prevailing environment is fundamental to their sustainable utilization. Breed survey (inventory) is the logical starting point as it provides population size and trends, among other data, that could be used to determine the level of threat and the nature of conservation intervention required. Inadequate awareness and documented information on the potential of indigenous breeds as well as inappropriate management approaches are among the reasons

for the prevailing unsustainable use of the breeds.

Breed survey, aims at establishing the unique and special attributes of the indigenous breeds. Many of such attributes are either known but remain unexploited or unknown by the livestock keepers. Knowledge of such attributes is required for planning sustainable utilization of the cattle genetic resources.

Farmers keeping indigenous cattle have definitive perceptions of the socio-economic attributes of these genetic resources including their adaptive value. This traditional knowledge has been the basis of the farmers' preference and choice of certain breeds and strains of cattle. However, its importance notwithstanding indigenous knowledge has been generally ignored when developing policies and utilization strategies for the indigenous cattle. Determination and documentation of farmers' knowledge of the socio-economic attributes of indigenous cattle would promote the wise use, development and conservation of locally adapted cattle genetic resources, improve food security, strengthen environmental protection and reduce poverty. It would also protect the traditional cattle practices of smallholder farmers and pastoralists. This is in line with one of the first clusters of National Strategy for Growth and Reduction of Poverty (NSGRP) i.e. the growth and reduction of income poverty.

1.4 Objectives

1.4.1 General objective

The general objective of this research is to describe the socio-economic values and genetic diversity of indigenous cattle in order to enhance rational decision on the conservation, improvement and sustainable utilization of TZC.

1.4.2 Specific objectives

- To inventorise farmers' practices and traditional knowledge for their cattle preferences and breed perceptions.
- To describe the existing production system and the mode of participation of local people in CaAnGR conservation.
- To describe the management constraints and optimal policy interventions for indigenous livestock under low input production systems.
- To describe phenotypic characteristics of TZC in terms of physical appearance, reproductive performance and body measurements.

1.5 The framework for study

The conceptual framework is a narrative outline presentation of variables to be studied and hypothetical relationships between and among the variables. In this study, genetic diversity may be realized when traditional and professional knowledge systems are reconciled. The reconciliation of both traditional and professional knowledge systems call for equal partnership with the community practices. The community practices and the resources base (CaAnGR) are mediated by both scientifically and culturally motivated institutions. Scientifically motivated institutions include research, where as culturally motivated institutions include norms, taboos and customs that regulate behavior with regards to conservation of the indigenous cattle. Both community practices and CaAnGR are

influenced by various socio-economic values that determine the development of the strategies for effective conservation of the CaAnGR. Objectives for the conservation of local breeds are to raise opportunities to utilise genetic diversity, to use such resources as an insurance against environmental changes such as changes in production, socio-economic values, and cultural conditions and research and development. The framework for the present research is shown in Figure 1.

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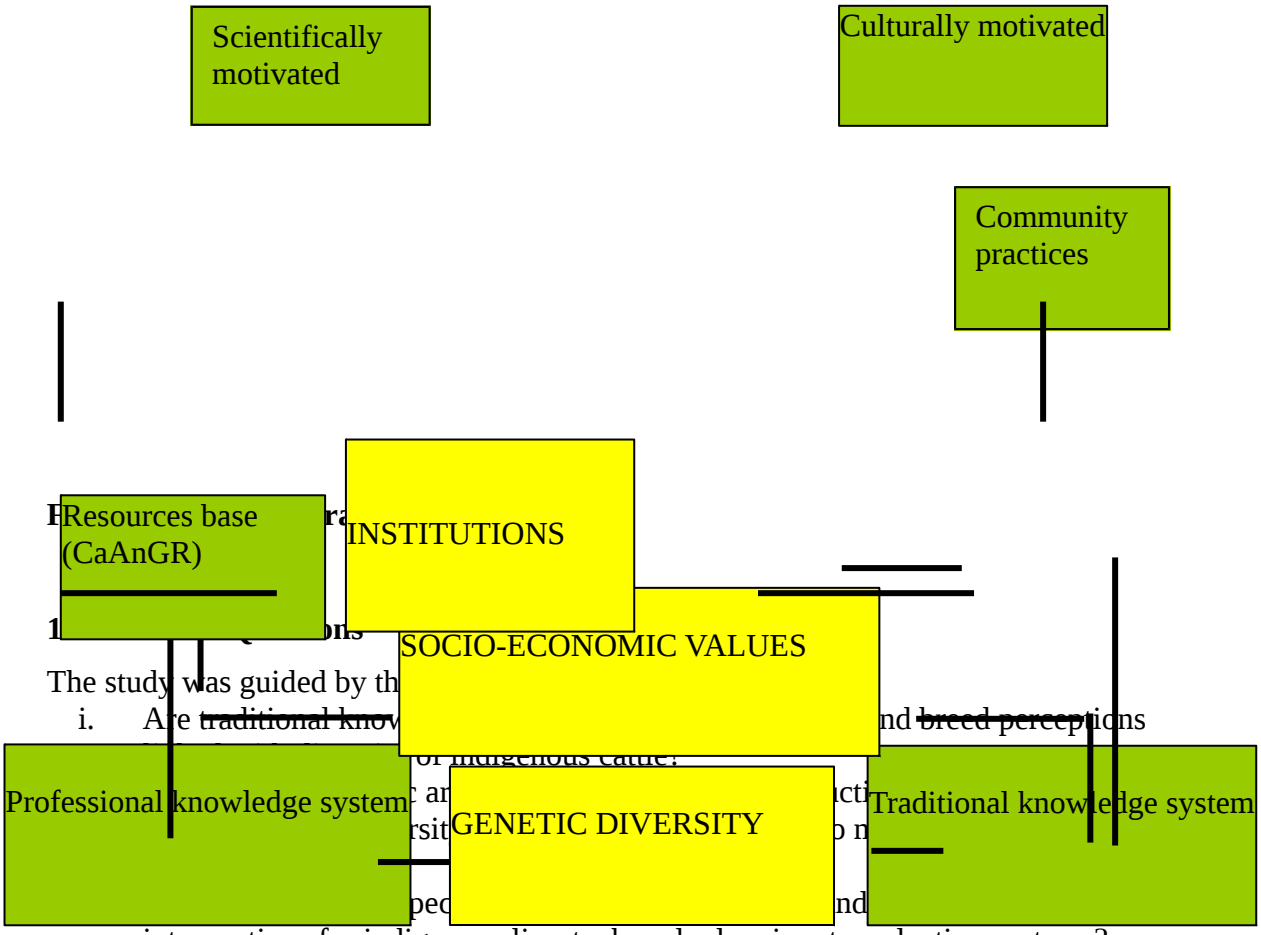

The study was guided by th

i. Are traditional know nd breed perceptions of indigenous cattle?

interventions for indigenous livestock under low input production systems?

iv. What are the unique phenotypic characteristics of TZC in terms of physical appearance and body measurements?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

In chapter one, background information on CaAnGR in Tanzania was discussed. The chapter also discussed about the importance of the traditional sector as the main source of livestock products. In this chapter, a review of what is known about diversity and socio-economic issues of CaAnGR are discussed as they helps to orient and locate the research by defining its breadth and limitation because Kumar and Casley (1988) have observed that a review of related literature brings clarity and focus to the research problem, improves methodology and broadens the knowledge base on the subject. This chapter begins by discussing the domestic animal diversity. It then proceeds to discuss, socio-economic values, phenotypic characteristics, conservation, traditional knowledge and status of research of indigenous cattle.

2.2 Domestic animal diversity

Africa is well endowed with an abundance of livestock genetic diversity; livestock of different species in this region fulfill different functions in the household economy and poor families often keep a diversity of species for this reason (Anderson, 2003). The term genetic diversity as used in this study refers to genetic differences existing and across all species, breeds and strains of livestock that are of economic, scientific and cultural interest to humankind in terms of food and agricultural production for the present or future use (Rege and Gibson, 2003). According to Reist-Marti *et al.* (2003) the diversity of domestic animals can be evaluated as differences in genetic or phenotypic attributes. Biological diversity encompasses both phenotypic as well as genotypic variations. The selection processes imposed by climate, soil type, altitude, available food supply, endemic diseases and parasites, management practices and market demands have resulted in thousands of breeds, types and strains, each with its own genetic make-up and adapted to its own specific niche (Henson, 1992).

Animal diversity has many importances; economically diversity can give assurance against changes in production situation, a recent disease or changes in market demands (Alderson, 2000). Diversity also has ecological value: environmentally adapted breeds (e.g. trypanotolerant cattle) allow sustainable food production in lower-input farming systems of traditional community (Adebambo, 2001). In general, genetic diversity is required to meet current production needs of CaAnGR in various environments, to allow sustainable genetic improvement and to facilitate adaptation to changes in climatic and consumption needs (Valle Zarate, 1996).

The Eastern and Central Africa (ECA) region carries about 60 per cent of the diversity of cattle genetic resources (CaGR) of sub-saharan Africa (SSA), the majority of which are indigenous types. The evolution of a large number of these cattle (>90 per cent) breeds, strains and populations has been driven by a range of biotic and abiotic environments. It is estimated that variation between breeds/strains account for up to about 50 per cent of the

total genetic variation in domestic animal species (FAO, 1993). Therefore, the genetic diversity within Cattle Animal Genetic Resources (CaAnGR) is important in the utilization of these cattle genetic resources.

The East African Short Horned Zebu (EASHZ) and sanga are the predominant cattle groups in the region where they account for over 90 per cent of the cattle genetic resources. The EASHZ group comprises about 60 breeds while the sanga group, represented by a total of 12 breeds/strains, has been classified into three main sub-groups (Rege, 1999): Nilotic sanga (e.g. Dinka, Nuer and Shulluk), the Abyssinian sanga (e.g. Abbigar, Danakil and Raya-Azebo), the Ankole group (e.g. the Bahima, Batutsi, Bashi and Ruzizi). This diversity is a prerequisite for breeding and selection for genetic improvement to improve livestock productivity (Gwakisa *et al*., 1997). As genetic diversity erodes, our capacity to maintain and enhance livestock productivity and sustainable agriculture decreases, along with the ability to respond to changing conditions. For society as a whole livestock diversity conservation may generate significant option and existence values. In general, genetic diversity is required to meet current production needs in various environments, to allow sustainable genetic improvement and to facilitate adaptation to changes in climate and consumption needs. Livestock diversity also provides genetic alternatives that facilitate sustainable agricultural development (Valle Zarate, 1996).

2.3 The socio-economic values of indigenous cattle

All classes of socio-economic values have a basis in human preferences. Locally adapted indigenous cattle breeds have multi-functions as they provide manure for crop production, draught power and they are a source of income and are considered as cash reserve (Scarpa *et al.,* 2003); they contribute to subsistence, nutrition, assets, security, social and cultural functions. Other functions of indigenous cattle include provision of non-food products such as hides, horns and fuel from dung (Scarpa *et al.*, 2003). The more important function in traditional societies is their role as capital investment representing the only durable form of storing wealth particularly in areas where there is no financial institutions to perform this function (Valle Zarate, 1996). The indigenous cattle breeds produce and reproduce under very harsh environmental conditions, and are therefore considered as an important asset since they have developed over time valuable adaptive traits (National Research Council, 1991). Indigenous Zebu cattle have high degree of tolerance to arid and semi-arid environment; among the TSHZ, Gogo strain is the most distinctive because it is well adapted to semi-arid environment and is considered to be “browsers” because of the ability to discriminate between browses during dry season (Rege and Tawah, 1999). N’Dama and Muturu cattle of West Africa are trypanotolerant breeds and therefore, they play an important role in tsetse infected regions of central and West of Africa (Adebambo, 2001).

Indigenous cattle populations have a very valuable genetic potential for sustainable agriculture, as they represent the consequence of local adaptation processes. Unlike commercial breeds, strongly selected for production purposes, local breeds have evolved mostly as a result of natural selection for centuries, becoming a very interesting source of genetic variation (FAO, 1998). The report by Brumby and Trail (1986) shows that in the lowlands where the environment is harsh, the indigenous cattle outperform introduced breeds and their crosses for the reason that they are well adapted to the local environment. Most of the indigenous cattle are kept under extremely simple management condition with

no or little supplementary feeds and health care. Therefore their survival depends on their ability to cope with environmental stresses (Brumby and Trail, 1986). Nevertheless, awareness among politicians and the general public about the socio-economic potential of indigenous livestock breeds is very limited and the overall significance of the livestock sector remains undervalued. This shows that the socio-economic values of performance of indigenous breeds for effective improvement require careful and accurate evaluation of different strains in their own local situation (Henson, 1992). They are the key factor for promoting sustainable development and environmental preservation (FAO, 1998).

2.4 Phenotypic characteristics of indigenous cattle in Tanzania

2.4.1 Physical characteristics

Rege and Tawah (1999) reported that there are variations in size and in morphology among the TSHZ populations. For instance, Maasai cattle tend to be predominantly black or black with white patches or grayish and are heavier than the average TSHZ (Kurwijila and Kifaro, 2001). Some of the TSHZ strains like the Mbulu, Chagga, Tarime and the Gogo could belong to the small sized TSHZ while the Iringa Red, Singida white, and Maasai could belong to the medium sized TSHZ (Rege and Tawah, 1999). Most of TSHZ have variable coat colour. Thoracic hump location, horns are small to medium, flat face profile and erect ears (Msanga *et al.,* 2001). As in all varieties of SEAZ, there is a wide range of colour among the TSHZ. Epstein (1971) and Mason and Maule (1960) described the physical characteristics of some Zebu cattle of Tanzania. Singida White strain has silver-gray to white coat colour while the brush of the tail; the skin, hooves and the muzzle are black. In the Makama type of TSHZ, a deep golden dun colour is frequently encountered, the golden dun colouring tend to turn black at muzzle, the switch of the tail and the extremities of the legs, while the skin is dark. The Ugogo type of TSHZ has body colour which vary from iron to steel grey, but irregularly splashed upon this are areas of red or black and a peculiar feature is the frequency with which grey eyes are encountered. Mason and Maule (1960) described further the Tanganyika zebu (TSHZ) as cattle with light and sloping sacrum whereby the dewlap and umbilical folds are moderate, while the hump is fairly well developed.

2.4.2 Body measurements

Linear body measurements reflect primarily the lengths of the long bones of the animal. When taken repeatedly over a period of time, body measurements would show the manner in which the animal body is changing shape. Body measurements from various African cattle are shown in Table 1.

Table 1: Body measurements for various African cattle

Trait	Cattle	Average	Breed	Place	Source
Body weight (kg)	Steer	389.0	TSHZ, special	Tanzania	Tanzania	Mpiri (1994)
		294.0	TSHZ, No. 1	Tanzania	Tanzania	Mpiri (1994)

		239.8	TSHZ, No.2	Tanzania	Mpiri (1994)
		226.0	TSHZ, No.3	Tanzania	Mpiri (1994)
	Entire male	265.7	IRZ	Tanzania	Sungael (2005)
		540.0	Butana	Sudani	Osman (1985)
		528.0	Kenana	Sudani	Osman (1985)
		550.0	Boran	Kenya	Kimenye (1985)
Height at wither (cm)	Entire male	140.0	Kenana	Sudani	Osman (1985)
		109.9	IRZ	Tanzania	Sungael (2005)
		151.0	Butana	Sudani	Osman (1985)
		135.0	Boran	Kenya	Kimenye (1985)
	Female	125.0	Kenana	Sudani	Osman (1985)
		144.0	Butana	Sudani	Osman (1985)
		127.0	Boran	Kenya	Kimenye (1985)
Heart girth (cm)	Entire male	171.0	Boran	Kenya	Kimenye (1985)
		145.7	IRZ	Tanzania	Sungael (2005)
		184.0	Butana	Sudani	Osman (1985)
		180.0	Kenana	Sudani	Osman (1985)
	Female	139.5	IRZ	Tanzania	Sungael (2005)
		174.0	Butana	Sudani	Osman (1985)
		167.0	Kenana	Sudani	Osman (1985)

Source: Sungael *(2005)*

Linear body measurements have significant relationship with a number of traits of economic importance and they are easy to measure. Consequently they have been used most often in animal characterization (Madubi, 1997). In addition, linear body measurements have been used as indicators of both animal live weights and carcass composition (Lawrence and Fowler, 1997).

Knowledge of body weight of cattle is essential for assessing growth rates, estimating monetary value of cattle and deciding when to sell or breed as well as to determine amount of veterinary drugs to administer to each animal. Body weight is normally determined directly using weighing scale, which is expensive and usually not affordable to most smallholder farmers in developing countries (Francis *et al.,* 2002). Therefore weigh bands and use of external linear body measurements, measured using measuring tapes, to predict live weight are cheaper alternatives to weighing scale and are easily accessible at field conditions (Belay *et al.,* 1992). Linear body measurements i.e. body length, heart girth, height at withers have been used successfully to estimate body weight (Lawrence and Fowler, 1997).

2.4.3 Reproductive and production performance

Mpiri, (1994) summarized some characteristics of SEAZ from different authors: Age at first calving ranges from 36 to 44 months; Milk yield appears to be between 530 to 950

kg/lactation; Calving interval ranges between 219 and 432 kg. Table 2 shows some characteristics of East African cattle.

Table 2: Reproductive and lactation performance of SEAZ

Traits	AverageBreed	Location	Source
Lactation length (months)	8.0SEAZ	Kenya	Mwacharo and Rege (2002)
	6.8IRZ	Tanzania	Sungael (2005)
	7.7SEAZ	Tanzania	Mpiri (1994)
Daily milk yield (litres)			
Lactation at start	2.8SEAZ	Kenya	Mwacharo and Rege (2002)
	1.3IRZ	Tanzania	Sungael (2005)
Lactation at peak	3.1SEAZ	Kenya	Mwacharo and Rege (2002)
	2.3IRZ	Tanzania	Sungael (2005)
Lactation at end	1.0SEAZ	Kenya	Mwacharo and Rege (2002)
	0.7IRZ	Tanzania	Sungael (2005)
Age at first calving (years)	4.5SEAZ	Kenya	Mwacharo and Rege (2002)
	2.9EAZ	Ethiopia	Mukasa-Mugerwa (1989)
	4.0IRZ	Tanzania	Sungael (2005)
	3.6EAZ	Uganda	Mukasa-Mugerwa (1989)
Calving interval	1.3SEAZ	Kenya	Mwacharo and Rege (2002)
	1.8IRZ	Tanzania	Sungael (2005)
	1.5Malawi zebu	Malawi	Mukasa-Mugerwa (1989)
	1.2Africander	Zambia	Mukasa-Mugerwa (1989)
Age at calling breeding females (years)	11.3SEAZ	Kenya	Mwacharo and Rege (2002)
Age at calling breeding males (years)	7.2SEAZ	Kenya	Mwacharo and Rege (2002)
Numbe of calves born per cow	7.6IRZ	Tanzania	Sungael (2005)

2.5 Losses of CaAnGR breeds

There is an increasing global concern about the potential long-term consequences of loss of animal genetic diversity and the need to conserve genetic resources. Many of the world's poor depend directly upon genetic diversity species for their livelihoods. Unfortunately, a large number of breeds have been lost and many more are at risk of loss caused by the main methods of genetic mixing which are selection, crossbreeding and migration. A survey in sub-Saharan Africa revealed that out of 145 cattle breeds identified, 47 (32 per cent) were considered to be at risk of extinction, and 22 (13 per cent) previously recognised in the continent have already become extinct (Rege, 1999). Promotion of exotic breeds and crossbreeding whereby indigenous livestock breeds are commonly crossed with exotic breeds as the way forward to improve productivity of indigenous breeds in a long run may lead to elimination of the local breeds (Das and Mkonyi, 2003). When a gene is subjected to selection, its frequency in the offspring is not the same as in the parents, since parents of different genotypes pass on their genes unequally to the next generation (Falconer, 1989; **Clemens,** 2003).

Losses of indigenous livestock breeds and strains are an irreversible process in which identifiable populations or genetically controlled characteristics disappear (Henson, 1992). The reasons for reduction in animal diversity comprise specialization and expansion of agriculture, which has changed from small production systems to large commercial systems (Patterson and Silversides, 2003). In many countries there has been a trend to hub

livestock breeding programmes on relatively few breeds without fully identifying, evaluating and taking step to conserve the wide range of local stocks available (Henson, 1992). Henson (1992) cautioned that genetic engineering and advanced DNA technology cannot recover the genetic material lost through extinction. Extinction of indigenous livestock breeds is the loss of resource base. Rege (1999) reported that, in sub-Saharan Africa out of 145 cattle breeds identified, 47 (32 per cent) were considered to be at risk of extinction, and 22 (13 per cent) previously recognised in the continent have already become extinct. For example, in order to identify the population at risk, Canadian Farm Animal Genetic Resources Conservation (CFAGRF, 2005) used the recommendations of the FAO (1992) and list of factors put forward by Maijala (1992) to develop sets of guidelines to determine which populations are most at risk. The guidelines are based on population size, effective population size and special considerations (Table 3).

Table 3: Classifications for cattle populations at risk

Risk status	**Ne** (Maijala, 1992)	**Nf** (FAO, 1992)	**Nf Special consideration** (FAO, 1992)
Critical		100	1000
Endangered	50	100 1000	1000 5000
Vulnerable	50 100	1000 5000	5000 10000
Rare	100 200	5000 10000	10000
Monitor		10000	

Source: *CFAGRF (2005)*
Note: Ne = effective population size; Nf = number of females

Another reason is the expansion of crop cultivation and irrigation into marginal areas and conversion of former grazing lands into protected areas such as nature and wildlife conservation which often leads to eviction of livestock keepers from their traditional pastures (Kohler-Rollefson, 2000). Absence of market and the loss of interest in some of the by-products of local breeds due to economic changes also can be contributing factors to the loss of indigenous livestock breeds. Consequently, rural culture and related indigenous knowledge of livestock keeping could vanish quickly even within a generation. When the indigenous knowledge disappear, it becomes very difficult to revive the breed and the information that goes with it (Kohler-Rollefson, 2004b).

2.6 Sustainable conservation of CaAnGR

According to FAO (2000), conservation of CaAnGR refers to all human activities including strategies, plans, policies and actions undertaken to ensure that the diversity of CaAnGR is maintained to contribute to food and agricultural production and productivity, now and in the future. Animal genetic resources eligible for conservation include animal populations with economic potential, scientific use and socio-cultural values (Rege and Gibson, 2003). The goal of conservation can be preservation of genes or preservation of breeds. All breeds or populations, which are unique and endangered are eligible for inclusion in some form of conservation programme (Henson, 1992). Indigenous livestock play important socio-economic roles, however uncontrolled crossbreeding has been and

remains a threat to the conservation of indigenous livestock animal populations (Clemens, 2003).

There is increasing global concern about the potential long term consequences of the loss of domestic animal diversity. Of particular interest is the situation in developing countries where on one hand, livestock makes the greatest contribution to human livelihoods while on the other, genetic erosion has placed important indigenous breeds at risk of extinction. Socio-economic valuation of these animal genetic resources (AGR) would improve decision making regarding their conservation and sustainable utilisation (Rege, 1999). Some of the most effective tools for enhancing the sustainable use and conservation as emphasized by Furze *et al.* (1996) entails involvement and participation of local people. Only when the utilisation of CaAnGR is attractive at the local level, the farmers will conserve these CaAnGR for future generation. Long-term food security as supported by the livestock sector is dependant upon production systems, which are used in a sustainable manner, and the sustainable use and conservation of animal genetic resources (FAO, 2000).There are two conservation methods for animal genetic resources; *ex situ*, and *in situ*, but it is not essentially that the use of one approach could complement to another (Rege, 2003).

2.6 1 *Ex situ* conservation of animal genetic resources

Ex situ coservation involves cryopreservation in which there is collection and freezing in liquid nitrogen of living semen, oocytes or embryos (Rege and Gibson, 2003). It is the conservation of animals in an environment apart from their normal habitat (Henson, 1992). The *ex situ* conservation also involves preserving a sample of live animal breeds in designated places such as zoo, ranches and farm parks (Rege and Gibson, 2003). The problem with *ex situ* preservation is lack of developed reproductive technology for some animal species (Rege and Gibson, 2003). Sometimes the livestock is not accessible for collection of semen or embryo due to reasons of politics, ownership or their remote locality (Henson, 1992). Also the breeds conserved through cryopreservation are not able to adapt to changes in the production environment or new disease challenges.

2.6 2 *In situ* conservation of animal genetic resources

In situ conservation is the maintenance of live populations of animals in their adaptive environment (FAO, 2000) and this involves using and maintaining animal genetic resources by farmers within the framework of a village or livestock-keeping community where those animal populations have evolved. The *in situ* conservation programme includes management of entire ecosystems, including immediate use of animal species, crops, forages, agro-forestry species and other plants that form part of the ecosystem (Rege and Gibson, 2003). On-farm conservation is also referred to as the *in situ* conservation. There are important socio-economic reasons why CaAnGR should be conserved '*in-situ*.' The *in situ* conservation of animal genetic resources conserves both the genetic material and the practices that give rise to the diversity. The *in situ* conservation programme makes use of local communities by which it is possible to select a number of farmers to be involved as individuals instead of collective community involvement (Rege, 2003).

2.7 The role of traditional knowledge in CaAnGR management

Traditional knowledge or farmer's knowledge as used in this study refers to a stock of knowledge accumulated over time as a result of direct interaction between community and their indigenous livestock species (Gandini and Villa, 2003). It is important to note that traditional knowledge manifests itself in the form of traditional practices, which are directly linked with socio-economic values. Traditional knowledge systems and practices were developed to adapt to and manipulate land, flora and fauna and that this knowledge constituted an invaluable resource that should be used in conjunction with the modern management systems (Cunningham, 1994). It includes knowledge and experience about genetic attributes of livestock as well as conscious strategies and mechanisms used by livestock breeders to influence the genetic composition of their herds (Gandini and Villa, 2003). Traditional knowledge has been acknowledged to have substantial impacts in socio-economic matters of indigenous livestock development. Of recent, therefore, there has been an increasing awareness of a need for integrating traditional knowledge with modern and more formal technologies (Nuwanyakpa *et al.*, 2000).

Complex, diverse and risk-prone peasant livelihood systems need CaAnGR that are capable of performing the functions required of them in these systems; flexible, resistant and diverse. In order to assess the importance of CaAnGR, as distinct from livestock per se, for sustaining and improving the livelihoods of the poor, the factors that differentiate between species and breeds in terms of the functions that animals fulfill in livelihoods and household socio-economies need to be better understood (Anderson, 2003). An important research and development goal is the systematic evaluation of breeds in production systems where they are typically found, the definition of relationships amongst breeds and the implementation of programmes for their effective management, including development of policies and strategies for conservation and sustainable utilization (Rege and Gibson, 2003). Nevertheless, awareness of the traditional knowledge among politicians and the general public about the socio-economic values/potential of indigenous livestock breeds is very limited and the overall significance of the livestock sector remains undervalued. This state of affairs has resulted in a lack of recognition, at national, regional and international levels, of the need for the provision/enabling of infrastructure, institutions and capacity, and technologies such as breeding programmes for low-input systems that enable farmers to take full advantage of their breeds and their knowledge.

The majority of breeds have developed as a result of the interaction between traditional communities, their animals, and the environment. They have been shaped by the indigenous knowledge and the breeding strategies of their owners. As long as these breeds contribute to sustainable livelihoods, communities will have a vested interest and are also best placed to develop, improve and conserve these resources. This is the underlying concept of Community-based Management of Animal Genetic Resources (CBMAnGR), which builds on principles of Community-based Natural Resource Management (CBNRM). Community-based management of farm animal genetic resources has the potential to contribute to both the sustainable use and conservation of African breeds as well as to rural poverty alleviation (Patterson and Silversides, 2003).

Mason and Maule (1960), cited by Das and Mkonyi (2003), pointed out that there is a lack of accurate and detailed information on many indigenous cattle strains in Africa. Furthermore, few studies on cattle in the traditional sector have been done to evaluate the

production parameters, and scarce information is available on indigenous cattle in Tanzania (Ministry of Agriculture and Cooperatives, 1997). Documenting indigenous knowledge of livestock preference and breeds perception has several benefits since it may serve as a source of information about existing breeds that have escaped attention of scientists and which may have unrecognized advantages and potentials. The critical component of animal biodiversity is knowledge, including both indigenous/local and scientific knowledge (Gandini and Villa, 2003).

2.8 The relevance of local institutions in the management and conservation of indigenous cattle

Institutions are social structure and social mechanisms of social order and cooperation governing the behaviour of two or more individuals (Mbwambo, 2000). Local institutions constitute an essential component of any attempt to facilitate community engagement in conservation and management of biological diversity. Umans (1993) as cited by Mbwambo (2000) identified two types of institutions, namely, culturally and politically motivated institutions. Culturally motivated institutions include norms, customs and taboos that regulate behavior and responsibility among members of the society. Politically motivated institutions on the other hand represent rules and regulations which regulate behaviour.

Local institutions and knowledge in genetic resources management have not been properly investigated in terms of significance and validity. Therefore, the importance of social capital, including factors such as trust has not been filtered into general awareness. This is particularly evident in the area of domestic animal diversity (Kholer-Rollefson, 2004). To appreciate the role that traditional communities play in the conservation and management of CaAnGR, it is important to understand the social institutions that define the animal management choices available to farmers. Indeed, social and cultural forces are often the most important factors in diversifying livestock (and livestock production systems) and in developing distinctive breeds. Social organization and institutions in a community can influence farmers' access to, and management of, household and community level resources, affecting their action regarding the CaAnGR (Blench 1999).

2.9 Status of research on indigenous cattle

Most of the beef consumed in Tanzania comes from indigenous cattle. On review of African cattle in relation to their productivity, Adeniji (1985) classified the majority of African cattle as beef types and few as dual or multi purpose breeds. But most of the performance reports of various cattle strain in Africa and more so on TSHZ cattle are biased towards milk production (Msechu *et al.*, 1987). Generally, there is a lack of information on meat quality or taste of the SEAZ as well as reports on consumers' preferences on beef of the indigenous cattle compared to others.

Over the last decade, considerable phenotypic and genetic data have been generated and in some cases, collated for a number of indigenous cattle breeds. However, the work accomplished so far is incomplete, hence the need for further studies. In an effort to improve accessibility to the information, the Food and Agriculture Organization (FAO) and International Livestock Research Institute (ILRI) have developed two separate databases, the Domestic Animal Diversity – Information System (DAD-IS) and the

Domestic Animal Genetic Resources Information System (DAGRIS) respectively. The DAD-IS is a global facility and DAGRIS is for Africa. The main constraints to the development of both databases include inadequate information. Development and regular updating of breed catalogues for indigenous cattle genetic resources would enhance development of the two databases, especially on indigenous breeds, and create awareness on their socio-economic value among a wide range of stakeholders.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the methods used to collect and analyse data on the socio-economic values and the diversity of indigenous cattle. The chapter is divided into six sections. Section one presents the study location and justification of its selection. Section two presents research design, which describes the type of respondents involved in the study, while section three presents the sampling procedures employed. Section four describes data collection, which is followed by data processing and analysis in section five. Section six describes the limitations of the study.

3.2 Study location and justification for its selection

3.2.1 Geographical, administration set up and indigenous cattle population

The study was conducted in 4 wards, 2 from highland and 2 from lowland zones of Tarime District in Mara Region. The region is among of 26 regions of Tanzania. Administratively, the region is divided into five districts namely; Bunda, Serengeti, Tarime, Musoma Urban and Musoma Rural (see Figure 2). Tarime District has a total area of 11,137 square kilometres and is situated in the North of Tanzania and lies between latitudes 1°00" – 1°45" South of the Equator and Longitudes 33°30 - 35°0" East of the Meridian. The District is bordered by Republic of Kenya to the North, Serengeti District to the East, Musoma District to the South and Lake Victoria on the Western side. The Tarime District is administratively divided into 41 wards (URT, 2004).

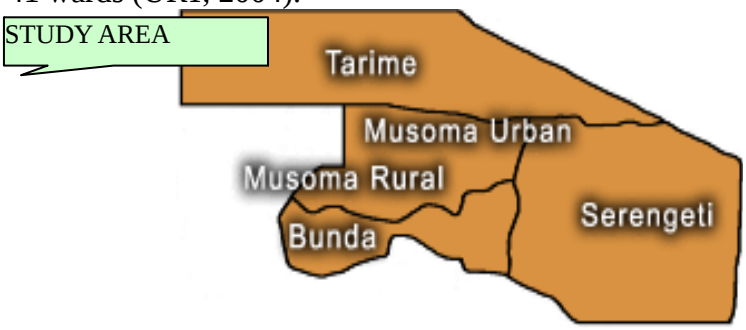

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Figure 2: Map of Tanzania showing the study area (Tarime District)

Study area (Mara region in Tarime district)
Mara region
Lakes

The estimated population of cattle in Tarime district according to the District Agricultural Sector Investment Project for 2005/06 (DASIP plan), is 386,591 indigenous cattle. The District has bimodal rainfall that starts in September to December (short rains) and February to June with heavy rainfall in April to May. The land surface is divided into three zones according to height from sea level as shown in Table 4.

Table 4: Distribution of Tarime District into three zones

Zone	Distance from sea level (m)	Rainfall (mm) per year	Temperature (°C)
1. High elevated area	1500-1800	1200-1500	14-20
2. Mid elevated areas	1200-1500	900-1250	20-25
3. Low lands	1000-1200	700-900	20-28

Source: *URT, 2004*

3.2.2 Justification for its selection

Tarime District was picked for the study following consideration of certain unique socio-economic characteristics and the genetic diversity of local Tarime zebu cattle (TZC) breed in the District. TZC breed have a valuable genetic potential for sustainable agriculture, as

they represent the consequence of local adaptation processes. They are the key factor for promoting sustainable development with environmental preservation (FAO, 1998).

3.3 Research design

The cross-sectional research design was employed in this study. This method allows data to be collected at one point in time and it makes possible to determine relationships between different variables that were in focus at the time of the survey (Bernard, 1996). This method is considered to be useful because of time limitation and resources constraints.

3.4 Sampling procedures

3.4.1 The population

The population from which the sample for this study was drawn involved socio-economic survey of household heads that own indigenous cattle to capture data on farmers' perception of the social and economic values of the Tarime breed from the 4 wards, which are Manga, Kisumwa, Muriba and Kemambo. These wards are among the 41 wards which form the study district. The sampling unit comprised of household heads. The choice of the household heads as a unit of analysis was based on the fact that it is the most appropriate unit for measurement when assessing socio-economic values in the society.

3.4.2 Sample size

Ideally, the sample size was supposed to be 400 (see Appendix I) but due to cost implications, 30 percent of this sample size (120) was interviewed of which 30 respondents came from each individual ward.

3.4.3 Sampling technique

To obtain the desired data, purposive sampling was used to select 4 wards, which are Manga, Kisumwa, Muriba and Kemambo. This technique has been generally recommended in social research, as it focuses directly to the area that has the best attributes to be studied. Simple random sampling techniques were employed for selection of the twelve villages i.e. three villages from each ward. For each ward the researcher listed the names of villages in each ward, then wrote them in small pieces of paper, folded, shuffled them, and eventually picked the piece of paper at random. The names of the villages that were obtained through this method was written in a prepared sheet of paper for each ward.

Table 5: Sampling frame

District	Wards	Villages
Tarime	Manga	Mtana
		Surubu
		Bisarwi
	Kisumwa	Kisumwa
		Nyanchabakenye
		Nyanjagi

		33
		33
		33
		33
	Muriba	Muriba
		Bungurere
		Kobori
	Kemambo	Mrito
		Kewanja
		Kerende

Transect sampling technique was used where every fifth household counting both left and right is sampled along a randomly selected village until the required sample size of 10 household heads from each village to make a total of 120 household heads. The Village Executive Officer (VEO) took the researcher and field supervisor to the respondents' household heads for interviews.

3.5 Data collection methods

3.5.1 Primary data

Both quantitative and qualitative data collection methods were used to obtain primary data. The main instrument for quantitative data was structured questionnaire containing both closed and open-ended questions (see Appendix III). This tool captures the information on breed, farmers' perception of the social and economic value of the breed, breed preferences, farmers' perceptions of trends in herd sizes and compositions. During data collection, the principal researcher (PR) interviewed an average of ten respondents per day.

More information was collected using checklists for key informants such as the Village Executive Officers (VEO), District Livestock Officer and Divisional Extension Officer. A key informant is an individual who is accessible, willing to talk and has a greater depth of knowledge about the issue in question (Mbwambo, 2000; derived from Katani, 1999).

3.5.2 Secondary data

Secondary data has been used to enrich the primary data source. These were obtained from sources such as, official documents both published and unpublished. Tarime District Council official documents were used to obtain information on climatic data, livestock populations, agro-ecological zones and cattle distribution.

3.6 Physical body measurements

A total of 93 animals were measured, measurements were taken before cattle had an access to feed and water, and that was between 0600 and 1000 hours. Measurements were done only on mature cattle. Heart girth was measured in centimetres, as described by Francis *et al.* (2002) using tailor's measuring tape. Since there were no weighing scales, the body weight was estimated using WE-BO animal measure, a weigh band alternative to weighing scale as described in literatures (Lawrence and Fowler, 1997 and Francis *et al.*, 2002). Body length was obtained by measuring the distance between the prominence of the shoulders and the hind edge of the ischium using tailor's measuring tape. The height at

withers measurements were recorded from the ground to the highest point of the withers in centimetres. The horn and ear length as well as ear width were measured in centimetres using tailor's tape.

3.7 Data processing and analysis

Both qualitative and quantitative data from field survey were coded and analysed using the Statistical Package for Social Sciences (SPSS) computer program. The data were first coded in a form suitable for addressing research questions and the method of analysis to be employed. Frequencies, percentages, mean, ranking, cross-tabulations, multiple responses, pie charts, *T-test* at 0.05 and *Chi-squire test* at 0.05 to compare the relationship between different variables; were used to summarize the data. Moreover, in the analysis the recorded and summarised data from key informants were used. The analysis has employed *ethnographic approach* that is relying on the direct information given by respondents according to the checklist used during the discussion. Although in most cases the analysis has used the summaries occasionally original statements have been included and used to obtain insights of the respondents about certain issues. Further analysis was carried out using a regression model to determine the influence of selected predictors of socio-economic factors towards the willingness to pay for preferred TZC conservation. The regression equation is as shown below:

$$Y_i = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \pm \beta_i(X_i) + e_i.$$

Where:

- Y_i = The value of the dependent variable which measures the bid of the i^{th} person for conserving TZC
- X_1 to X_i = independent variables of the ith respondent; household income, age of household head, education, total number of cattle owned by households, dowry payment, cattle breed preferred, draught power.
- β_1 to β_i = Independent variable coefficient
- β_0 = intercept
- e_i = Random error
- I = 1, 2 ,n. Where n is the total number of variables.

3.7 Limitations of the study

Some respondents were not willing to give information because previous researchers had not fulfilled the promises they had made upon completion of their studies to the respondents.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Overview

In this chapter, the results of the study are presented and discussed in line with the study objectives and research questions. The chapter is divided into three sections. Section one describes the results of the descriptive analysis, which includes an overview of the basic demographic (age of household head, Sex of household head and household size) and socio-economic characteristics (education level, occupation and marital status) of farm households as well as the results of the overview of livestock species, cattle breed preference kept by the households and production systems characteristics. Section two discusses the results of the ranking of the socio-economic values of TZC preferences and breed perceptions; multiple regression models employed to determine socio-economic factors that influence the willingness to pay (WTP) in order to conserve TZC. The third section discusses the results of the breed-specific management constraints and desired policy interventions for indigenous breed as well as the result of relative importance of crops and livestock enterprises for food security and income generation. Section four presents the importance of local institutions for management of CaAnGR and lastly is the body measurements and phenotypic descriptions of TZC and SZC.

4.2 Household characteristics

Some of the household related characteristics are presented in Table 6. The average household size across the entire sample is 6.3 adult equivalents. This is comparable to the average household size of 5.5 for the Mara region reported by the Population and Housing Census report of 2002 (URT, 2004). Households in highland zone have an average household size of 6.9 adult equivalents compared to 5.7 in lowland zone. However, the *T-test* results show that the mean household sizes for the two groups of farmers are not significantly different ($p>0.05$).

The average monthly income for the highland zone households was significantly higher than that for lowland zone households ($p<0.05$). The average monthly household income for highland and lowland zones households was 6248.3 TSh and 4570.8 TSh respectively, while it was 5,409.6 TSh across the entire sample. The difference in income is due to cash crop production (coffee and banana) found in the highland zone due to the favourable agro-ecology found in the area. This boosts farm income in comparison to subsistence food crops production in the lowlands.

Table 6: Household related characteristics

Parameter	**Mean (N = 120)**		
	Highland zone	**Lowland zone**	**Sig.**
Average household size	6.9	5.7	0.071^{ns}
Average total monthly household income (TSh)	6248.3	4570.8	0.040*

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Average land size (ha)	1.9	2.2	0.149^{ns}

* *Significant at P < 0.05*
^{ns} *not significant at P 0.05*

Households in lowland zone have large land sizes compared to those in highland zone. The average land size is 2.2 and 1.9 ha for the lowland and highland zone households respectively, but the mean land size for the two groups of farmers according to the *T-test* results is not significantly different (p>0.05). The main land tenure systems found in the study area include freehold, communal, private and rentals from individuals as illustrated in Figure 3. Most respondents seem to have acquired land through freehold. The land tenure systems have an important influence on the traditional cattle production system. The freehold system tends to promote social security and agricultural production as opposed to the communal systems with less sense of ownership. In the study area livestock keepers depend on natural pastures available on communal grazing lands. Therefore in planning and implementing proper land use, there is a need for rural community involvement.

Table 7 shows the characteristics of the household heads in the study area. The household head is defined as the senior member of the household who makes key decisions in the household and whose authority is acknowledged by other members. The results indicate a predominance of households headed by males as opposed to females. A large proportion of the interviewed households (79 per cent) were male headed while 20 per cent were female-headed in which the majority of the females were widow. The dominance of males in

heading the households and ownership of cattle agrees with the survey made by Maeda-Machang'u *et al.* (2000) in gender analysis study of agro-pastoral communities in Tanzania. This revealed that access to resources in the traditional system is determined by the patriarchal system in which males dominate all the household-related authorities. This is due to the fact that in these communities, inheritance of resources favours men over women. The basic resources such as land or assets such as livestock are owned and controlled by men.

Table 7: Demographic characteristics of the households head by sex

Category	(N = 120)	
	Male	**Female**
Proportion of household heads (%)	79.2	20.8
Average age of household head (years)	52.3	55.3

The average age of the household head in male and female-headed households is 52.3 and 55.3 years respectively. Figure 4 shows that the major education level found in the study area is primary education, which provides the basic elementary education. Post-primary education has the lowest number of respondents. During the survey, information on education attainment was collected from every respondent in terms of whether or not the respondent had been to school and the highest level of education attained. The results in general reveal that the majority of the respondents had primary education (51.7 per cent), followed by 47.5 per cent with none formal education. Very few of the respondents had post-primary education (0.8 per cent).

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Figure 4: Distribution of respondents by education levels

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Household heads in the study area were also asked about their major occupations. The purpose was to determine the economic activities done by household heads. There are no intrinsic difficulties in clarifying occupations because there is a narrow range of jobs and income generating activities that household heads perform. The survey results in Figure 5 reveal that 75.8 per cent of respondents were practicing crops and livestock production while the rest were Livestock keepers only (10 per cent), Livestock and Off-farm business (1.67 per cent), Retired with pension (5 per cent) and Crop production (1.67 per cent) as their major occupations. But across the entire sample of household heads they all own indigenous cattle.

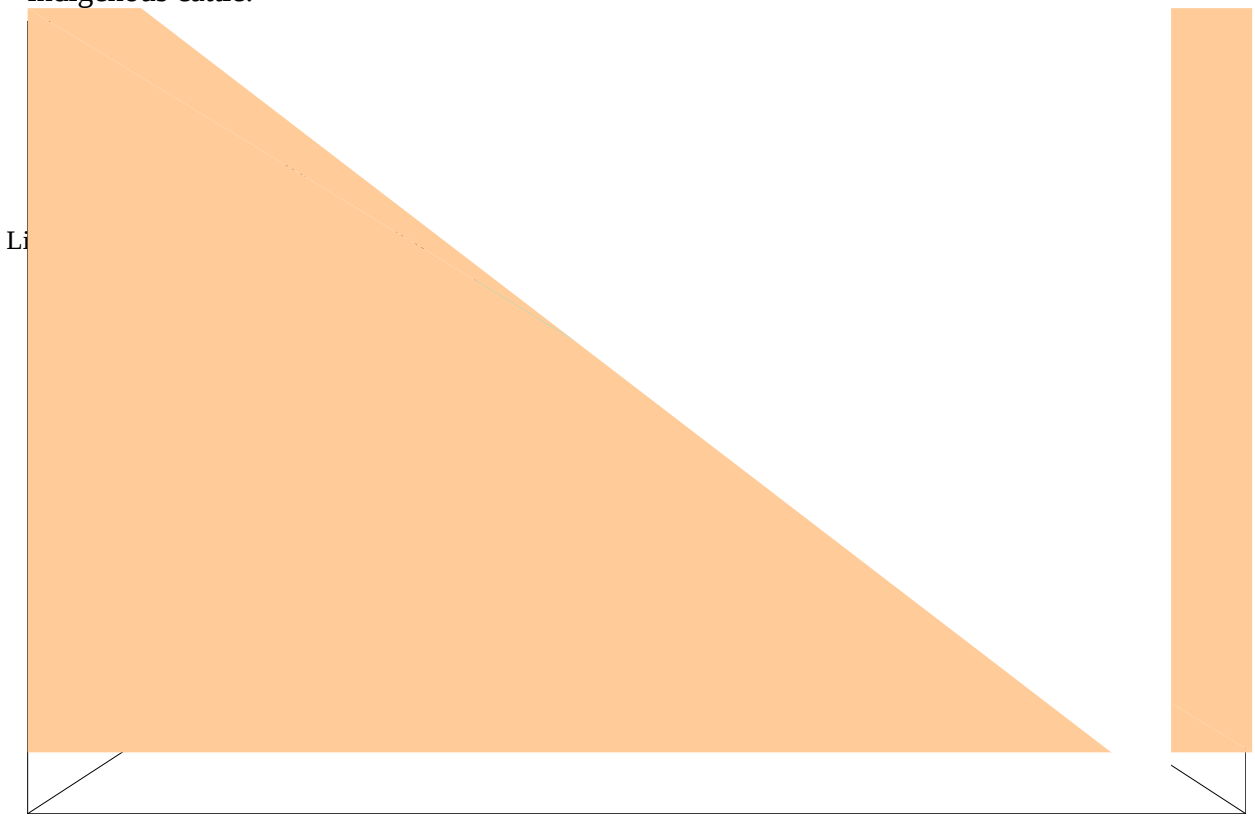

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Figure 5: Distribution of respondents by occupation

The study reveals that, there is a high level of crop-livestock integration as the main occupation among the households. The livestock production found in the highland as well as in the lowland zones of Tarime District can be classified as crop-livestock integrated system.

4.2 Livestock species kept by the households and cattle breed preferences

4.2.1 Livestock species kept by the households

All farmers surveyed kept livestock in multi-species enterprises. Table 8 summarizes some of the indigenous animal genetic resources species based on the surveyed results. Traditionally in Tarime District, various kinds of indigenous animal genetic resources supplied a great deal of animal products to the population. The breeds are tenacious with few requirements, but in general exhibited a low performance level in terms of milk production as compared with imported high performance animal hybreeds (Gandini and

Villa, 2003). During the survey it was difficult to find information on the exact number of livestock; the average household has about 44.8 heads of cattle (Table 8). This figure may be misleading because the respondents were never willing to give the exact number of their cattle for fear of cattle raids. Animals reared are mostly cattle, goats, sheep chicken and donkeys. The practice of keeping several types of livestock that was observed in the study area was typical of most smallholder holdings in developing countries where a farmer keeps different types of livestock species mainly for socio-economic and socio-cultural reasons (Bebe *et al.*, 2003a). Also the majority of the animal reared are chickens with the average flock size of 41.4 birds. This observation is in accordance with those reported in Iringa region (Tanzania) by Maeda-Machang'u *et al.* (2000) in agro-pastoral and pastoral production systems. This revealed the importance of cattle in the traditional farming from other livestock species.

Table 8: Estimated number of livestock species in the surveyed villages

Variable	Mean	SD	Minimum	Maximum
Tarime zebu cattle	44.8	43.5	3	256
Local goats	22.4	16.2	2	94
Local sheep	12.5	16.1	0	104
Donkeys	0.7	1.3	0	6
Local chicken	41.4	22.9	2	105
Ducks	2.3	6.1	0	42

The average flock size was 22.4, 12.5, 2.3 and 0.7 for goats, sheep, ducks and donkeys, respectively. The results are consistent with the findings of Kurwijila and Kifaro (2001) who reported that; Tanzania is endowed with a wide range of domesticated animal species, which can be categorized into farm animals of socio-economic importance such as cattle, sheep, goats, pigs, rabbits, horses and donkeys and birds such as chickens, ducks and gees, turkeys and guinea fowls. Livestock of different species fulfill different needs in the household's socio-economy and traditional livestock-keepers mostly keep a diversity of species for this purpose. Studies reveal that, facilitating increase in the productivity and production of these diverse livestock species is one of the major means of improving the livelihoods of poor livestock-keepers and consequently reducing poverty, and attaining sustainable agriculture and universal food security.

It has been observed from both individual interviews and discussions with key informants in this study that there is little or no attempt by farmers to improve their stock by selection or by any other method. Previously in the lowland zone households used to exchange cattle animal genetic resources (CaAnGR) with their neighbors (the Sukuma people), but the practice stopped as Sukuma cattle breed couldn't survive better in the lowland zone of Tarime. However, current practice was that, Sukuma people bought heifers from Tarime zebu cattle and crossed with their Sukuma zebu cattle; the resulting offspring survived better in their environment. This is a form of indigenous gene flow in cattle animal genetic resources (CaAnGR). On the other hand, farmers believe that their herds in the community are still genetically superior, even though there are no institutionalised schemes for genetic improvement. A common observation in almost all interviews and key informants discussions has been that households that do not own any animals are usually considered the poorest in the rural communities and those with large numbers of animals are

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considered as rich members of the community.

4.2.2 Cattle breed preferences

The majority of the interviewed farmers in the highland (75 per cent) and lowland (96.7 per cent) zones rejected the idea of introducing new "improved breeds" arguing that only the local breed can be suitable for the area. The results shown in Table 9 indicate that although the majority of the respondents in both zones preferred TZC breed, the results for *Chi-square test* indicate that there was significant association between zone and breed preferred ($p<0.05$) in which there was a substantial number of respondents in highland zone (23.3 per cent) who preferred both improved and local breed compared to Lowland Zone (3.3 per cent), whereas 1.7 per cent in the highland zone indicated their preference to the new improved breed. But the breed has negatively impact because of their high feed requirement and the high level of management required.

Table 9: Preferred cattle breeds

Breed	Per cent (N = 120)		X^2-value	Sig.
	Highland	Lowland		
Tarime breed	75.0	96.7	0.033	0.033*
Improved breed	1.7	0.0		
Tarime and improved breed	23.3	3.3		

* *Significant at P < 0.05*
X^2 value = Chi-squire

A livestock field Officer (LFO's) as one of the key informant revealed that:

> *"Despite having mixed types of colour in their herds, the majority of the farmers admitted that they are preferring TZC with brown colour or mixture of brown with white or grey colour or brown with steaks of other colour, villagers do not prefer cattle with black colour due to the reasons that they are easily tired when used as draft animals. Hence in the local livestock market the black colour cattle are sold cheaply ".*

4.2.3 Herd structure of TZC

The cattle herds were composed of TZC strain with an average numbers per herd being 44.8 (Table 8). The results from Table 10 indicate that there was no significance difference ($p>0.05$) on males and females young stock herd structure between highland and lowland zones. The number of adult females was significantly higher ($p<0.05$) in the lowland zone (24.53) compared to highland zone (20.43) (Table 10). The average number of bulls per herd in lowland and highland zone were around 9.17 and 10.02, respectively. The ratio of males to females in highland zone was 1:2.2 and in the lowland was 1:2.4, demonstrating a relatively big number of male animals. However, the number of breeding bulls in each

herd was within the range of a mating ratio of one bull to below 10 breeding females. Aiello and Mays (1998) as cited by Mwacharo and Rege (2002) reported that this ratio is expected in livestock production system where the main function of the herd is to supply milk and draught power as it was the case in the present study. This ratio portrays a proportionately larger number of breeding bulls because in the agro-pastoral system farmers need draught animals, also it might be the guard against unpredicted losses of breeding bulls as a result of disease outbreaks.

Table 10: Herd structure of TZC

Herd structure	Location						Sig.
	Highland zone			Lowland zone			
	N	Mean	SD	N	Mean	SD	
Male young stock	60	3.70	3.50	60	3.75	3.24	0.794 ^{ns}
Male adults	60	9.17	8.14	60	10.02	12.68	0.077 ^{ns}
Female young stock	60	9.00	9.39	60	9.03	7.34	0.460 ^{ns}
Female adults	60	20.43	16.17	60	24.53	27.84	0.006*

Note: N=number of respondents
** Significant at P < 0.05*
^{ns} *not significant at P 0.05*

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Figure 6: A herd of Tarime zebu cattle

4.3 Sources and production systems characteristics of TZC

4.3.1 Characteristics of production systems for TZC

Table 11 summarises some of the cattle production systems characteristics based on the survey results. The majority of the farmers practiced traditional extensive grazing system of production whereby, cattle were herded continuously during dry and wet seasons. and minority practiced backyard production especially in the highland zone. The results indicate that although the majority of the respondents in both zones practiced extensive grazing production system, however results for *Chi-square test* indicate that there was significant association between zone and production system (<0.05) in which there was a substantial number of respondents in highland zone (23 out of 60) who practiced backyard production system compared to Lowland Zone (2 out of 60).

Table 11: Cattle production systems

Production system	Count (N = 120)		X^2-value	Sig.
	Highland	Lowland		
Backyard	23	2	22.282	0.000*

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Extensive	37	58
Overall	60	60

* *Significant at P < 0.05*
X^2 value = Chi-squire

In the traditional extensive grazing system, the predominantly kept cattle breed in the highland is the local breed (TZC) where those kept in the backyard system is the new improved breed dairy cattle under the MFEC-Project. Much of the traditional extensive grazing is practiced in the lowland zone. The local breeds are predominant in the two zones because they are adaptable to the harsh climatic conditions. The new improved breed dairy cattle under the MFEC-Project, mainly kept in the backyard system are found in highland zone, where they are adaptable and climatic conditions are favourable for fodder production.

4.3.2 Production performance of TZC

Productivity information of TZC was based on farmers' views and experience since they do not keep written records. The productivity of TZC in response to farmers' experience are presented in Table 12. Average productive lifetime for bulls and cows were 11.4 and 13.9 years, respectively. The TZC, like in many other domestic animals, females had greater longevity compared to males. Farmers' preferences and the type of animal use can determine the disposal time of cattle. Livestock keepers tend to retain females in their herds so as to have many calves, since one female calves only one animal per parturition.

Table 12: Production performance of TZC

Variables	**Location (N = 120)**				**Overall**
	Highland zone		**Lowland zone**		
	Mean	**SD**	**Mean**	**SD**	
Bulls productive life time (years)	11.25	2.12	11.67	2.16	11.46
Cows productive life time (years)	14.33	2.91	13.59	2.42	13.96
Number of calves per cow's life time	10.02	2.13	9.58	1.77	9.80
Age at first calving (years)	4.30	3.28	4.19	3.26	4.25
Calving intervals (months)	17.58	5.14	17.52	5.06	17.55
Lactation length (months)	7.88	2.29	8.53	2.20	8.20
Milk yield at start of lactation (litres)	1.72	0.67	1.47	0.57	1.59
Milk yield at peak of lactation (litres)	1.97	0.84	1.75	0.71	1.86
Milk yield towards end of lactation (litres)	0.79	0.38	0.65	0.24	0.72

Note: N = number of respondents

Average age at first calving was 4.2 years while average number of calves per cow's life time was 9.8. Average age at first calving for TZC in the study area is similar to that of other zebu cattle in Kenya (Mwacharo and Rege, 2002). Sungael (2005) found that advanced age at first calving and long calving intervals which are common both on private farm and in government farms is due to inadequate levels of feeding and is an indication of infertility or suboptimal fertility in the herd that is related to nutritional status of heifers.

Average calving interval was about 17. 5 months and lactation length was 8.2 months. The mean calving interval for TZC in the study area is close to the value of other SEAZ reported by Mwacharo and Rege (2002) in Kenya and within the range of calving interval for the TSHZ in Tanzania (Maeda-Machang'u *et al.,* 2000). Mwacharo and Rege (2002) as cited by Sungael (2005) found that the short calving intervals observed in some Maasai herds in Kenya is influenced by early weaning due to short lactation length, which facilitates early return to oestrus and thus conception.

Average milk yield at start of lactation, at the peak and towards the end of lactation were 1.59, 1.86 and 0.72 litres, respectively. The milk yields at start and peak of lactation for TZC in the study area is lower than the values of 2.1, 3.1 and 1.0 litres observed in other SEAZ in Kenya (Mwacharo and Rege, 2002). Absence of nutritional supplements and poor feeding may be the cause of low milk yield hence breed improvement programmes through selection is important by identifying farmers with high milk producing animals.

The TZC found in the study area had similar lactation lengths of 8.2 months compared to other SEAZ cattle reported by Mwacharo and Rege (2002). Mwacharo and Rege (2002) as cited by Sungael (2005) found that partial suckling which involved separation of a calf from its dam for a part of the day during grazing encourages early return to oestrus after parturition, hence short lactation lengths. Therefore, continuous milking of the dams and calf suckling should be encouraged as it could prolong lactation lengths.

According to Saeed *et al.* (1987), the rate of genetic progress is closely related with reproductive efficiency. The main traits associated with reproductive performance are age at first calving, calving intervals and, from these two, the potential lifetime production can be estimated. Absence of recording scheme for indigenous cattle performance is a most important factor that markedly restricts breed improvement initiatives.

4.3.3 Sources of TZC

Data on sources/origin of cattle in the respondents' herds at the time of the survey are presented in Table 13. The study revealed that care-taking, dowry payments and interbreeding are the main ways that farmers exercise breed choice or preference in their herds. Overall, 72.5 per cent of the cattle held by these households were inherited or they were born to an inherited TZC, 12.5 per cent were from dowry settling, 10 per cent originated through care-taking from friends or relatives, and just 5 per cent were purchased. Inheritance was the most important source for TZC breed; however, dowry payments and care-taking were also much more important source for TZC.

Table 13: Sources/Origin of TZC in the sample herds

Breeds	**Per cent (N = 120)**			
	Inherited	Purchased	Dowry payments	Caretaking
Tarime zebu cattle	72.5	5.0	12.5	10.0

Inheritance, dowry payments and purchase of cattle from neighbours within the district should be encouraged as they can help to maintain well-defined strain of TZC in the area as it was the case in the present study, while buying animals from other places without

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knowledge of its purity should be discouraged, since this is one of the sources of erosion of the genetic resources due to crossbreeding.

Figure 7: Example of genetic diversity in a herd of TZC

4.4 Socio-economic values of cattle preference and breed perceptions

The cattle enterprise is a multi-objective enterprise. In this study, the relative importance of the various objectives is sought by ranking. Farmers are asked their objectives of cattle keeping and relative weights of the objectives derived. The ranking of the preference of keeping TZC strain (shown in Appendix V) are summarized in Table 14. The orders of ranking were different between the two zones; however, draught powers, dowry payments settling and the role of cattle in home consumed milk are the most important objectives of keeping cattle in both highland and lowland zones. The role of cattle as security, source of income generation, offspring and store of wealth are relatively more important than prestige and source of manure in the surveyed area.

Table 14: Relative importance of keeping TZC

Objective	Highland zone (n =60)		Lowland zone (n = 60)	
	Relative weight	Rank	Relative weight	Rank

Socio-Economic uses				
Home consumed milk	0.13	3	0.12	3
Home consumed meat	0.10	5	0.10	5
Store of wealth /assets	0.07	6	0.07	6
Milk and livestock sales income	0.11	4	0.10	5
Security (servings and insurance)	0.11	4	0.11	4
Draught power	0.15	1	0.14	2
Calves	0.07	6	0.06	7
Manure	0.04	8	0.04	9
Socio-Cultural uses				
Dowry payments	0.14	2	0.18	1
Prestige	0.05	7	0.05	8
Sacrifice	0.01	10	0.01	11
Hides/skin	0.03	9	0.03	10

Note: Calculations were based on weight of 12, 11…., and 1 for the 1st, 2nd ...., and 12th rank respectively.

The relative importance of cattle in terms of hides/skin and as a sacrifice (e.g. circumcision) across the zones is the same though they ranked last in both zones. The role of cattle as work animal (draft, threshing, transport, and carrying water/firewood), milk production for home consumption, dowry payment and security (servings and insurance) were in the top four ranks. The results are consistent with the findings of Mphuru (1991) who reported that; indigenous cattle produce milk and meat for subsistence, supply draught power and manure for cropping and provide fibre, skin and transport; sales of livestock provide farmers with cash to purchase household necessities and farm inputs. The availability of local market for cattle makes most farmers to be commercially oriented and thus depend more on income from livestock and milk sales. The on-farm characterization study of the SEAZ production system on Southern rangelands of Kenya by Mwacharo and Rege (2002) indicated that the use of cattle for commercial sales is increasing in importance among the livestock keepers compared to socio-cultural value of cattle.

The integration of the rural communities into market economy is due to commercial sale of live animals and their outputs and the trend is increasingly replacing the socio-cultural value of cattle as illustrated in Table 14. The scenario has a negative effect since in due time the situation may contribute to the extinction of local breeds through replacement with the new improved breeds due to lack of competitiveness for the indigenous breeds (Kohler-Rollefson, 2004b). This revealed the importance of sensitization to livestock keepers in order to value the cultural values attached to their cattle strains so as to maintain the traits of TZC. Livestock field Officer (LFO's) as one of the key informants revealed that;

> *"Despite having new improved breeds, demand for TZC meat and milk have not changed since consumers in the villages and Tarime town are still interested in the meat and milk from traditional sector because of good taste".*

This breed perception is the most favourable starting point for conservation of TZC through sustainable utilization of CaAnGR and mobilization of production of the pure

strain of TZC population to farmers. This fact portrays the need of reliable source of support from government, non-government organizations and other institutions such as SUA for conservation of CaAnGR. We need to develop our indigenous animal genetic resources through advocacy and recognition of the roles which they play.

Figure 8: TZC bulls; they work as every day draught animals

4.4.1 Purpose of keeping TZC

The purposes of keeping TZC strain and other types of cattle are summarized in Table 15. Respondents indicated different purposes for keeping Tarime zebu cattle (TZC) breed. According to the survey results, the purposes for keeping TZC were to provide home consumed milk (89.2 per cent), draught power (72.5 per cent), home consumed meat (66.7 per cent), dowry payment (50.8 per cent), source of income (40 per cent) and social security (23.3 per cent) across the zones.

Table 15: Purpose of keeping TZC

Parameter	Per cent (n=120)		
	Highland (n=60)	Lowland (n=60)	Overall
Dowry payment	45.0	56.7	50.8
Home consumed milk	88.3	90.0	89.2
Draught power	60.0	85.0	72.5
Home consumed meat	58.3	75.0	66.7
Source of income	30.0	50.0	40.0
Social security	16.7	30.0	23.3

Note: *Data set were based on multiple responses*

The importance of cattle for home consumed milk, draught power and home consumed meat has been put as the priority one's in both highland and lowland zones, but also dowry payment settling (56.7 per cent) and the use of cattle as a source of income (50 per cent) are also the main purposes of keeping cattle in the lowland zone. The study also shows that the purpose of keeping indigenous cattle as a source of income (30 per cent) and social security (16.7 per cent) has got less priority in the highland zone. This can be revealed by the fact that Muriba ward in the highland zone was under MFEC-Project that provided loan of in-calf heifer to farmers, with conditions of establishing half to one acre of Napier grass and in turn to surrender 2 female calves. Hence people have shifted their mindset to the improved highbred cattle as a source of income through milk sales and a form of social security.

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Figure 9: Cow being milked

4.4.2 Traits/attribute preferences of TZC as perceived by farmers

The respondent's desirable traits/attributes of TZC are summarized in Table 16. About 70 per cent respondents in the highland zone and 86.7 per cent in the lowland zone mentioned that TZC strain has good tolerance to diseases. Furthermore, 65 per cent of respondents in both study areas said that TZC strain was a good draught animal and its meat (30.8 per cent) was also good. About 25 per cent of the respondents in the highland zone said that TZC have got quality milk since they had an experience with new improved breed of cattle milk from MFEC-Project as compared to 3.3 per cent of respondents in the lowland zone that entirely depends on milk from the traditional sector. But also more milk in Tarime town was still provided by the traditional sector, this was revealed by key informant LFO's.

Table 16: Preferred traits/attribute of keeping TZC breed

Parameter	Per cent (N = 120)		
	Highland	Lowland	Total
Disease resistance	70.0	86.7	78.3

	50		
	50		
	50		
	50		
Draught power	61.7	68.3	65.0
Good meat taste	30.0	31.7	30.8
Meat production	6.7	26.7	16.7
Quality milk	25.0	3.3	14.2

Note: Data set were based on multiple responses

Livestock keepers' perception that TZC are tolerance to diseases and good performance as draught animal with quality meat taste, reveals that these types of cattle are important to their livelihoods and possess survival traits/attribute under low level of livestock management. The results are consistent with the findings of Rege, (1999) who reported that, indigenous cattle are blessed with tick resistance and tolerance to vector-borne diseases and they frequently perform better than exotic breeds under low-input conditions, climatic stresses and especially during times of drought. Research conducted since the 1970s has demonstrated that, besides producing well in challenging environments, indigenous breeds also have the potential for higher production if provided with higher levels of input.

During discussions with the key informants, they revealed that they prefer TZC to other types of cattle because of their working ability and tastier meat (meat quality). At one point during survey although TZC calves commanded for premium price by Gwakisa P. S. (Prof.) for research project initiated by ILRI, farmers were found reluctant to sell their TZC calves under normal circumstances. This implies that TZC are highly respected culturally and used in a sustainable way as a form of social security. They continue to form the basis for many rural peoples' livelihoods, especially in the marginal areas, and respond to their cultural needs. The observation that farmers put much emphasis on environmental adaptation of their local breeds has been consistent in this study and other similar studies (Mwacharo and Rege, 2002) and therefore should be considered as a major criterion in designing future genetic improvement programmes.

4.4.3 Socio-economic factors influencing WTP for conservation of TZC

The willingness to pay question was administered in two forms. One was where the respondent was willing to pay cash, and the other applied if the respondent was willing to pay in kind (livestock). The second part of the question was meant to cater for those respondents who were unable to part with some cash but preferred to pay in kind. These were then converted to cash terms derived from the local market rates for livestock. The purpose of the question was to ascertain how much people would be willing to pay in cash/livestock for an environmentally sound TZC in order to conserve our genetic diversity of indigenous breeds. The answer to this question was most probably biased because some livestock keepers gave a willingness to pay zero not because they do not want to pay anything for TZC conservation but they felt that the problems concern government more for negligence of livestock keepers on proper animal management than they concern typical livestock keepers.

The respondent's willingness to pay is summarized in Table 17. The mean WTP for in order to conserve the preferred TZC was Tanzania shillings 1,500 and 150,000 at the surveyed period for the highland and lowland zone, respectively. This was equivalent to US $1.81 and US $10.19 for the highland and lowland zone, respectively. This figure is high, especially given that the income of the people in the highland and lowland is low.

This generally would reflect a need for TZC conservation in the study area. However, the mean WTP for the two groups of farmers was significantly different (p0.05). Difference in WTP for TZC conservation is due to emphasized MFEC-Project's new improved breeds by the highland zone community because of the favourable agro-ecology for the new improved breeds in the area.

Table 17: Willing to pay (WTP) for TZC conservation

Location	(N = 120)				
	Min (Tsh)	**Max (Tsh)**	**Mean (Tsh)**	**Mean (US $)**	**Sig.**
Highland zone	0	1 500.00	2 357.50	1.81	0.017*
Lowland zone	0	150 000.00	13 250.00	10.19	

** Significant at P < 0.05*

About 55% of the respondents across the zones were willing to pay in order to conserve the TZC, however, 45% were not willing to pay (Figure 6).

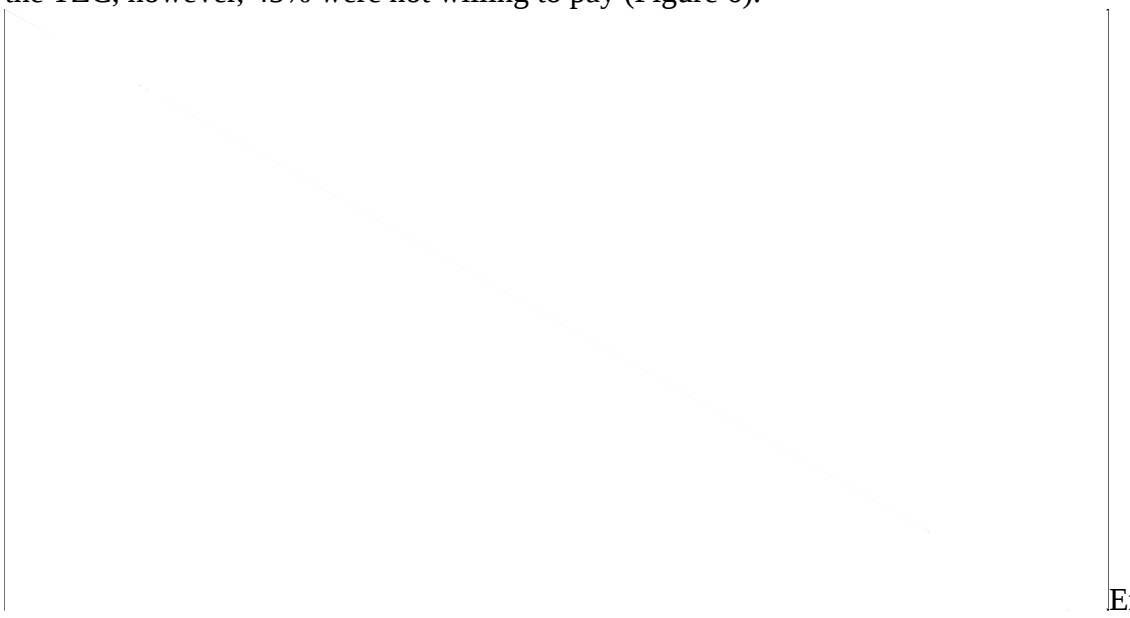

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Figure 10: Respondents' WTP for TZC conservation

Multiple regression models employed to determine socio-economic factors that influence the willingness to pay in order to conserve TZC. The dependent variables are the bids reflecting the respondents' willingness to pay (WTP) in order to conserve the preferred TZC. The socio-economic measures used as explanatory variables are income, number of cattle owned by households, education, age of household head, disease tolerance, dowry payment, draught power and breed preference. If outputs from TZC are assumed as normal goods, it is expected that higher income (also expressed by number of cattle) respondents would bid larger amounts. The remaining socio-economic variables used as explanatory variables are motivated by the literature on TZC conservation. For instance, educated individuals are expected to bid for more future improvements of TZC management systems. The regression model is as shown below:

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$WTPYi=\beta_0+\beta_1(INC)+\beta_2(TCAT)+\beta_3(EDUC)+\beta_4(AGE)+\beta_5(CATBR)+\beta_6(DROTP)+\beta_7(DSET)+\beta_8(DOW)+e_i$.

Where:

β_1 to β_i = Independent variable coefficient

β_0 = intercept

e_i = Random error

I = 1, 2 ،n. Where n is the total number of variables

Y_i = Dependent variable (WTP for TZC conservation)

X_1 to X_8 =Variables illustrated in the table 15

Table 18: Variable description, explanation and types of measurement

VARIABLE	DESCRIPTION OF VARIABLE	TYPES OF MEASURE	EXPLANATION BEHIND
INC (X_1)	Respondent's monthly income	Tshs.	Higher income (also expressed by number of cattle) respondents would bid larger amounts
TCAT (X_2)	Total cattle owned by farmer	Number of cattle	Farmers with more livestock are better placed in terms of WTP for conservation of TZC
EDUC (X_3)	Respondent's years of education	Number of years in school	Educated individuals are expected to bid for more future improvements of TZC management systems
AGE (X_4)	Respondent's age	Number in years	Older people are expected to bid less than the young ones, because the younger people have a longer time to face the problems genetic erosion
CATBR (X_5)	Cattle breed owned by farmer	Dummy (1=TZC, 0=Any other)	Respondents who preferred TZC are expected to bid more for TZC
DROTP (X_6)	TZC power serve as an input to crop production	Dummy (1=Yes animal, 0=No)	Respondents using cattle as a draught animal are more WTP for TZC
DSET (X_7)	Ability to survive and tolerate diseases	Dummy (1=Yes animal, 0=No)	Farmers are expected to bid more if TZC are resistant to diseases
DOW (X_8)	Use of TZC for settling dowry payments	Dummy (1=Yes animal, 0=No)	Respondents using TZC for settling dowry payments are expected to bid more to avoid genetic erosion

To assess goodness of fit of the regression model, a coefficient of determination (R^2) was employed. Coefficient of determination shows the strength of the relationship between dependent and independent variables. Standardized equations using partial regression coefficients beta weights (b*) were developed in this study. Standardized figures are used more when trying to assess the relative impact of each independent variable. A standardized partial regression coefficient (beta weights) reflects the weight to be applied to an independent variable when one or more specified independent variables are included in the equation. Beta weights were used to explain different phenomenon in this study.

Table 19: The relationship between socio-economic variables (Xi) and WTP for TZC conservation (Y_i)

Independent variable Xi	Beta (b*)	Sig. t
Income	0.301	0.000*

Total no. of cattle owned by hh	0.116	0.202 ^{ns}
Disease tolerance	0.220	0.015*
Age of hh head	-0.181	0.079 ^{ns}
Dowry payment	0.276	0.005*
Education	-0.116	0.267 ^{ns}
Cattle breed preferred	0.082	0.342 ^{ns}
Draught power	0.104	0.201 ^{ns}

R^2 = Coefficient of determination (0.503)
** = Significant at P < 0.05*
ns = not significant at P > 0.05
b = beta weight*

Table 19 reveals an R^2 of 0.503 means that 50.3 per cent of the variation in Y is explained by variation in X. There is significant correlation between the willingness to pay for TZC conservation with income obtained from livestock and milk sales, disease tolerance and dowry payment; these were statistically significance at $p<0.05$. These results implied that the three predictors had more influence than the other in the regression model towards the WTP for conservation of TZC in the study area.

4.4.3.1 Household income

In general, the results revealed that there are socio-economic variables that were systematically related to willingness to pay. Income is significantly correlated with the WTP for TZC conservation ($p<0.05$). It has got large beta weight value (0.301) relative to other X variables in the model. The effects of income on bids tended to be big and positive, as would be expected, indicating that people with higher income as a results of livestock and milk sales are willing to pay more for TZC conservation. The likely explanation for this could be that households with higher incomes could be deriving most of these incomes from indigenous livestock enterprise related activities. Therefore, such households would be more willing to pay to have TZC conserved.

4.4.3.2 Dowry payments settling

In a similar regression, we used dowry payments by households head instead of income since it is a common practice in the study area and hence there could probably be multi-colinearity between the two variables. The results were not significantly different from those on income ($p<0.05$. The variable rank second in beta weight value (0.276) relative to other X variables in the model. An interpretation of this result is that respondents with large numbers of cattle are likely to realize the effects of dowry payment and are thus more willing to pay for TZC conservation.

4.4.3.3 Disease tolerance and total number of cattle owned by farmer

As expected, ability of TZC to resist diseases encourages people to bid more. The coefficient on the disease tolerance ability is positive and significant ($p<0.05$). The variable rank third in beta weight value (0.220) relative to other X variables in the model. More support was found for the expected positive relationship between awareness of TZC disease tolerance and WTP, implying that respondents who are aware of disease tolerance

within the herd of TZC are WTP to conserve environmentally tolerance TZC. Cattle animal genetic resources (CaAnGR) are particularly important in feeding a rapidly expanding population in the traditional sector under typically harsh environmental conditions. No systematic relationship between the total number of cattle owned by households and the amount of the bid was found. Although households with large number of cattle tended to bid more, the coefficients are positive but not significant in the statistical sense.

4.4.3.4 Age of household head

The results indicated a negative correlation between age and the WTP for TZC conservation. The coefficient on age is negative and not significant. This may be caused by various factors; young people are concerned more with TZC conservation since they have long life period of facing the challenges of high level of genetic erosion through crossbreeding; while older people are not concerned on the likely effects (Table 19).

4.4.3.5 Education of household heads

The study revealed that there is negative correlation between education and WTP for TZC conservation (Table 19). The coefficient on the education level is negative and not significant ($p>0.05$). This implies that the higher the education the less WTP for TZC conservation since most educated individual tends to possess improved hybreeds. There is a need to sensitize stakeholders on the need to conserve our indigenous animal genetic resource.

4.4.3.6 Preferred cattle breed and using TZC as draught animal

There is a positive correlation between preferred cattle breed i.e. TZC as well as using cattle as a draught animal and WTP for TZC conservation, however the coefficient in both categories were not significant ($p>0.05$) (Table 19). More support was found for the expected positive relationship, implying that respondents who preferred TZC as well as using cattle as a draft animal are more WTP for TZC conservation, however the results are not significant.
Most of the respondents who were WTP were interested in paying cash rather than foregoing their livestock, reflecting the strong attachment these people have with their livestock. This kind of attitude may likely be the starting point to conserve the TZC.

4.4.4 Importance of crop and livestock enterprises

In order to assess the importance of the crop and livestock enterprises, responses on the two enterprises were obtained from interviews. With regard to food security, both crops and livestock in the surveyed were equally ranked in the two zones. The results from *Chi-square test* in Table 20 indicate that there was no significant difference on ranking between zones and enterprise for food security ($p>0.05$) in which there was a substantial number of respondents in both highland and lowland zone who ranked both crop and livestock enterprise as a source of food security. This revealed that the interaction between the two enterprises for food security was high. Through animal draft power and manure, cattle contribute directly to increased crop production.

Table 20: Relative importance of crops and livestock enterprise for food security

Enterprise	Per cent (N = 120)		X^2-value	Sig.
	Highland	Lowland		
Crop	48.3	50.0	0.033	0.500^{ns}
Livestock	51.7	50.0		

ns not significant at P > 0.05
X^2-value = Chi-squire value

This suggests that there is a high level of crop-livestock enterprise integration as a source of food security among the cattle owning households. This observation is in accordance with those reported by Mphuru (1991) which emphasizes that in developing sustainable production enterprises, integration of crop and livestock enterprise are of great importance. The integration has the potential of raising sustainable yield of crops and livestock. The study area is potential for agricultural production for perennial crops (coffee and banana) in the highland zone and crops such as maize, Irish potatoes, legumes and vegetables across the zones.

With regard to the sources of incomes, most of the respondents ranked livestock enterprise with its outputs as the first source of income across the zones (Table 21). Variation in ranking orders of crops and livestock enterprise in contribution to income of households was observed whereby in the highland zone 81.7 per cent of farmers ranked livestock as the major contributor of household income through selling indigenous livestock and milk from improved hybreeds compared to 68.3 per cent in the lowland zone selling indigenous livestock and milk from indigenous cattle. However, there was no significant difference across the zones on using indigenous livestock as a source of income generation for the households (p>0.05). This revealed that the crops enterprise was taken as secondary enterprise to generate capital for the family.

Table 21: Relative importance of crop and livestock for income generation

Enterprise	Per cent (N = 120)		X^2-value	Sig.
	Highland	Lowland		
Crop	18.3	31.7	2.844	

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Livestock	81.7	68.3	0.070^{ns}

ns not significant at P > 0.05
X^2 value = Chi-squire value

4.5 Breed-specific management constraints and desired policy interventions

4.5.1 Production and marketing constraints of TZC

The study revealed that diseases (59.2 per cent) and parasites (45 per cent) were the common challenges to the most of the farmers of highland and lowland zones (Table 22). Ectoparasite control was not commonly practiced despite the tick challenges. This was revealed by the Village Executive Officer (VEO) as one of the key informants said that;

> *"Positive characteristics of TZC are their high level of resistance to diseases and efficient utilization of poor quality feeds and good adaptability to harsh environment, this is due to the fact that the majority of the farmers do not control ectoparasites through dipping their animals and housing is provided in form of yard/kraal without roofing".*

This implies that animal health-related problems, particularly tick-borne diseases were the general concern of the livestock keepers in the study area. Farmers (25 per cent) mentioned grazing land shortages as a major constraint to cattle production. In addition, 14.2 per cent of the respondents mentioned lack of vet services and drugs together with feed shortage during the dry season as another limiting factor to cattle production. Other problems mentioned were inadequate extension service (9.2 per cent), inadequate cattle dip (6.3 per cent), water shortage (4.2 per cent) and inadequate quality feeds (3.3 per cent). However, there is slightly difference between the two zones in terms of percentages, where highland zone experienced minor problems of quality feeds (1.7 per cent), water shortage (1.7 per cent), cattle dips (1.7 per cent), extension services (5 per cent) and veterinary services and drugs (8.3 per cent) (Table 22).

The constraints to TZC production are similar to those reported in Iringa region (Tanzania) by Maeda-Machang'u *et al.* (2000) in agro-pastoral and pastoral production systems. Diseases and parasites observed to be the main production constraints to livestock keepers. Biwi and Shamhuna (1986) also reported that constraints to the livestock sector in Tanzania include inadequate feeding especially during the dry season, diseases, low genetic potential of indigenous animals and problems related to management. The majority of the livestock keepers had no strategies for diseases and parasites control regime. The situation was due to inadequate extension services and dips or presence of functionless dips. Feed shortages during dry season was found to be of concern in the lowland zone, therefore, there is a need for awareness creation to livestock keepers be educated on the importance of conserving forages for use at time of scarcity.

Table 22: TZC production constraints

Parameter	Location (N = 120)		Overall (%)
	Highland (%)	Lowland (%)	
Inadequate quality feeds	1.7	5.0	3.3
Water shortage	1.7	6.7	4.2
Diseases	56.7	61.7	59.2

Parasites	48.3	41.7	45.0
Feed shortages during dry season	8.3	20.0	14.2
Lack of vet services and drugs	8.3	20.0	14.2
Grazing land shortages	36.7	13.3	25.0
Inadequate extension service	5.0	13.3	9.2
Inadequate cattle dips	1.7	15.0	6.3

Note: Data set were based on multiple responses

The availability of cattle auction markets in Tarime district makes majority of the farmers to be commercially oriented and thus depend more on indigenous livestock and milk sales income. The district has three major livestock markets at Magena, Randa and Mtana and eighty small cattle auction markets. There are two indigenous livestock milk markets in the district i.e. Tarime town and Sirari. However, the respondents revealed that disorganised livestock and milk market (47.5 per cent), low price of milk (25.8 per cent), lack of reliable market for milk (25.7 per cent) and disorganised tax for livestock (14.2 per cent) were the common challenges to the majority of the farmers of highland and lowland zones (Table 23). The results are in accordance with those reported by Butterworth (1985); who revealed the absence of effective marketing channels in the tropics as a major constraint to growing cattle sales and off takes. Where there are no proper market infrastructure and management, cattle frequently sold to middlemen who make premium profit from livestock keepers who are in need of finance. The capacity to market the livestock is increasingly becoming important. Livestock marketing was identified as an issue. Traditional farmers are taking a more market oriented outlook as people are being asked to pay for a wide range of services from education to health. Therefore, the establishment of a more efficient marketing system is an important aspect of any livestock development strategy.

Table 23: Marketing constraints

Parameter	Location (N = 120)		Overall
	Highland (%)	Lowland (%)	(%)
No reliable market for milk	28.3	23.3	25.8
Low price of milk	28.1	23.3	25.7
High tax in local livestock market	11.7	13.3	12.5
Disorganised livestock and milk market	55.0	40.0	47.5
Disorganised tax for livestock	5.0	23.3	14.2

Note: Data set were based on multiple responses

4.5.2 Desired policy interventions for improving production and market

The results of the study indicated various policy and marketing recommendations obtained from survey. It was recommended that new strategies be put in place to promote indigenous breeds from policy level to community level. For example, provide extension services to farmers by the government (48.3 per cent) (Table 24), could be employed to encourage farmers to continue farming with indigenous breeds. Extension officers need to be trained regarding the value of indigenous breeds. The respondents also desired to have reliable market for livestock and milk (28.3 per cent) and encourage governments to interfere with market activity in the form of proper market infrastructure, controlling price and tax relief as well as provision of veterinary services (21.7 per cent) for proper animal

health. Generally, there is poor delivery of animal health services in pastoral areas. Conventional veterinary centers are very few, under-equipped, costly and inaccessible due to long distances to these centers and poor road infrastructure. The results are in accordance with those reported by Geerts, *et al*. (2001) who revealed that; pastoralists mainly rely on livestock drugs purchased from vendors without any quality assurance or proper information on application procedures and dosage requirements which can cause failure of drug treatment. Improvement of water sources through construction of dams "malambo" and cattle dips (17.5 per cent) could reduce the water shortage and tick-borne diseases as well as increase support for the development of traditional production systems based on indigenous cattle.

Table 24: Desired policy interventions

Parameter	Location (N = 120)		Overall (%)
	Highland (%)	Lowland (%)	
Extension services to farmers	53.3	43.3	48.3
Reliable market for livestock and milk	38.3	18.3	28.3
Diseases control programme	8.3	10.0	9.2
Vet services and drugs	11.7	31.7	21.7
Cattle dips and "malambo"	20.0	15.0	17.5

Note: Data set were based on multiple responses

Cunningham (1994) reported that; policies should not be developed in a boardroom; instead, they need to be designed in consultation with all stakeholders. Indigenous knowledge plays significant role for improving indigenous livestock breeds and must be protected through intellectual property rights. Without such knowledge, policy makers and development agencies lack the basic information they need to ensure their efforts are contributing to sustainable development. This was revealed by local extension staff in Muriba ward as one of the key informant said;

> *"TZC improvement in terms of policy interventions strategies will have the greatest impact when there is community involvement integrating traditional knowledge and innovations with modern livestock management practices".*

Policy interventions are therefore necessary to support their knowledge especially on production if society's goals are to be met.

4.5.3 The relevance of local institutions in the management of CaAnGR: "Kusaghali(ri)"

The study revealed that it would also be important to document local concepts as well as the social dimensions, i.e. knowledge about the economic and social-local institutions that have shaped community in defining how CaAnGR are governed at the village, ward and or division levels. It has been observed from both individual interviews and key informants in this study that, conservation and development of local breeds has to be backed up by politically motivated institutional (86.7 per cent) support guaranteeing access to pastures as well as water. Culturally motivated institutional (56.7 per cent), that is local ideology that underpin cattle ownership institution among local Kurya communities in Tarime

district. Scientifically motivated institutional (25.8 per cent) support includes research and development on the improvement of the local breeds in terms of productivity.

Table 25: Desired institutions for management of CaAnGR

Parameter	Location (N = 120)		Overall (%)
	Highland (%)	Lowland (%)	
Politically motivated institutions	88.3	85.0	86.7
Culturally motivated institutions	56.7	56.7	56.7
Scientifically motivated institutions	25.0	26.7	25.8

Note: Data set were based on multiple responses

Local Kurya respondent in Kemambo ward revealed that;

> *"The local institution that makes a contribution to maintaining livestock genetic diversity of TZC is "kusaghali(ri)" (literally in swahili "kuwekeza"). It is ubiquitously practiced in many parts of Tarime district and region as a whole. It generally fulfils an important socio-economic and security function whereby 2/3 of the farmer's livestock herd is distributed and given to other friendly individuals or family members for rearing on his/her behalf. However, it is also a form of milk-assistance and draught power for those without cattle or with little ones. Kusaghali(ri) is regarded as serious partner of risk spread (security) in case of disease outbreaks or cattle raids by rustlers and in the conservation and management of local livestock breeds by the community".*

This observation is in accordance with those reported by Mbwambo, (2000), that local institutions constitute an essential component of any attempt to facilitate community engagement in conservation and management of biological diversity. The observation therefore, portrays the importance of socio-economic capital, including factors such as trust, opportunities for *in-situ* conservation which are explored from a people-centered approach considering the management of CaAnGR in terms of local institutions. The observations are also consistent with the findings of Köhler-Rollefson, (2000) who reported that; it will be difficult if not impossible to conserve *in-situ* animal diversity without understanding and invigorating local institutions and embedded knowledge systems. Therefore, management of CaAnGR involves important institutional decisions because once a breed becomes undervalued, either through lack of a resource base or through lack of demand for its outputs, then a secondary development is the disintegration of the traditional institutions that were associated with it. The superior quality of TZC is a reflection of highly developed and sustained local institutions for conservation and managing CaAnGR in the study area.

4.6 Body measurements and phenotypic descriptions of TZC and SZC

4.6.1 Linear body measurements of TZC and SZC

The estimated live weights for mature zebu cattle in the study were 292.3 ± 32.2kg for males, 319.1 ± 35.9kg for castrates and 249.2 ±.23.5kg for females (TZC); 308.2 ± 42.5kg for males, 365.3 ± 14.4kg for castrates and 262.3 ± 26.1kg for males (SZC) in Table 26 below. However, the mean body weights for the two groups of animals (Tarime and

Misungwi districts) were not significantly different ($p>0.05$). The mean body weight of castrates was significantly higher ($P<0.05$) than that of males and females, but also the differences in weights between intact males and females were statistically significant ($P<0.05$) for the two groups of animals (Table 26). The mean body weight values are closely related with those reported by Sungael (2005) for Iringa red zebu cattle in Tanzania. However, the average body weights of TZC and SZC for each sex were lower compared to that of Butana and Kenana cattle reported by Osman (1985) in Sudan. These differences are probably contributed by genetic makeup and age differences at which the measurements were taken since animal increase in weight with ages. Butterworth (1985) reported that cattle in the tropics rarely reach mature weight of 450kg.

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Table 26: Least square means (± SD) for body measurements of TZC and SZC

Variables	Sex	Location				Sig.
		Tarime		Misungwi		
		N	Mean ± SD	N	Mean ± SD	
BW (kg)	M	6	292.32 ± 32.16^{b}	11	308.20 ± 42.53^{b}	0.260^{ns}
	F	26	249.34 ±.23.45^{c}	27	262.29 ± 26.06^{c}	
	C	10	319.12 ± 35.88^{a}	13	365.28 ± 14.42^{a}	
HW (cm)	M	6	111.08 ± 6.33^{b}	11	120.89 ± 7.82^{b}	0.000*
	F	26	107.09 ± 4.46^{b}	27	115.30 ± 6.51^{ab}	
	C	10	116.11 ± 6.38^{a}	13	124.85 ± 3.74^{a}	
BL (cm)	M	6	85.85 ± 2.72^{b}	11	114.18 ± 14.20^{b}	0.000*
	F	26	85.66 ± 3.39^{b}	27	94.56 ± 8.43^{c}	
	C	10	95.93 ± 10.18^{a}	13	123. 69 ± 14.07^{a}	
HG (cm)	M	6	150.00 ± 4.56^{b}	11	152.06 ± 6.88^{b}	0.437^{ns}
	F	26	144.45 ± 5.04^{b}	27	141.87 ± 4.76^{c}	
	C	10	154.31 ± 6.07^{a}	13	161.08 ± 4.25^{a}	
RW (cm)	M	6	30.93 ± 1.69^{b}	11	33.25 ± 2.63^{b}	0.000*
	F	26	29.58 ± 1.26^{c}	27	30.89 ± 1.06^{c}	
	C	10	32.05 ± 1.91^{a}	13	34.56 ± 0.46^{a}	
EL (cm)		42	19.94 ± 2.96	51	18.59 ± 2.34	0.016*
EW (cm)		42	12.63±1.29	51	11.91±1.01	0.004*
HL (cm)		42	23.60±8.90	51	31.37±11.73	0.001*

** Significant at P < 0.05 and ^{ns} not significant at P 0.05 between TZC and SZC. ^{a,b,c} Means within a column within variable with different superscripts are significantly different P<0.05.*
BW = Body weight; HW = Height at withers; BL = Body length; HG = Heart girth; RW = Rump width; EL = Ears length; EW = Ears width; HL = Horns length; M = Males; M = Males; F = Females; C = Castrate

The height at withers for mature TZC were 111.1±6.3cm (males), 107.1±4.5cm (females) and 116.1±6.4cm (castrate); for mature SZC were 120.9±7.8cm (males), 115.3±6.5cm (females) and 124.9±3.7cm (castrate) (Table 26). The mean wither height of castrate were higher followed by that of males and females ($p<0.05$), but also the mean height at withers for SZC in Misungwi was significantly higher than for TZC in Tarime ($p<0.05$). The height at withers for TZC and SZC are lower compared to those of Kenana and Butana cattle reported by Osman (1985) in Sudan and Boran cattle in Kenya (Kimenye, 1985). The differences in height at withers are contributed by the differences in genotypes of cattle.

The results in Table 26 show that the mean body length for SZC in Misungwi district was significantly higher than for TZC in Tarime district ($p<0.05$). The mean body lengths for TZC were 85.9±2.7cm (males), 85.7±3.4cm (females) and 95.9±10.2cm (castrates); while

for SZC were 114.2±14.2cm (males), 94.6±8.4cm (females) and 123.7±14.1cm (castrates). The mean body length of castrates was the highest in the two groups of animals followed by that of males and females, but there were no significant differences ($p>0.05$) on body length between males and females for TZC. The mean body length values are low compared with those reported by Sungael (2005) in phenotypic characterization and slaughter characteristics of Iringa red zebu cattle in Tanzania. The differences in body length for the two groups of animals are contributed by genotype since the kind of management which the cattle receive are the same.

The average heart girth values for TZC were 150±4.6cm (males), 144.5±5.0cm (females) and 154.3±6.1cm (castrates); for SZC were 152.1±6.9cm (males), 141.9±4.8cm (females) and 161.1±4.3cm (castrates). However, the results show the mean heart girth values for the two groups of animals (TZC and SZC) is not significantly different ($p>0.05$). The heart girth of castrates was greater than that of males and females ($p<0.05$). The mean heart girth values are equal with those reported by Sungael (2005) for Iringa red zebu cattle in Tanzania. However, the values of heart girth for TZC and SZC are lower compared to those of Butana cattle reported by Osman (1985) in Sudan and Boran cattle in Kenya (Kimenye, 1985). This difference in heart girth is attributed to the differences in body size and degree of fatness. Furthermore, mean rump width for SZC in Misungwi district was significantly higher than that for TZC in Tarime district ($p<0.05$). The mean rump width for TZC were 30.9±1.7cm (males), 29.6±1.3cm (females) and 32.1±1.9cm (castrates); while for SZC were 33.3±2.6cm (males), 30.9±1.1cm (females) and 34.6±0.5cm (castrates). Castrates for both groups of animals had significant wider rump than males and females ($p<0.05$). These observations on rump width suggest that TZC and SZC are among the Zebu cattle with medium body size as it was mentioned by Msanga *et al.* (2001).

The ANOVA test showed that there were significant differences ($p<0.05$) between the groups and within the groups on ears length and width for TZC and SZC (Table 26). The average ear lengths were 19.9±3.0cm (TZC) and 18.6±2.3cm (SZC) while the average ear widths were 12.6 ±1.3cm (TZC) and 11.9±1.0cm (SZC). Ear length observed in this study is similar to those of other TSHZ cattle reported by Joshi *et al.* (1957). With regards to horn length, the differences between the groups and within the groups for horn length were significant ($p<0.05$). The mean value of horn length for TZC was 23.6±8.9cm and for SZC was 31.4±11.7cm as shown in Table 26. The differences in body measurements between the two groups and within the group explain the genetic diversity of the indigenous cattle in the study areas.

Simple linear regression equation was used to assess the suitability of linear measurements for predicting body weights of TZC and SZC measured at the field level (Table 27).

Table 27: Simple linear regression equation for prediction of body weight (Yi) using linear body measurements of TZC and SZC at field level

Independent variable Xi	SE	Beta (b*)	Sig. t
Heart girth	0.01	0.94	0.000*
Height at wither	0.11	- 0.05	0.015*
Body length	0.06	0.07	0.002*
Rump width	0.48	0.07	0.001*

Xi = All independent variables (Heart girth, Height at withers, Body length, and Rump width)
Yi = Dependent variable (Body weight)
R^2 = Coefficient of determination (0.982)
** = Significant at P < 0.05*
b = beta weight*
SE = Standard error of estimates

The result reveals an R^2 of 0.982 which means that 98.3 per cent of Yi (body weight) is explained by Xi (heart girth, height at wither, body length and rump width). Heart girth predicted body weight with the highest accuracy of statistical significant ($p<0.05$) as well as beta weight value (0.94). In comparison with other variables, heart girth showed a comparatively better prediction accuracy and low error of estimates of body weight than the rest of the linear body measurements taken. These observations support the findings by other authors (Francis *et al.*, 2002; Lawrence and Fowler, 1997) that heart girth is the body measurement, which exhibits the highest correlation with body weight. This implies that the relationship between heart girth and body weight is high, hence it the reliable body measurement that can be used for prediction of body weight even in TZC and SZC.

Prediction of body weight by taking body measurement is easier and cost effective to smallholder farmers than the direct use of weighing bridge for measuring body weight. Weighing bridges are expensive and usually unavailable to smallholder farmers. Francis *et al.* (2002) suggested that external body measurements obtained by using measuring tapes are cheaper and useful tools at field condition and easily accessible by farmers and extension workers in rural areas. Therefore, livestock keepers should be trained to make use of physical measurements so as to make plans for rational decision about selling or breeding as well as daily management of their cattle.

4.6.2 Physical characteristics of TZC and SZC

The phenotypic description of TZC (Tarime Zebu cattle - Tarime district) and SZC (Sukuma zebu cattle - Misungwi district) is summarized in Appendix VI and Figure 11a, 11b and 11c. According to 83.3 per cent (Tarime) and 82.4 per cent (Misungwi) of interviewees, these animals exhibit docile temperament. The ear tips were frequently brown (59.5 and 82.4 per cent), black (26.2 and 17.6 per cent) and white colour (14 and 0.3 per cent) for TZC and SZC respectively. About 69.9 per cent of the animals had brown colour on their muzzles where by 19.4 per cent and 10.8 per cent had black and grey colour respectively; and their hooves were generally grey (86 per cent), black (12.9 per cent) or cream (1.1 per cent). Naval flap was absent in most animals (77.4 per cent) and 77.5 per cent of them had medium dewlap. Roofy rump profile was found (75.3 per cent) in most animals. Some animals (53.8 per cent) had small hump size and others (37.6 per cent) had medium sized hump at thoracic and face profile was flat similar with the findings by Sungael (2005). Tail thickness at the base was medium (89.2 per cent) and

about 52.7 per cent of animals had long tail length (below the hock joint) and 44.1 per cent had medium tail length (at the hock joint); tail switch had brown (65.7 per cent), black (20.4) and white colour (14 per cent). Many animals (88.2 per cent) had curved horn shape and others (11.8 per cent) had straight horns that were oriented upward (87.1 per cent). The horns were frequently (71 per cent) grey or with cream (23.7 per cent) and black colour (5.4 per cent). The majority of the cow had small (92.3 and 66.7 per cent) to medium (7.7 and 33.3 per cent) udder size for TZC and SZC respectively; and their front quarters were frequently small (64.2 per cent) in size and large in some (35.8 per cent) of them. The teat size was medium sized for the majority (86.8 per cent) of cows but there were others (13.2 per cent) that had small teat size.

Figure 11a: Typical mature Tarime Zebu bulls utilizing maize stovers

Figure 11b: Typical mature Sukuma Zebu bull

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Figure 11c: A typical mature Sukuma Zebu cow

Observations for coat colours of indigenous cattle in the study area are summarised in Table 28. Among the 93 herds sampled, the dominant colours in both locations were brown followed by spotted (black with white spots or red with white spots), roan (mixture of brown with white or grey) and red. Forty-two herds with 626 heads of cattle were observed in Tarime district whereby the common colours for TZC were brown (14.2 per cent), fawn i.e. light yellowish brown (13.4 per cent), grey (12.6 per cent) and roan (10 per cent). In Misungwi district 51 herds were sampled which in total had 627 heads of cattle in which the common colours for SZC were brown (11.9 per cent), spotted (11.7 per cent), roan (10 per cent) and red (9.3 per cent). The findings suggest the diverse coat colours of TZC and SZC but quite a fair percentage of cattle were brown.

Table 28: Body coat colour description of TZC and SZC

Coat colour	Tarime (n = 42)		Misungwi (n = 51)		Overall (n = 93)	
	N	% of Total sum	N	% of Total sum	All N	Total %
Red	22	0.8	95	15.2	117	9.34
Brown	89	14.2	60	9.6	149	11.89
Black	51	8.1	49	7.8	100	7.98
White	59	9.4	40	6.5	99	7.90
Grey	79	12.6	22	3.5	101	8.06

Pied	57	9.3	42	6.7	99	7.90
Spotted	50	8.0	97	15.5	147	11.73
Fawn	84	13.4	25	4.0	109	8.70
Dun	24	3.8	77	12.3	101	8.06
Brindle	48	7.7	58	9.4	106	8.46
Roan	63	9.9	62	9.9	125	9.98
Total sum	626		627		1253	

Note: n = number of herds surveyed; N = number of cattle observed

Information about population status of TZC and SZC was based on farmers' perception and field observation. Despite preferences for indigenous zebu cattle, breed numbers are considered to have been in decline. The population trend of TZC and SZC within herd as perceived by the respondents is indicated in Table 29. More than half of the respondents (55.9 per cent) reported that the TZC and SZC were decreasing while 25.8 per cent said that they were stable.

Table 29: Population trend within herd of TZC and SZC

Variable	**Location (per cent)**		
	Tarime (n = 42)	**Misungwi (n = 51)**	**Overall (n = 93)**
Increasing	9.5	3.9	6.5
Decreasing	61.9	51.0	55.9
Stable	19.0	31.4	25.8
Unknown	9.5	13.7	11.8

The decrease in the TZC and SZC breed numbers was attributed mainly in decreasing grazing land, the reduction in farm size and the increase in the human population. This observation as well as the perception by farmers that the number of TZC and SZC are decreasing in their herds suggests that the cattle strains are under risk of extinction. But that decrease in TZC and SZC breed per respondent may not necessarily mean decrease of the breed's population in the study area as the livestock may be spread among family members as suggested in the"*kusaghali(ri)"*institution. Unfortunately, to make solid statement about the estimated population size of TZC and SZC is difficult since there is no comprehensive survey which has been carried out to establish their population census. This argument is supported by Sungael (2005) who reported that, it is unfortunate that all indigenous cattle strains are considered as one group of TSHZ cattle, hence, there is no population data specific for each TSHZ strain. Therefore, it is important to estimate the population size of indigenous cattle according to their strains in order to facilitate the monitoring and planning purposes.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Overview

Information from literature reviews and the summary of the major findings in this dissertation brought to light significant features in the application of traditional knowledge in socio-economic value preference of indigenous livestock production in general. This final chapter draws conclusions and recommendations emanating from the study.

5.2 Conclusion

As in most traditional subsistence livestock production systems elsewhere, the livestock keepers in Tarime neighbouring Misungwi districts, North-West Tanzania, depend on their local and highly adapted cattle breeds for survival. The livestock keepers in the study area prefer TZC for their working ability, testier meat, dowry payments settling and home consumed milk. Docile temperament and easiness to train as draught animals are the other criteria that make TZC to be preferred in crop-livestock integrated production system.

The TZC are kept under crop-livestock integrated system and the predominant grazing system is extensive system whereby cattle are herded on natural pastures. Attempts to integrate the two major livestock and crop enterprises for mutual relationship are highly emphasized. Extension services should make an effort to emphasize on the improved production of TZC and crop enterprises to encourage linkages between the two enterprises as a source of food security. Improvement of water sources through construction of dams could reduce the water shortage.

In the present study, it has been found that TZC have medium body size with an average body weight of 292±32, 249±24 and 319±36kg for males, females and castrates. For neighboring SZC the corresponding figures were 308±43, 262±26 and 365±14kg body weight. The assessment of the reproduction performance of TZC showed that age at first calving is four years, calving interval is 17.5 months and lactation length is 8 months. The TZC have distinctive adaptive features (resistant to disease, vectors and challenges) that are recognised and appreciated by farmers and made the breed first choice in their production system. It is, however, observed that both breeds are at risk from paradigm shift towards improved livestock production, and from poverty and lack of awareness and/or interest by government and non-government organizations such as MFEC-Project operating in the area. Creating the Right Policy Framework is absolutely essential as lack of access to grazing areas prevents people from keeping traditional breeds, restoration of grazing rights or opportunities. Devising urgent measures that incorporate the sustainable use of the genetic resources with full participation of the communities is a requisite to halt and reverse, in the long term, the journey of the breed to extinction and making the people that depend on them for their livelihoods less vulnerable. Projects and programmes to conserve and develop indigenous livestock resources must build on local knowledge’s socio-economic considerations and institutions. Recovery and strengthening of animal production-related indigenous knowledge must be the starting point of all interventions.

5.3 Recommendations

Traditional knowledge in socio-economic value must be tapped and where necessary be improved for the benefit of all the involved parties i.e. farmers, researchers and extension agents, with a general view of sustainable productivity of indigenous tropical livestock systems.

It is recommended that studies should be done to verify additional measurements that were difficult to measure them accurately under on-farm conditions.

Frequent livestock census is required to obtain the actual number of animals present so as to help in deliberate checking of actual stocking rates in order to estimate extinction rates of TZC. External intervention for improving indigenous livestock productivity could be enriched with traditional knowledge and farmers' experiences associated with biological, economic and social outlook. A high value of the TZC as well as many threatening factors provides justification for launching an *in-situ conservation* programme for TZC, even if the breed in question is not yet recognised as being endangered.

There is a need for expansion of DAD-IS and DAGRIS format to include information about the traditional knowledge on their socio-economic value associated with particular breeds. The road map to sustainable livestock production must insist on immediate and deliberate efforts to integrate traditional knowledge and contemporary scientific knowledge in such a way that a brick laid by the traditional knowledge is cemented by contemporary scientific understanding and *vice versa*.

Future studies in traditional knowledge must also employ contemporary data acquisition and analytical techniques including the use of geographical information systems (GIS) and computer modeling approaches.

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APPENDICES

Appendix 1: Sample size Calculation

The simple formula used:

$$n = \frac{Z^2 pq}{d^2}$$

Where n = sample size when population is greater than 10,000

Z = Standard normal deviate, set at 1.96 (≈ 2.0) corresponding to 95% confidence level,

p = proportion in the target population estimate; if not known use 50%.

q = 1.0 – P

d = degree of accuracy desired, set at .05 or .02.

Therefore sample size will be

$$n = \frac{Z^2 pq}{d^2} = \frac{(2)^2 (0.50 \times 0.50)}{(0.05)^2} = \frac{4 \times 0.25}{0.0025} = \frac{1}{0.0025}$$

= 400 respondents.

30 percent of the sample size which is equivalent with 120 respondents was used in this study due to cost implications

84

84

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Appendix 2: Husehold head questionnaire

SECTION A: IDENTIFICATION

Village----------Village (Hamlet) ----------
Ward----------Division----------
Name of Enumerator----------Date of interview----------
Name of Field Supervisor----------Date of editing----------

SECTION B: HOUSEHOLD CHARACTERISTICS

1.1 Name of Household head----------
1.2 Age of household head----------
1.3 Gender of household head Male Female
1.4 Marital status of household head
Single
Divorced
Widow
Widower
Monogamous married
Polygamous married and number of wives
1.5 Main occupation of household head
Crop production
[Livestock production/trade
[Off-farm business
[Formal employment
[Informal employment
1.6 Average monthly household income Tshs----------
1.7

Highest level of formal education completed by household head

[None
[Primary
[Secondary
[Certificate course
[Diploma course
[Bachelors degree
Postgraduate Diploma course
[Masters degree
[Doctorate degree

1.8 Size of household land (acres)----------

1.9 Land tenure system

[ ] Communal----------
[ ] Private----------
[ ] Freehold----------
[ ] Rentals from individual----------Others (Specify) ----------

2.0 Family composition

Age	Male	Female
< 18 Years		
18 – 55 Years		
> 55 Years		

SECTION C: LIVESTOCK ENTERPRISE

2.1 Please indicate the various livestock species and breeds that you keep.

Livestock species	**Breed**	**Number of adult males**	**Number of adult females**	**Number of male young stock**	**Number of female young stock**
Cattle					
Sheep					
Goats					
Chicken					
Donkeys					
Pigs					
Other (specify)					

87
87
87

SECTION D: LIVESTOCK PRODUCTION

2.2 What type of production system do you practice?

. Intensive----------
. Semi-intensive----------
. Extensive----------
. Backyard----------
. Tethering----------

Others (specify) ----------

2.3 What is the source of your cattle?

. Inherited----------
. Purchased----------
. Caretaking----------

Others (specify) ----------

2.4 Productivity of the main Zebu strain

Average productive life time: Bulls [ ] years Cows [ ] years

Average number of calves per cow's life time [ ] years

Average age at first calving [ ] years

Calving interval [ ] years

Average lactation length [ ] months

Average milk yield (litres): At start of lactation [ ]; peak [ ]; towards the end [ ]

SECTION E: CATTLE PREFERENCES AND BREED PERCEPTIONS

Why do you keep cattle? (Rank the main reasons for keeping cattle)

Reason	**Rank**
Milk production	
Meat production	
Store of wealth/assets/savings	
Insurance	
Work (draft, threshing, transport, carrying water/firewood e.t.c.)	
Calves	
Manure	
Socio-Cultural uses	
Dowry payment	
Contests/shows	
Food during funerals	
Sacrifices (circumcision, birth rites e.t.c.)	
Hides/skins	
Crop residue utilization	
Other (specify and rank)	

For each of your main purposes of keeping cattle, please indicate the preferred breeds, traits and the amount of money that you would be Willing To Pay (WTP) in order to conserve the preferred cattle.

Purpose of keeping cattle	Preferred breed	Preferred traits/attributes	WTP in Tshs	WTP in US$

What is the relative importance of your crop and livestock enterprises for food security and income generation?

Enterprise	Rank for food security	Rank for income generation

89

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SECTION F: BREED-SPECIFIC MANAGEMENT CONSTRAINTS AND DESIRED POLICY INTERVENTIONS

2.5 For each of your preferred cattle breeds, please indicate the major production and marketing constraints, and the desired policy interventions

Preferred cattle breed	Production constraints	Marketing constraints	Desired policy interventions

THANK YOU!

Appendix 3: Checklist for key informants

GENETIC RESOURCE MANAGEMENT – What is the available traditional mechanism of describing breed? – Is there any traditional knowledge of other breeds? – What are the traditional practice in CaAnGR management? – What role should local breeds continue to have in local economies?
STRATEGIES FOR GENETIC IMPROVEMENT OF INDIGENOUS BREED OF CATTLE – What is the most efficient management system for animal conservation programs? – What are the methods of improving the indigenous breed of cattle? – Which institutions are currently involved in helping indigenous livestock keepers to conserve CaAnGR?
PROBLEMS AND CONCERNS FOR INDIGENOUS CATTLE IN IMPROVING THE LIVELIHOOD – What are the major problems associated with keeping indigenous cattle? – What are the major problems associated with keeping cross breed cattle? – What are the major problems facing your household as indigenous livestock keepers?

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Appendix 4: Record sheet for Phenotypic Description of cattle breeds

Questionnaire number …….. Date …….

District…… **Ward** ……. **Village** ……

A: HERD OBSERVATION

Number of pure breeds (*tick*)

0	1	2	3	4	5

Name of the breeds…….

1. Local breed name……
2. Trend within herd (*tick*)

Increasing	Decreasing	Stable

3. Numbers by age and sex (*enter numbers*)

Category	Calves	Weaners	Adults
Intact male			
Castrate			
Female			

4. Body coat colour description

(Indicate in each box the number of animals of each colour or with each marking)

SOLID COLOURS

Colour	Red	Brown	Black	White	Grey	Others, specify
Numbers						

PIED

(mixture of colours) ……. *(state colours)*

SPOTTED ……...

FAWN

(light yellowish brown)……...

DUN

(greyish brown)…….

BRINDLE

(brown with steaks of other colour)

ROAN

(mixture of brown with white or grey)

Other (specify) ……..

Hair

Short	Medium	Long	Straight	Curly

5. Body parts Colour *(enter numbers as in 4 above)*

Head [ ] Ear tips [ ] Hoof [ ] Muzzle [ ] Tail switch [ ]

B: INDIVIDUAL ANIMAL OBSERVATIONS AND MEASUREMENTS

(Only for the main zebu cattle)

1. Sex (*tick*) Male [ ]
Female [ ]

2. Body weight [ ] kg

3. Body size Height at withers [ ] cm Body Length [ ] cm Heart girth [ ] cm
Rump width [ ] cm Rump height [ ] cm

4. Dewlap (*tick*)

Absent	Small	Medium	Large
[ ]	[ ]	[ ]	[ ]

5. Hump (*tick*)

Size: Absent [ ] Small [ ] Medium [ ] Large [ ]

Shape: Pyramidal …… [ ] Drooping (bent sideways) [ ] Phrygian (cup-shaped) …. [ ]

Position: Thoracic ……. [ ] Cervico-thoracic [ ]

95

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95

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6. Profile (*tick*) Face Flat ….. [ ] Back Hollow [ ] Rump Flat [ ]
Concave [ ] Straight [ ] Sloping [ ]
Convex [ ] Roofy [ ]

7. Horns (*tick*) Present in all [ ] Present in some [ ] Absent in all [ ]
Colour of horns (specify) ……

Shape: Straight…….[ ] Orientation: Lateral ……..[ ]
Curved……...[ ] Upward……..... [ ]
Coiled (spiral) [ ] Backward ……. [ ]
Lyre-shaped Downward …… [ ]
Forward…….……..[ ]
One horn pointing up & the other down.. [ ]
One horn pointing forward & the other backward [ ]

Length [ ] cm Spacing: Narrow [ ]
Wide [ ]

8. Naval flap (*tick*) Absent [ ]
Small [ ]
Medium. [ ]
Large [ ]

9. Ears (*tick*) Size Small [ ] Shape Round-edged [ ] Orientation Erect [ ]
Large [ ] Straight-edged [ ] *(in relaxed state)* Lateral [ ]
Drooping [ ]

Dimension Length [ ] cm
Width [ ] cm

10. Tail (*tick*) Length Short (above the hock joint) [ ] Thickness at the base Narrow [ ]
Medium (at the hock joint) [ ] Medium [ ]
Long (below the hock joint) [ ] Wide

[ ]

11. Udder (*tick*) Size: Small [ ] Relative size of quarters: Front quarters Larger [ ]

Medium [ ] Smaller [ ]

Large [ ]

12. Teats(*tick*) Size of teats: Rudimentary (hard to hold between thumb and index finger)[ ]

Medium (can easily be held between thumb and index finger) [ ]

96

96

96

96

Large (can be held between multiple fingers and thumb) [ ]

13. Temperament* (*tick*) Docile …… [ ]

(* *Ask owner*) Wild (aggressive) [ ]

Appendix 5: Relative importance of keeping cattle by ranking

REASON	FREQUENCY PER RANK ORDER												Total Weight*	Relative Weight
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th		
Home consumed milk	14	34	20	15		36	1						1,135	0.12
Home consumed meat	1	1	33	20	28			1	36				906	0.10
Store of Wealth				13			34	71	1			1	681	0.07
Milk & livestock sales income				36	22	48	14						920	0.10
Security(servings and insurance		16	37		33	34							1,048	0.11
Draught power	54	49	16	1									1,356	0.15
Calves						2	71	46	1				678	0.07
Manure									48	69	2		403	0.04
Dowry payments	51	20	14	34	1								1,286	0.16
Prestige				1	36			2	29	4	15	10	475	0.05
Sacrifice										7	18		57	0.01
Hide and skin	1								5	40	62	12	288	0.03

*** Calculations were based on weight of 12, 11 ….and 1 for the 1st, 2nd …..and 12th rank respectively.**

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Appendix 6: Qualitative traits of TZC and SZC

Variables		Location (per cent)		Overall (n=93)
		Tarime (42)	Misungwi (51)	
Temperament	Docile	83.3	82.4	77 (82.8)
	Wild (aggressive)	16.7	17.6	16 (17.2)
Ear tips	Brown	59.5	82.4	67 (72)
	White	14	0.3	6 (6.5)
	Black	26.2	17.6	20 (21.5)
Hoof colour	Grey	73.8	96.1	80 (86)
	Black	23.8	3.9	12 (12.9)
	Cream	2.4	0	1 (1.1)
Muzzle colour	Black	26.2	13.7	18 (19.4)
	Grey	2.4	17.6	10 (10.8)
	Brown	71.4	68.6	65 (69.9)
Tail switch colour	Brown	73.2	58.8	61 (65.7)
	Black	21.8	19.6	19 (20.4)
	White	4.8	21.6	13 (14)
Dewlap	Small	7.1	11.8	9 (9.7)
	Medium	83.3	72.5	72 (77.4)
	Large	9.5	15.7	12 (12.9)
Hump size	Small	45.2	60.8	50 (53.8)
	Medium	50	27.5	35 (37.6)
	Large	4.8	11.8	8 (8.6)
Rump profile	Flat	14.3	5.9	9 (9.7)
	Sloping	19	11.8	14 (15.1)
	Roof	66.7	82.4	70 (75.3)
Horns colour	Grey	50	88.2	66 (71)
	Black	9.5	2	5 (5.4)
	Cream	40.5	9.8	22 (23.7)
Horns shape	Straight	19	5.9	11 (11.8)
	Curved	81	94.1	82 (88.2)
Horns orientation	Lateral	4.8	0	2 (2.2)
	Upward	85.7	88.2	81 (87.1)
	Backward	0	2	1 (1.1)
	Downward	2.4	5.9	4 (4.3)
	Forward	4.8	3.9	4 (4.3)
	One point up and the other down	2.4	0	1 (1.1)
Naval flap	Absent	69	84.3	72 (77.4)
	Small	28.6	15.7	20 (21.5)
	Medium	2.4	0	1 (1.1)
Tail length	Short (above the hock joint)	7.1	0	3 (3.2)
	Medium (at the hock joint)	78.6	15.7	41 (44.1)
	Long (below the hock joint)	14.3	84.3	49 (52.7)
Tail thickness at the base	Narrow	4.8	0	2 (2.2)
	Medium	88.1	90.2	83 (89.2)
	Wide	7.1	9.8	8 (8.6)
Udder size	Small	92.3	66.7	42 (79.2)
	Medium	7.7	33.3	11 (20.8)
Front quarter size	Large	38.5	33.3	19 (35.8)
	Small	61.5	66.7	34 (64.2)
Teat size	Medium	80.8	92.6	46 (86.8)
	Large	19.2	7.4	7 (13.2)

Note: Figures in parenthesis are percentages, n is number of TZC and SZC