THE ROLE OF TRADITIONAL ECOLOGICAL KNOWLEDGE IN MANAGEMENT OF DRYLAND ECOSYSTEMS AMONG THE MAASAI PASTORALISTS IN KITETO DISTRICT, TANZANIA

SAMWEL KORINJA OLEKAO

A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

2017

ABSTRACT

Understanding the way the Maasai pastoralists' Traditional Ecological Knowledge (TEK) affects management of natural resources in dry lands is of practical importance. Failure to recognise its contribution in resources management and use can result into mismatch of varied land uses leading to loss of biodiversity and deterioration of livelihood conditions. Conventional range management has often neglected pastoralists' participation, largely due to perception of resource managers that the knowledge lacks objectivity. Management of rangelands is expert - based and the part played by traditional knowledge is not given proper attention. The study was done in semi-arid area, Kiteto district (Maasai Steppe), characterised by high livestock density, low human density and short unpredictable rainfall. Data were collected using Participatory Rural Appraisal (PRA), pilot-tested questionnaires, Focus Group Discussions and key informants interviews. Statistical Package for Social Sciences (SPSS) was used to analyze quantitative data, PRA data were analysed by the help of communities and content analysis was used to analyze qualitative data. Findings showed that socio-economic factors; sex, age, education level, income from livestock, household size and time spent in keeping livestock influenced the perceived usefulness of TEK. TEK practices were herd splitting, grazing patterns, livestock mobility, co-existence of wildlife and livestock, water sources management and construction of settlement played role in management. TEK thus, enables pastoralists to control and manage rangeland resources by regulating access by users and sanctioning abusers. Using medicinal plants to treat some diseases and ailments instead of conventional medication could be due to high costs or availability of drugs and proximity to health centers. Government and actors should work on policies that undermine pastoral ways of life and range ecologists should design a model that integrates TEK and scientific/expert based knowledge to be used in dry land ecosystems management.

DECLARATION

I, SAMWEL KORINJA OLEKAO**,** do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

_____ _____

Samwel Korinja Olekao Date

(MSc. MNRSA)

The above declaration is confirmed by

_____ _____

Dr. Anthony Zozimus Sangeda Date

(Supervisor)

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ACKNOWLEDGEMENTS

First of all, I give thanks to God Almighty for his love unconditionally, granting me physical and mental health and strength throughout my studies.

I wish to express my sincere thanks to Dr. Anthony Zozimus Sangeda for his tireless efforts in going through and commenting my work. Surely, it has been his efforts, close supervision and guidance that made this work possible.

I am grateful to IRISH AID for the financial and logistical support to pursue this degree programme through the Irish Council for International Students (ICOS). The closest support provided and timely response on issues of concern is highly appreciated.

I also acknowledge the support from the Sokoine University of Agriculture academic staff, other friends outside the University and my fellow students; Mohamed M. Wawa, Muna Elimboto, Suzan Magita, Madaila Dalidali and Sebastian Mhanga for their scholarly and material support towards achieving my goal.

Last but not least, my acknowledgements go to my employer, KINNAPA DEVELOPMENT PROGRAMME for granting me the study leave to pursue this course. It has been my pleasure to have this favour to continue building my career, thank you so much.

DEDICATION

To my family and loving children Anna, Naserian and Tayiani who have been my trusted friends and endured my long absence. Also, to my parents, Mzee Korinja Olekao and Naitapwaki Olekao who by their willingness laid the foundation for my education and life.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASALs	Arid and Semi-arid Lands
CBD	Convention on Biological Diversity
CBPP	Contiguous Bovine *Pleuro* - Pneumonia
CCAFS	Climate Change, Agriculture and Food Security
CCPP	Contiguous Caprine *Pleuro* - Pneumonia
CGIAR	Consortium of International Agricultural Research Centers
DED	District Executive Director
ECF	East Coast Fever
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
GFCS	Global Framework for Climate Services
IIED	International Institute for Environment and Development
IUCN	International Union for Conservation of Nature
KINNAPA	Kibaya, Kimana, Njoro, Ndaleta, Namelock and Partimbo villages
Km	Kilometers
NCA	Ngorongoro Conservation Area
NGOs	Non-governmental Organizations
PRA	Participatory Rural Appraisal
REPOA	Research on poverty Alleviation
SEK	Scientific Ecological Knowledge
SPSS	Statistical Package for Social Sciences
TEK	Traditional Ecological Knowledge
TME	Tarangire - Manyara Ecosystem

TZS	Tanzania shillings
UNCCD	United Nations Convention to Combat Desertification
URT	United Republic of Tanzania
VEOs	Village Executive Officers
VLUP	Village Land Use Plans
WHO	World Health Organization
WMA	Wildlife Management Area

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Understanding the way Maasai Pastoralists' Traditional Ecological Knowledge affects (positively or negatively) the management of natural resources in the dry lands is of practical importance for maintaining ecosystem function and resource availability. Failure to recognize the contribution of this traditional knowledge in resources management and use to enhance biodiversity and the livelihood of people can result into a mismatch of varied land uses that may lead to loss of biodiversity and deterioration of people's livelihood conditions.

Traditional knowledge is described by Pierotti *et al.* (2000) as the knowledge, innovations and practices of indigenous and local communities around the world developed from past experiences gained over centuries and adapted to local culture and environment. Traditional knowledge is transmitted orally from generation to generation and is collectively owned by members of a particular indigenous community taking the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and crop and animal husbandry practices including development of plant species and animal breeds *(Ibid)*. It is described that TEK as a system of understanding the environment based on observations and experience built over generations because of people being dependent on the land and sea for their food materials (Wehi, 2014) is a one of the central contributions of indigenous people to conservation and management of natural resources.

According to IPRN (2016), Traditional Ecological Knowledge (TEK) is mainly of a practical nature, particularly in such fields as crop farming, animal husbandry, fisheries, health, horticulture and forestry. It is the basis for local decision-making in livestock

keeping, crop farming, hunting and gathering, nutrition and food preparation, resource management, education and health as well as social, economic, and political organization. It is recognized as “the inextricable link between cultural and biological diversity” *(Ibid)*. It describes aboriginal, indigenous, or other forms of traditional knowledge regarding sustainability of local resources. The term, as per IPRN (2016), refers to "a cumulative body of knowledge, belief, and practice, evolving by accumulation of traditional knowledge related to the environment and handed down from one generation to another through traditional songs, stories and beliefs. It concerns the relationship of living beings (including human) with their traditional groups and with their environment (IPRN, 2016).

Local people have a very good understanding of ecological zones representing a system of interactions among plants, animals, soils and of course, the people themselves (Kangalawe *et al.,* 2014). Also, Searle (1999) reported that species preferred by villagers for forestation are those wood species which are indigenous to the area out of which some species are scientifically identified but other species may have vernacular names. According to Niamir (1990), local people can identify more species and varieties of plants than well qualified botanists, probably due to the fact that they have had more time to search and find all the plants in their area. This cuts across most societies whose livelihood is dependent upon the natural resource base for survival; the pastoralists fall in this category.

Lynn (2010) stated that conservation programs that discount indigenous land management practices may have exactly the opposite effect of that intended; resources that policies intend to protect can be compromised by the failure of institutions to consider the resources as part of a greater, functioning ecosystem that includes people and their evolving land management practices. For instance, Popova (2014) reported that in

Australia under the state-sponsored Indigenous Protected Areas programme, which aimed at facilitating protective management of lands and/or sea territories owned by indigenous communities, the land-managing agreements that recognize indigenous right to self-governance helped to meet interests of indigenous communities, and thus became an instrumental in facilitating intercultural and intergenerational dialogue and conservation within the framework of programmes.

TEK is central to indigenous world views and practices and is one of the most important contributions that indigenous people can bring to conservation partnerships (Wehi, 2014). This study seeks to bring the attention of the people about the role played by traditional ecological knowledge of the Maasai and its importance in managing dry lands ecosystems in which they live. The knowledge from this study is important for building platform for promotion of the integration of TEK into modern scientific methods of natural resources management for sustainability.

1.2 Problem statement

There is undeniable fact that pastoralists have been involved in farmer - herder conflicts in Tanzania and elsewhere in Africa. Of recent, clashes between the parties in Kilosa, Kiteto, Kilindi, Kilombero and Bagamoyo are an example of escalation of resource use conflicts in the country. Eviction of pastoralists in some parts of the country to pave way for agriculture expansion, state - backed investment and conservation such as in Ihefu, Mbarali and Loliondo are the signs of demise of pastoralism and that can lead to further conflicts between the two. Mwamfupe (2015) argued that pastoralists have lost considerable amount of their land due to lack of security of tenure of land for rural producers and policy deficiencies and contradiction. Despite continued loss of their land, pastoralists remained persistent to their traditional way of resources use that is central to their livestock development and environmental conservation.

Maasai pastoralists have been custodians of dry lands for years keeping livestock such as cattle, sheep, goats, donkeys and others. Despite living in these drier parts (fragile ecosystems) of the country, Kiteto District inclusive, their areas have remained with natural vegetation and considerable wildlife species unlike areas where crop farming is extensive. Studies show that pastoral communities worldwide have in-depth knowledge of the traditional methods of rangeland assessments, which in turn influence patterns of land use (Mills *et al.,* 2002). On a daily basis, herders monitor the status of rangelands (Homewood and Rodgers, 1991) and determine grazing (Cotton, 1996).

The knowledge possessed by Maasai is collectively termed as Traditional Ecological Knowledge (TEK) which includes all practices kept and performed by them that relate and/or contribute to environmental conservation and management. The practices are built around livestock grazing patterns management, kraal and hut construction, ownership and management of water sources, socialization and up - bringing, land use management and plant use (including medicinal value of plants).

Despite the role played by pastoralists in management of rangelands, the modern science (conventional range management) has often neglected pastoralists' participation, largely due to the perception of official resource managers that herder knowledge lacks objectivity (Oba and Kaitira, 2006). Furthermore, though the Maasai pastoralists have a long time experience on the use of dry land ecosystems products using their traditional ecological knowledge, the management of the rangelands is expert - based and part played by traditional knowledge is not given proper attention for sustainability, Kiteto District in particular. The study thus, aimed to describing the role played by this ecological knowledge of the Maasai people in dry lands management in the study area

and to argue on a highly charged criticism from ecologists that all pastoral systems contributed greatly to destruction of environments.

1.3 Justification of the study

Documentation of Traditional Ecological Knowledge is crucial as the knowledge may be available for managing dry land ecosystems. Also, documentation of community plant knowledge is a valuable contribution to the understanding of resource management in the tropics, especially wherein the traditional knowledge is integrated with expert-based knowledge, example perception on the effectiveness of medicinal plants. Documentation also ensures that the TEK does not get lost given technological advancements that seem to emerge abruptly. TEK may be the current, relevant, and viable system for understanding the situation and providing a basis towards solutions for sustainable management of natural resources.

Research findings will help to inform policy makers at different levels on potential role of pastoralists' TEK on dry lands conservation, management and improvement of land use planning process in Kiteto and elsewhere in the country. Findings will thus serve as input when preparing strategies to address challenges of dry land ecosystem management. In addition, the findings will help to bridge the gap between scientific conservation methods and indigenous conservation practices of Maasai Pastoralists. The study is important as a generator of knowledge that can be incorporated into Education Curricula at different study levels for sustainable resource management in Tanzania and elsewhere as may be applicable.

The study is guided by the Cultural Policy of Tanzania (URT, 1997) which states that, a close linkage between culture, natural resources, the environment and development

programmes shall be emphasized. The policy states further that, traditional knowledge, skills and technology which are environmentally friendly shall be identified and their use encouraged, research on traditions and customs which are supportive of environmental conservation shall be encouraged with a view to identifying and popularizing their use.

1.4 Research objectives

1.4.1 Main objective

The main objective was to assess the role of Traditional Ecological Knowledge in management of dry land ecosystems among the Maasai Pastoralists in Kiteto District, Tanzania.

1.4.2 Specific objectives

The specific objectives were to:

1. Assess socio-economic factors that influence adherence of TEK practices
2. Identify existing TEK practices in the study area
3. Examine pastoralists' perceptions on how TEK practices promote or hinder management of dry lands in the study area and
4. Assess effectiveness of medicinal plants as a TEK practice in curing human and livestock disease in the study area

1.5 Research questions

The study strove to answer the following questions;

1. What and how socio-economic factors influence adherence of TEK practices in study area?
2. What are the existing TEK practices that are useful in the study area?

3. How do pastoralists perceive the usefulness or detriment of TEK in managing dry lands in the study area?
4. What evidence is available indicating effectiveness of medicinal plants in curing livestock and people diseases or injuries in the study area?

1.6 Conceptual framework for the study

This study was based on traditional ecological knowledge of the Maasai pastoralists in managing the dry lands in which they live. Natural resources available in the dry lands and usable by pastoralists include but not limited to pasture land, water sources, forests and wildlife as well as land used as crop-land by agro - pastoralists. The study examined the way various TEK practices regulate the use and management of those resources to enhance natural resource base (flora and fauna) with the ultimate goal to sustain the dry land ecosystems management in the region (Fig. 1).

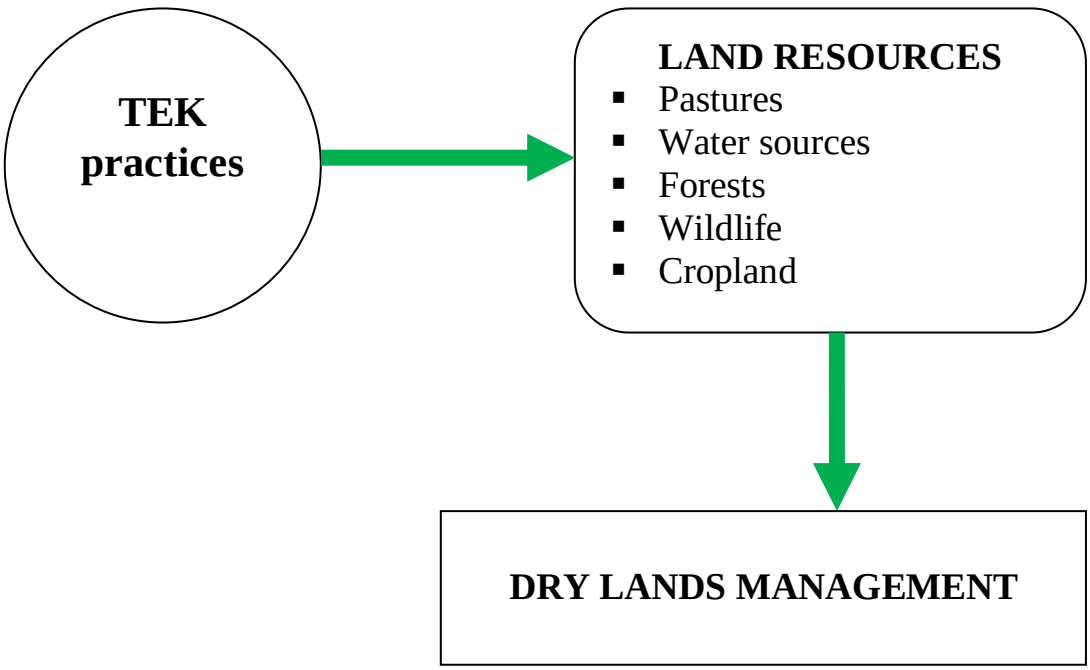

Figure 1: Conceptual framework for the study

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theory of traditional knowledge

According to Gepts (2004) modern science can perhaps be dated to Newton's times. But Traditional Knowledge (TK) systems dated from more than 2 million years, when *Homo habilis* started making his tools and interacting with nature. TK is integral to the identity of most local communities. It is a key constituent of a community's social and physical environment and, as such, its preservation is of paramount importance.

Whyte (2013) put that the concept of Traditional Ecological Knowledge (TEK), along with synonymous or closely related terms like indigenous knowledge and native science, has some of its origins in literatures on international development and adaptive management. There is a tendency that people want to determine one definition for TEK that can satisfy every stakeholder in every situation. Yet a scan of environmental science and policy literatures reveal there are differences in definitions that make it difficult to form a consensus. What should be explored instead is the role that the concept of TEK plays in facilitating or discouraging cross-cultural and cross-situational collaboration among actors working for indigenous and non-indigenous institutions of environmental governance, such as tribal natural resources departments, federal agencies working with tribes, and co-management boards.

Following the difficulty to form a consensus, Gepts (2004) described that 'Tradition-based knowledge' refers to knowledge systems, creations, innovations and cultural expressions which have generally been transmitted from generation to generation, are generally regarded as pertaining to particular people or territory, and, are constantly evolving in

response to a changing environment. Categories of TK could include; agricultural knowledge, technical knowledge, ecological knowledge, medicinal knowledge, including related medicines and remedies, biodiversity- related knowledge and expressions of folklore.

In Miraglia (1998), as in Huntington (2000), TEK is defined as the knowledge base acquired by indigenous and local peoples over many hundreds of years through direct contact with the environment. It includes an intimate and detailed knowledge of plants, animals, and natural phenomena, the development and use of appropriate technologies for hunting, fishing, trapping, agriculture, pastoralism and forestry, and a holistic knowledge, or "world view" which parallels the scientific discipline of ecology.

Whyte (2013) explained that TEK is often invoked in ways that are controversial describing that there are three plausible reasons why this may be the case;-

a) TEK often refers to knowledge production systems whose value has been overlooked or disapproved of by scientists and policy makers. Ignorance and disapproval are often tied to colonial, imperial, and other discriminatory attitudes and institutions of science toward "non-Western" knowledge systems (Hardin, 1998).
b) Definitions of TEK are often formulated by scholars or professionals who are not community members and hence have tendencies to privilege their own agendas for environmental and natural resources stewardship and management (McGregor, 2006).
c) TEK is perceived as being a competing authority with science, creating divisions between indigenous and scientific expert authorities (McGregor, 2006).

Whyte (2013) therefore, argues that the concept of TEK should be understood as a collaborative concept. It serves to invite diverse populations to continually learn from one

another about how each approaches the very question of "knowledge" in the first place, and how these different approaches can work together to better steward and manage the environment and natural resources. Therefore, any understanding of the meaning of TEK is acceptable only so long as it plays the role of bringing different people working for different institutions closer to a degree of mutual respect for one another's sources of knowledge.

2.2 Traditional ecological knowledge

As defined by Berkes (2008:7) traditional ecological knowledge (TEK) encompasses factual knowledge about ecological components and processes, knowledge put into practices of environmental use, and the cultural values, ethics, and philosophies that define human relationships within the natural world.

TEK is commonly used in natural resource management as a substitute for baseline environmental data to measure changes over time in remote regions that have little recorded scientific data. The use of TEK in management is controversial since methods of acquiring and accumulating TEK, although often including forms of empirical research and experimentation, differ from those used to create and validate western scientific ecological knowledge (SEK), (IPRN, 2016).

Several studies have been undertaken about pastoralists but mainly on economic value of livestock, zoonotic diseases, carrying capacity, herd - farmer conflicts and climate resilience. Coppolillo (2000) conducted a study to examine the factors affecting the maximum distances herds travel from home and the distribution of grazing around pastoral settlements of the Sukuma agro-pastoral system in the Rukwa Valley, Tanzania. According to the study, the distribution of dry season water structured the landscape-scale

distribution of grazing throughout the year, not just during the dry season. Water availability strongly affected the distances herds ranged from home in the dry season and the distribution of grazing around pastoral settlements throughout the year. Also Mapinduzi *et al.* (2003) undertook a study (using indigenous ecological knowledge) to assess effects of grazing and cropping on rangeland biodiversity at micro-and macro-landscape scales in Northern Tanzania. The survey identified indicator plant species and their associations with micro-landscapes and livestock grazing suitability (i.e. for cattle and small ruminant grazing).

Another study was done in Mongolia (Fernandez-gimenez, 2011) to assess the ecological knowledge of Mongolian Nomadic Pastoralists in rangeland management showing how herders' knowledge is reflected in pasture use norms and attitudes towards pasture privatization as well as herding practices. According to McGregor (2006), Canada has responded to the challenges brought forth by both the Brundtland report and the CBD is attempting to incorporate TEK into various environmental decision-making processes, such as a growing body of Canadian environmental legislation that includes the *Canadian Environmental Assessment Act,* the *Canadian Environmental Protection Act,* and the *Species at Risk Act*. Also, Gagnon *et al.,* (2006) argued that the field of TEK is well on its way to becoming firmly entrenched in the theory and practice of environmental management in Canada, particularly in the North, where it is already part of routine public policy. TEK is viewed now as presenting viable alternatives to the status quo, which is seen to have caused today's environmental problems in the first place.

Though there is great diversity in pastoral systems, they are usually characterised by low population densities, high mobility and dynamism, complex information systems and a high dependency on local knowledge (CBD, 2010). Pastoralist communities are also often

socially, economically and politically marginalised. Yet, they make significant contributions to national economies, to the achievement of development goals and to the maintenance of ecosystem goods and services in rangelands (CBD, 2010). As users of rangelands who are reliant upon the provision of numerous ecosystem services (e.g. water, food, fodder), pastoralists have a unique knowledge of how a balance between conservation and sustainable use can be maintained. Thus, researchers ought to focus on indigenous knowledge and best practices of pastoralists as put by Temesgen (2015) in an attempt to improve pastoral livelihood in Africa.

2.3 Importance of dry land ecosystems

Dry lands all over the world are increasingly becoming remarkable ecosystems. They are home to nearly 2 billion people. CBD (2010) explained that dry lands support one third of the Global Conservation Hotspot Area and are home to 28% of endangered species. They cover 40% of all land and include unique habitats such as savannas, mist forests and oases: these include high-value resource patches that are crucial for the survival of vast ecosystems and for long-range species migration that characterize the dry lands.

Basically, dry lands provide ecosystem services that are enjoyed locally and globally. They provide fodder, food, fuel and other goods that are used to create resilient livelihoods. They regulate climate locally, through provision of shade and shelter, and globally through capture and storage of carbon: globally, 36% of terrestrial carbon is stored in dry lands, mostly in dry land soils. Despite their aridity, they include globally important water sheds that supply clean water to millions of people, and they regulate flows and mitigate flood and drought risks.

The United Nations Convention to Combat Desertification (UNCCD, 1994) is aware that arid, semi-arid and dry sub-humid areas together account for a significant proportion of the Earth's land area and are the habitat and source of livelihood for a large segment of its population. In CBD (2010), the Convention on Biological Diversity, it is reported that the traditional management systems in the dry lands of Africa must be responsive to variability and uncertainty. Pastoralists' knowledge of species, ecosystems and climate form the basis for sustainable land management.

According to Temesgen (2015), Pastoral systems in Africa are found in the vast arid and semi-arid areas. Pastoralism is uniquely well adapted to dry land environments; as an economic and social system, it operates effectively in highly variable conditions, managing the complex relationship between people and the natural environment. These areas are characterized by marked rainfall variability, and associated uncertainties in the spatial and temporal distribution of water resources and grazing for animals.

Kisanga (1999) reported that in Tanzania, there has not been a rigorous attempt to delineate semi-arid regions. One of the earliest attempts to delineate or describe semi-arid parts of Tanzania was made in 1977 in a Technical Paper prepared for the United Nations Conference on Desertification (URT, 1977). Because of the difficulties and uncertainties of defining semi-aridity, the paper suggests that it is safer to regard the areas of Tanzania falling below the 800 mm (31.5") rainfall isohyets as semi-arid area (URT, 1977). Also, Selemani (2014) described that Tanzania has a total land area of about 88.6 million hectares of which over 74 % are rangelands (Mwilawa *et al*., 2008), and approximately, 80% of the total land area in Tanzania is classified as semi-arid with highly variable rainfalls in one or two seasons separated with long dry season.

Hesse (2013) put that the dry lands in Kenya and Tanzania are not empty and barren, although that is how governments tend to perceive them. Pastoralists who live there see a tapestry of livestock routes, pastures and water sources. Aboud *et al.* (2012), pointed out that the dry lands in Tanzania are critical to tourism and national food security. They support agriculture, livestock rearing, tourism and wild resource harvesting. Ninety eight per cent (98%) of meat and thirty per cent (30%) of milk and other livestock products consumed in Tanzania come from the dry lands.

2.4 Role of TEK in managing dry lands

TEK as a system of understanding the environment based on observations and experience built over generations because of people being dependent on the land and sea for their food materials (Wehi, 2014) is a one of the central contributions of indigenous people to conservation and management of natural resources. Hesse *et al.* (2009) stipulated that, pastoralists are highly specialized livestock herders and breeders and have skills and indigenous knowledge of direct national value. They rely on scarce natural resources under shifting conditions, demanding considerable knowledge of animal husbandry, sustainable rangeland management and informal livestock markets.

The study by Conroy (2002) explained that livestock have long provided economic security and a way for the Maasai to confront natural disasters, such as frequent droughts and disease, with some form of resilience and flexibility. Livestock can move to areas with rainfall, greener pastures, and away from pests, the agricultural crops do not have this flexibility. According to Markakis (1993) mobility and flexibility are required to make good use of meager range resources, thus units of production are small and widely dispersed. The logic of the pastoral economy is to minimize risk in order to secure preservation of the family. As an adaptation to ecosystems in which forage and water are

critical parameters, transhumant herding largely depends on dry season forage within reach of dry season watering points.

Nyinondi (2011) described that Maasai herders had good understanding of landscapes and resources found. Also, Mung'ong'o *et al.* (2003) put that pastoralist transhumant herding patterns have been in tune with the ecological realities of dry land areas where rainfall and grazing are subject to high risk and seasonal variability. They have allowed vegetation to be renewed every year as they resorted to temporary migration and such migration has essentially been a traditional drought-coping strategy and has had positive effects to environment in that it allowed the affected area to recuperate.

2.5 The Maasai and their origin

According to Ndaskoi (2005), Maasai means speakers of *Maa* dialects and there are several sub-sections that speak *Maa*. Some whose remnants still exist today are *Il Purko, I Salei, Il Kisonko, I Lumbwa, I Sikirari, Il Kaputie, I Loodokilani, I Larusa, Il Damat, Il Matapato, I Laitayiok, Il Loitai, I Siria, Il Uasin Nkishu, Il Dalalekutuk, Il Keekonyokie, Il Kankere, Il Moitanik* and many others.

Boys (1982) also puts that the Maasai are a tribe of people who live in parts of Tanzania and Kenya and are known as tall and fierce warriors. They can be recognized by the special red clothes they wear which is called *Shuka,* Maasai live a nomadic life, moving from place to place with their animals, they rely on their animals for food (including milk, meat and animal blood) and walk for many miles with their animals to find fresh pasture and water. They get all the other foods they need by trading (swapping) with other people. Maasai men herd cattle and carry spears to protect their cattle from wild animals such as lions (Ibid).

Other literatures also show that the Maasai are thought to have originated in the Upper Nile Valley. Their myths speak about climbing up from a broad and deep crater bounded on all sides by a steep, long cliff. By the 1600s, they had begun migrating with their herds into the vast arid, savanna-like (grassland) region of East Africa straddling the Kenya-Tanzania border. About the Maasai of Tanzania, Tenga, *et al.* (2008) put that the Maasai population, whose livelihood is based on pastoralism, is estimated to be around 350 000 and is concentrated in North-East of the United Republic of Tanzania but at present also in the Central and Southern parts of the country. Natural resources are principally used on a collective basis, grazing/pasture land, water points and salt-licks.

2.6 Pastoralism as mode of life

Pastoralism is analysed as a way of life depending primarily on livestock keeping or an extensive system of livestock production that involves different degrees of movements (mobility), and where families depend on livestock and their by-products for a substantial level of their subsistence and income by over 50 per cent (Tenga *et al*., 2008, Looloitai, 2014). Markakis (1993:1) defined pastoralism as "a mode of production which depends on natural forage" and pastoralists are found in many parts of the African continent from North to South and from West to East and mostly live in arid or semi-arid lands.

URT (2015) stated that the Government of Tanzania is committed to working closely with the private sector from within and outside the country in unleashing the immense potential for developing the livestock sector for the benefit of rural communities and to improve national health and nutritional standards. The Tanzania Livestock Modernization Initiative consist of thirteen key strategic areas and the Rangelands Conservation and Management is one of these strategies.

Hesse *et al.* (2006) explained that pastoral systems in East Africa are complex, diverse, and extremely dynamic as pastoralists seek to adapt to evolving social, political and economic conditions at local, national and regional levels. While capturing the diversity, most pastoral systems display, to varying degrees, a number of common characteristics as shown in Table 1.

Table 1: Key characteristics common to different pastoral systems in East Africa

Aspect	Characteristics
Family	Rely on livestock for a substantial proportion for their livelihoods, dependence on other sources is currently inevitable
Livestock	Are composed mostly of indigenous herds but improved breeds are now being imported
Purpose	Livestock are kept for a mix of subsistence (particularly milk) and market needs (e.g. livestock sales to other requirements including other food stuffs etc.)
Value	Livestock have significant values beyond just economic assets including cultural and spiritual assets too. They define and provide social identity and security
Pasture	Pastoralism relies on natural pastures as well as family members‟ work-force and expertise contribution, that mostly divided based on gender and age.
Mode of grazing	Mobility and migration are key mitigation strategies although land is reduced and mobility restricted
Land	Land is more than physical resources but it also has family and livestock needs attachment
Resource ownership	Pastures and water are mostly managed through a common property regime. Formalization of resource tenure is now coming in.

Modified from Hesse and McGregor (2006)

Selemani (2014) reiterated that the main sources of livelihoods in semi-arid rangelands are from pastoralism and agro-pastoralism and Tanzania is highly populated with domesticated ruminant livestock: there are about 21.3 million cattle, 15.1 million goats and 5.7 million sheep (as in URT, 2015) making it a third country in Africa with highest number of livestock after Sudan and Ethiopia. Kisanga (1999) identified that purely pastoral systems are the principal means of livelihood in arid and semi-arid areas where climatic and soil conditions do not favour sufficient food production. The Maasai tribe forms the core of this semi-nomadic system in Tanzania.

In the dry lands pastoralism has been a valuable asset that benefits pastoralists and the country at large. Subsistence is number one benefit accrued from pastoralism whereby pastoralists obtain their food and other materials. Other benefits emanating from pastoralism are as shown in Table 2.

Table 2: Direct and indirect values of Pastoralism

Direct values	Indirect values
Subsistence and livelihood values:	**Economic inputs values**
Milk, meat, blood, firewood, honey, fruits, medicine	Added value to agricultural production
The herd as a form of insurance, savings and risk management	Benefits to tourists and the tourism industry
Socio-cultural values and the development of social capital (absence of conflict)	**Environmental values:**
	Nutrient recycling
Economic values:	
Marketed products: sales and exports of milk, livestock, hides, leather and non-timber forest products	Maintenance of pasture productivity and biodiversity
Raw material production: inputs to supply chains involving informal or quasi - formal economic activity – butchers, traders, transporters	Tree regeneration
	Maintenance of natural ponds and water cycling
Human capital values:	
Employment of 9 to 20 million East Africans	Building environmental resilience to climate change
Skill development and indigenous knowledge	

Source: Hesse and MacGregor (2009)

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area

3.1.1 Location

Kiteto District is one of the five administrative districts of Manyara Region in Northern Tanzania, lies between 6° 7' and 6° 16" S, and 36° 37' and 36° 30" E (Fig. 2). According to the district profile (URT, 2014), the district lies between 1000 m and 1500 m above sea level. Although there are remarkable variations in the amount of precipitation, the District receives an average of 350 mm to 700 mm of rainfall annually and there is one rainfall season (Uni-modal) between the months of January and May. The hot months are August, September, October and November and it is considered to be semi - arid.

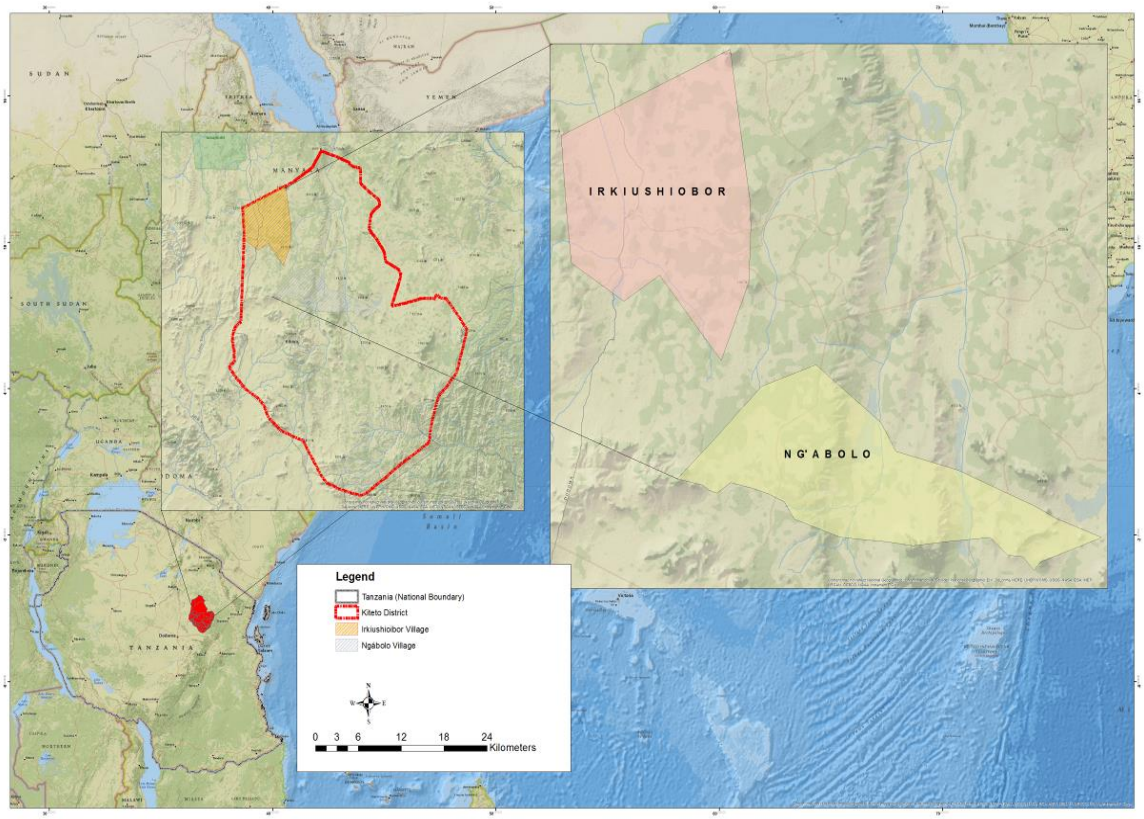

Figure 2: Kiteto District map showing study villages

3.1.2 Agro – ecological zones

The distribution of the vegetation in Kiteto District is closely related to the rainfall, altitude and the soil type. There are three major agro - ecological zones, namely the rift valley highlands, the semi-arid midlands, and the bushed *Maasai Steppe* (Coulibaly *et al.*, 2015). Ecologically, the dry lands of Kiteto District lie in the vast Somali - Maasai Regional Center of Endemism, administratively in Manyara Region which was formerly part of Arusha Region. Also, Coulibaly *et al.* (2015) reiterate that the Maasai Steppe is an arid grassed plain mixed with bushes. Livestock density is high while that of human is low. Rainfall is short and unpredictable ranging from 350 mm to 700 mm per annum.

3.1.3 Economic activities

Socio-economic activities in Kiteto district include pastoralism, crop farming, petty trading and beekeeping. While crops cultivated include maize, sorghum, groundnuts, sunflowers and cowpeas, livestock kept are cattle (short - horned zebu), sheep, goats and donkeys. Other activities include small scale industries such as sunflower oil and maize mills and other business entrepreneurship. Some parts of the district are so dry and only favour pastoralism and wildlife conservation and by virtue of that nature, tourist hunting is another economic activity that earns the local communities with cash.

As reported by Krätli (2015), pastoralists produce food in the world's harshest environment, and pastoral production supports the livelihoods of rural populations on almost half of the world's land. They have traditionally suffered from poor understanding, marginalization and exclusion from dialogue. Parts of Kiteto district inhabited mostly by the pastoralists are arid and semi- arid (Makami Division) as compared to other parts and therefore favour only livestock keeping and wildlife conservation (URT, 2014).

3.1.4 Population and ethnicity

According to the National Human and Housing Census of 2012 (URT, 2014), the district has a population of about 244 669 people) and about 366 000 livestock (cattle, donkeys, sheep and goats) and abundant wildlife species(URT, 2013). Pastoralists account for about 42% of total population in Kiteto district. In the district, pastoralists inhabit Makami, Kijungu, Kibaya, Olboloti and Sunya Divisions but also inhabit other parts of the district in small percentages. Ethnic groups in the district include the Maasai, Rangi, Gogo, Kaguru, Kamba, Nguu and others, also in small percentages.

3.1.5 Rationale for selection of the study area

As pointed out earlier, Kiteto district is inhabited by Maasai pastoralists by about 42% and therefore, provides a good experimental scenario to assess the role of the TEK in managing the dry lands ecosystems. The area has an apparent diversity of habitats and ecosystem functioning, and Maasai pastoralists have lived in these areas for many years and so they are thought to have acquired enough knowledge to develop a well-defined traditional system of natural resources management.

3.2 Research design

As defined by Kothari (2000), a research design is the arrangement of conditions for the collection and analysis of data in a manner that aims at combating relevance to the research purpose and economy in procedure. It is a conceptual structure within which research is conducted. The research design for this study was cross-sectional whereby data were collected in single point in time, combining qualitative and quantitative approaches.

3.2.1 Sampling procedure

Makami Division was purposively selected out of 7 divisions of Kiteto District because it is located in the dry lands and inhabited by the Maasai pastoralists. All the two (2) wards of Makami Division which are Makami and Ndedo, were selected for the study. From the two wards, stratification was developed to select the village with pastoralists only and the one with pastoralists and agro-pastoralists. Then, from each stratum one village was randomly selected using random numbers developed using excel computer program and Irkiushioibor and Irng'abolo villages were selected respectively. Households for questionnaire survey were selected randomly using random numbers developed from excel computer programme, and the head of household was the respondent. Focus Group Discussion (FGD) involved eight to twelve members composed of knowledgeable Maasai elders who are custodians of traditional practices, herders who perform the role of daily livestock grazing and women who are responsible for *Manyatta* (huts) construction and collection of fuel wood. District Agriculture and Livestock Development Officer (DALDO), District Forest officer (DFO), District land Officer (LO) and two leaders from NGOs involved in land use planning and land right programmes to pastoralists were the key informants for this study.

3.2.2 Sample size

According to Saunders *et al.* (2009) the sample size depends on the nature of study, time and available resources. In this study, number of households for enumeration was obtained using a formula by Bartlett *et al.* (2001) such that:

$$n = \left(\frac{n_0}{1 + \frac{n_0}{N}} \right) \quad \text{.....(1)}$$

Where: n is the required (adjusted) sample size, N is the population size; n_0 is the sample size as calculated by Cochran's (1977) formula:

$$n_0 = \left(\frac{t^2 \times pq}{d^2} \right) \quad \text{.....(2)}$$

Where: p is the proportion of respondents that will give you information of interest (the proportion *confirming*), q viz (1-p) is the proportion not giving you information of interest (proportion *defective)*, and $p^* q$ is the estimate of variance (*which is maximum when p = 0.50 and q=0.50)*. The maximum population variance of 0.25 will give the maximum sample size.

Based on the information above, Lusambo (2009) modified the sample size formula as:

$$n = \frac{384}{1 + \frac{384}{N}} \quad \text{.....(3)}$$

Where n is the sample size of finite population, and N is the population size. Study villages and the sampled households are presented in Table 3.

Table 3: Study villages and respondents of the study

Village	Sub-village	Total households (N = 125)	Sampled households (n = 120)
Irkiushioibor	Armame	5	5
	Engarkash	15	14
	Ilchurrah	9	9
	Impopong'	11	11
	Loombeneck	9	9
	Osirei	12	12
Irng'abolo	Loong'oswani	10	10
	Maitei	22	21
	Munyambwai	22	21
	Loldupai	8	8

3.2.3 Pre-testing of research tools

To ensure data quality control, pre-testing of the research instruments was done to assess the efficiency of the tools and practical nature of the study area. The results from pre-testing were used to improve the data collection instruments. Triangulation of various methods was done to confirm information obtained through other methods.

3.2.4 Data collection

Both primary and secondary data were collected for this study. Secondary data included information about the study area and research topic. Primary data included a list of TEK practices, role of TEK practices in management of natural resources available, local institutions guiding the use of pasture and water, grazing patterns used in the area, drought coping strategies and various plant species' uses including those with medicinal values. These were collected by using various methods which included Participatory rural appraisal (PRA) as put by Cavestro (2003), household questionnaire survey in Appendix I (Plate 1), focus group discussion and key informants interviews.

Plate 1: Household questionnaire survey at Irng'abolo village.
(Photo: Research assistant, 2017)

3.2.5 Data analysis

Statistical Package for Social Sciences (SPSS) was used to analyze quantitative data. Descriptive statistical analysis such as frequency, means, standard deviations and percentages were used to give information on respondents' characteristics and identifying TEK practices. Binary logistic regression model was used to determine the perceived usefulness of TEK when managing natural resources (rangelands, water sources and forests). The Binary logistic regression model equation is given by:

$$Log\,(Y) = \ln\left(\frac{p}{1-p}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_n X_n + e \quad \text{..... (4)}$$

Where: p is the probability of Perceived usefulness of TEK (Dependent variable), X_s = independent variables (social-economic factors) (Table 4), α is the Y intercept, β_s are regression coefficients and e is an error term.

Table 4: Variables used in the binary regression equation

Variable	*Description*
Y	Perceived usefulness of TEK in managing dry land ecosystem in the area (0 = Not useful, 1 = Useful)
X_1	Sex (0 = Female, 1 = Male)
X_2	Age (years)
X_3	Education level (0=no formal education, 1=formal education)
X_4	Household size
X_5	Length of time one lived in the area (number of years)
X_6	Number of local cows
X_7	Number of goats
X_8	Number of sheep
X_9	Length of time in keeping livestock (number of years)
X_{10}	Total income from sales of cattle
X_{11}	Total income from sales of goats
X_{12}	Total income from sales of sheep

Data collected using Likert scale, Chi - square test were used to test the effectiveness of the medicinal plants in curing both livestock and human diseases in the study area. Data collected by use of PRA were analyzed by the help of community. Tools such as participatory resource mapping were used and analysis of the data was done at the site with the help of communities. To validate information collected from PRA, feedback meetings were organized. Content analysis was used to analyze qualitative data whereby chunks of words were coded and categorized into themes and meaningful textual units (Cavestro, 2003). Both the quantitative and qualitative data were synthesized to establish the reality of the role played by traditional ecological knowledge in the management of dry lands ecosystems. Plant specimens given in vernacular were identified by using field keys and assistance of expertise. These provided information on socio - economic importance of plant species used in the study area, mostly medicinal values.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Demographic characteristics of respondents

This section gives the summary of empirical findings obtained from this study starting with socio-economic characteristics to get a general picture of study respondents. Respondents were 120, both men and women from two wards of Makami and Ndedo: Makami (Irkiushioibor village) and Ndedo (Irng'abolo village). This means, 60 people were interviewed from each village.

Table 5 presents sex, marital status and education level of respondents. As shown in the Table, illiteracy level was so high, about 68.3% of respondents had no basic education. Although the number of males interviewed (65.8%) exceeded that of females (34.2%) the study ensured that both sexes participated. This was important because females participate in both livestock keeping activities and domestic chores that involve resource use. Findings show that 44.2% of respondents had multiple wives.

Table 5: Characteristics of respondents (n = 120) in the study villages, Kiteto district

Attribute	Frequency	Percent
Sex of respondent		
Male	79	65.8
Female	41	34.2
Marital status		
Married (single wife)	40	33.3
Married (multiple wives)	53	44.2
Widow/widower	27	22.5
Education level		
No formal education	82	68.3
Primary	31	25.8
Secondary level	7	5.8

Table 6 presents statistics of respondents' age, number of wives; household size and duration that respondent had lived in the study village. Mean age of respondents was 48.43 years indicating that most people interviewed were adults and had knowledge on the research topic (TEK). Findings showed that household, being the unit of the study, had a mean of about 9 members indicating that the families are extended as other families in an African context.

Table 6: Descriptive statistics on demographic characteristics in the study villages

Parameter	N	Min.	Max.	Mean	Std. Dev.
Age of respondent (years)	120	27	78	48.43	10.35
Number of respondents with multiple wives	53	1	6	3	0.97
House hold size (total composition)	120	2	30	9	5.33
Number of years lived in villages	114	1	60	36.65	14.82

4.1.1 Description of livestock kept

The study found that although all respondents (100%) kept livestock, Saibull *et al.* (1981) described that a Maasai without cattle or children is better off dead and, an intimate bond exists between the Maasai and their cattle. They know their cattle by voice, by colour and by eye, and will call them by name. There was significant difference ($p<0.001$) between numbers of livestock kept in the two study villages. Dominant type kept were local cows, goats, sheep and donkeys (Table 7). The number of livestock kept in the two study villages was statistically significant ($p<0.001$), Irng'abolo village having the lowest mean (33) than that of Irkiushioibor (61). This is an indication that people in Irng'abolo village have diversified economies and in this case, crop cultivation (agro - pastoralism) was adopted when compared to Irkiushioibor village.

Table 7: Descriptive statistics on livestock in the study villages, Kiteto district

Parameter	Village		
	Irkiushioibor Mean	Irng'abolo Mean	p - values
Number of local cows	61	33	0.000**
Number of goats	50	28	0.002**
Number of sheep	50	17	0.000**
Number of cattle sold/slaughtered for the past 12 months	44	58	0.099
Market price of cattle sold/slaughtered (TZS)	326 666.667	282 000.000	0.003*
Total income from cattle (TZS)	14 195 833.333	16 480 166.667	0.366
Number of goats sold/slaughtered for the past 12 months	7	10	0.074
Market price of goats sold/slaughtered (TZS)	40 116.667	47 250.000	0.007**
Total income from goats (TZS)	307 950.000	459 083.333	0.036*
Number of sheep sold/slaughtered for the past 12 months	6	8	0.103
Market price of sheep sold/slaughtered (TZS)	31 450.000	33 650.000	0.082
Total income from sheep (TZS)	205 866.667	303 333.333	0.100
Litres of milk sold for the past 12 months	0.533	0.000	0.169
Market price of milk sold (TZS)	166.667	0.000	0.165
Total income from milk (TZS)	2 533.333	0.000	0.157

Key: * = Statistically significant at $p<0.05$
** = Statistically significant at $p<0.01$

Villagers keep short - horned zebu type of cattle kept that are drought tolerant and resistant to diseases such as East Coast Fever (ECF), Contiguous Bovine *Pleuro-pneumonia* (CBPP), Foot and Mouth Disease (FMD) and other Tick-borne diseases. They are small sized when compared to other breeds such as Saihwal and Boran and also eat less than the two other types and, due to reasons above, the Zebu can walk long distances to access water and pastures. Fratkin (2001) alluded that their herds are often large and in poor condition, but hardy enough to survive periodic drought and sparse vegetation.

Sheep and goats kept were also small sized and can tolerate drought and diseases such as Contiguous Caprine *Pleuro-p*neumonia (CCPP), skin diseases and other bacterial

infections. The types of animals kept by the Maasai are suitable to drier areas that had unreliable rainfalls and long dry spells. These results conform to URT (2015) that traditional breeds dominate the Tanzania livestock sector. Tanzania Short Horn Zebu is the most widespread cattle breed in the nation. Pastoralists' households account for 80% of livestock production, agro-pastoral communities 14% and remaining 6% comes from the commercial ranches and dairy sector. Sheep and goats are widely distributed and adapted to many agro-ecological zones.

4.1.2 Income earning from livestock kept

As indicated in Fig. 3, income earning from livestock kept was very substantial among pastoralists. This is an indication of how the pastoralists benefited from keeping livestock through selling them to meet household needs, the tangible benefits. Average income for the past 12 months from livestock for households surveyed was TZS 1 835 292.00 from cattle, TZS 313 975.00 from goats, TZS 71 733.30 from sheep, TZS 3 333.30 from donkeys and TZS 1 267.00 from sales of milk. It was noted that 98.3% milked their cattle while only 8.3% of that sold the milk they obtained. Milk, meat and blood are the main foods for Maasai pastoralists (Saibull *et al.*, 1981, Ndagala, 1982) and this could be the reason for only a few of them selling milk. This results conforms to statistics from URT (2015) that the majority of households depend on livestock for their livelihoods nationwide, 50% of households keep livestock (27 million people). Rural livestock farmers that utilize livestock extension services have a net annual income of $ 17 per live animal and $ 430 net annual income per herd. Pastoralists also benefited from livestock in non - monetary ways such as paying dowry and donations to strengthen social ties.

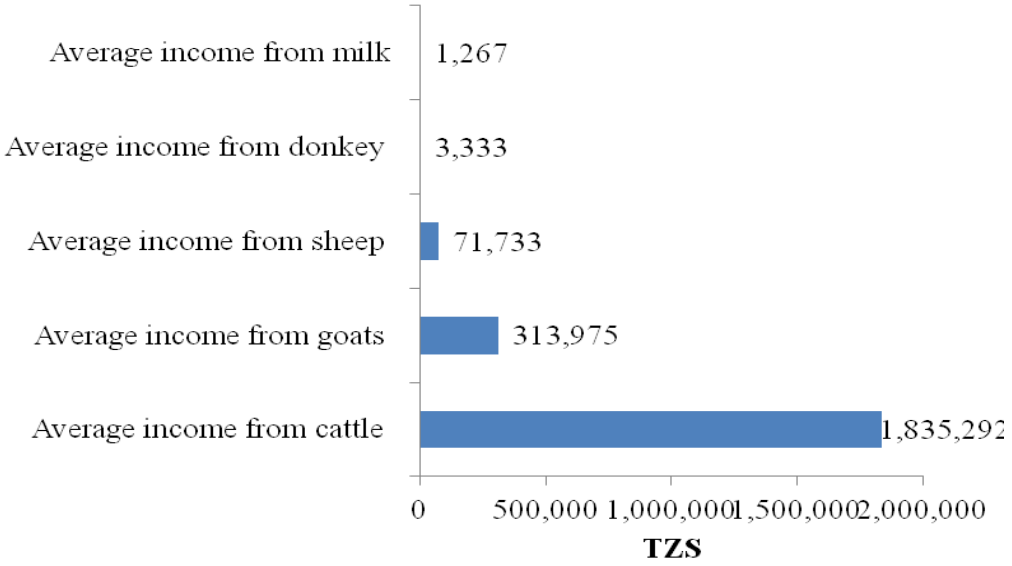

Figure 3: Average income earning from livestock (TZS).

Fratkin (2001) states that milk and milk products account for 60 to 65% of the dietary energy of Maasai, Turkana, and Rendille, consumed mainly in wet seasons, while meat (usually from goats and sheep), blood (tapped from living animals), and cereals are consumed as the dry season sets in and milk yields diminish. The study showed that milk yield was about 3 - 4 litres per day per cow and actually very little to be sold and still having some for family. Milk sold was about 0.533 on average in Irkiushioibor (Table 7).

4.1.3 Mode of livestock feeding

The study found that most used mode of feeding livestock was transhumance. This is the action or practice of moving livestock seasonally from one grazing ground to another, typically to highlands *(Orkung'u)* in wet season and lowlands *(Engusero)* in dry season (93% in Fig. 4). During the day livestock is moved out of *bomas* to search for pasture and water and return them back to *bomas* in the evening as opposed to zero grazing in which livestock is confined in one point or area to received hay or crop residues (stall feeding).

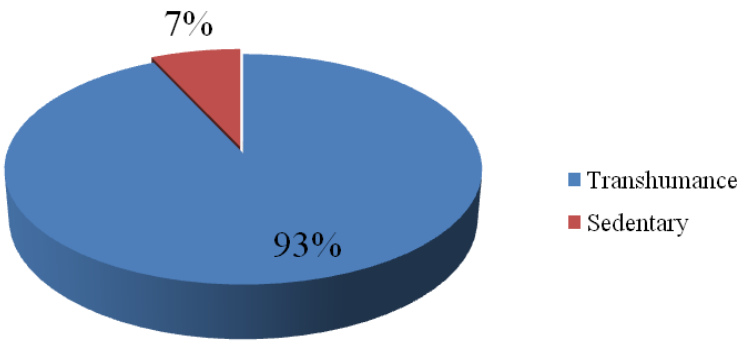

Figure 4: Mode of livestock feeding in the study area

Approximately 93% of pastoralists expressed that transhumance (Fig. 4) was important and that it was a kind of coping strategy at adverse climate extremities like scarce vegetation during the dry season. As put by Nkedianye *et al.* (2011), pastoral mobility is a drought coping strategy which historically helped many pastoralists to manage uncertainty and risk in arid lands (also in Selemani (2014). Arid ecosystems are spatially and temporally variable and to a large degree unpredictable, pastoral mobility enables the opportunistic use of these natural resources. In Tanzania, pastoralists reduce risk of livestock mortality by seasonal movement of livestock to the productive and high rainfall areas. Evidence indicates that, pastoral mobility is economic effective (i.e. less costly) because it requires minimal labor and inputs compared to stall feeding system (*Ibid*). However, in areas where there were both farmers and pastoralists like Irng'abolo village this mode caused conflicts because of intrusion of livestock into crop fields, Selemani (2014) opposed this by putting that pastoral mobility serves as symbiotic interaction with farmers, whereas livestock supply manure to the farmers and farmers provide crop residues for livestock feeds.

4.2 Socio-economic factors that influence adherence of TEK practices

4.2.1 Age class

The study found that all respondents kept livestock as their main occupation (100%) although, some practiced crop farming (agro-pastoralists) and few practiced other occupations to earn a living. The age classes of the Maasai pastoralists were an important factor in the study because Maasai pastoralists are transhumant and livestock keeping being the main economic activity was performed based on age set system whereby each group participated in one or several activities related to livestock keeping and dry land ecosystems management and promotion of natural resources available (Table 8). These results conform to Conroy (2002) who put that seasonal cattle herd migration is usually done by the *Morani* (young warriors), while the rest of the family and small livestock remain at the main homestead. The movement of the livestock has always been controlled by elders. They understood the dynamics of the grasslands, as well as, the livestock and wildlife that share it. Nyinondi (2011) also reiterated that each pastoralist Maasai age group has a role and authority in practice.

Table 8: Age-based division of roles for management of dry land ecosystems in the study area

S/N	Age group	Age	Role played
1	*Il Mertien*	*8 - 25*	Livestock herders Had understanding of availability of pasture resources
2	*Il Mirihi*	*26 - 40*	Protect land against grabbers and intruders Undertook scouting to search new pastures and water *(Eleenore)* Move livestock to access distant pastures and water, *(Ronjo)* They perform the duty of watering livestock throughout the dry season *(Eokore)*
3	*Il Kimunyak*	*41 - 60*	Provide advice on suitability of landscapes for grazing Own water sources by virtue of their Sections/kinship (Clan heads) Provide directives to herders on grazing duties
4	*Il Kishumu & Iseuri*	*> 60*	Own water sources on behalf of their kin Put in place grazing patterns *(Alalili)* that are observed by village and non-village members Perform cleansing of water sources (*Orkeju)* at the beginning of dry season Preserve traditional practices and historical knowledge of events Provide advice to other age groups on resources management

Ndaskoi (2005) described that the organization of the Maasai men starts right after initiation and that, the system is based on age set, *Olporro*. Under this system all the boys, attaining the age of sixteen or thereabout, are circumcised and accepted into a particular age-set, a unit possessing a single name (Table 8) and a sense of unity. It is further stated that among the Maasai people there are no rulers but there are leaders. For every sub-tribe each age group had a leader (*Alaigwanani* singular, *Ilaigwanak* plural) elected by the largest possible assembly of the members of the group. There is also a deputy leader (*Engopiro* singular, *Ingopir*, plural). These leaders *(Ilaigwanak)* are responsible to institute regulations tenable for land and natural resources management across Maasai land.

4.2.2 Sex of respondents

Basically, among the pastoralists, Maasai men, '*Eng Keju e Aulo'* or Away Leg (Saibull *et al.,* 1981) perform livestock activities such as watering, pasture scouting and grazing, temporary camping, *Ronjo,* treatment as well as marketing. Women do not do much of these activities as compared to men. Young ladies could go to take care of livestock (grazing) in absence of boys, and during the study, it was noted that the girls were not scorned as boys in case livestock were lost. Nyinondi (2011) reported that traditionally, Maasai communities assign roles and authority to individuals based on gender and age group. Maasai women are culturally prohibited to disclose information about landscapes hence, role of landscape assessment is generally for men. Although women and young girls performed most of the household chores, *'Eng Keju e Ang'* (Home leg) as put by Saibull *et al.* (1981) being the construction of huts, *Manyatta* and milking, they had knowledge on resource use and medicinal plants. So, both men and women play an important role in promoting TEK practices among the Maasai pastoralists in the study area.

4.2.3 Household size

Findings in Table 6 show that average household size (n = 120) in the study area was about 9 people. Household size in a pastoralist setting means more labour to work on livestock related activities. While young boys could go to herd cattle and calves, the two are normally not mixed during the day, warriors would do watering specifically during the dry season and looking for pastures, women will undertake milking and later separate calves from adult cattle. The larger the household size the more livestock is kept and the TEK practices that favour livestock keeping and resources management will be adhered to and also promoted.

4.2.4 Level of education

Findings show that the level of illiteracy was so high, about 68.3% of respondents had no primary education. This could be associated with the reasons for keeping livestock as there are reduced chances of other economic opportunities given the fact that area is dry to allow for crop cultivation. This being the business, practices that favour livestock keeping while conserving environment will likely be observed by them and promote TEK practices. Saibull *et al.* (1981) put that despite the reasons that the full force of modern world is upon them, and that their land is coveted by invaders and their territory has been reduced to an area of miles of marginal land and years of drought have diminished their cattle, the Maasai tribesmen will surely continue keeping cattle.

4.2.5 Time spent in the village

Average number of years spent by respondents in the study villages was about 37. Given the nature of the area (dry lands), the Maasai opted to keep livestock and any practices that influenced livestock keeping in the area were adhered to and will continually be promoted. Nyinondi (2011) contend that Maasai lived in the Maasai Steppe for centuries and grazed their livestock in the area, so have acquired knowledge to develop a well - defined grazing system and codes to govern resource use in the landscape (also Oba and Kaitira, 2006). Binary regression equation model was used to test whether the socio-economic factors influenced the perceived adherence of TEK practices in managing dry lands ecosystems in the study area (Table 9).

The regression equation model used to test whether socio-economic factors influenced the perceived adherence of TEK practices in managing dry lands ecosystems indicated that the model fits very well as indicated by Hosmer and Lemeshow Test being above 0.05 ($p = 0.97$). Results from the binary logistic equation indicate that variables influencing the perception of usefulness of TEK contributed from 11.1% to 29.6% as explained by Cox

and Snell R^2 and Nagelkerke R^2 values. All the predictors contributed equally to the model because they had probabilities greater than 0.05. Table 9 shows that Wald's statistics are non-zero values, and according to Powers and Xie (2000), the non-zero Wald's statistics values indicate the presence of relationships between the dependent and explanatory (independent) variables. Thus, on the basis of the results of this study, the research question on what and how socio-economic factors influenced the perceived usefulness of TEK in managing dry land ecosystems in the area at 5% level of significance.

Table 9: Socio-economic factors influencing overall perceived usefulness of TEK in managing dry land ecosystems in the study area

Predictor	B	S.E.	Wald's χ^2	df	Sig.	Exp(B)	95% C.I. of Exp(B)	
							Lower	Upper
Sex	-0.509	1.289	0.156	1	0.693	0.601	0.048	7.516
Age	0.135	0.107	1.585	1	0.208	1.144	0.928	1.411
Education level	-1.252	1.256	0.994	1	0.319	0.286	0.024	3.349
Household size	-0.111	0.161	0.47	1	0.493	0.895	0.652	1.228
Time in village	-0.029	0.06	0.226	1	0.634	0.972	0.864	1.093
No. of cows	0.047	0.033	2.069	1	0.15	1.049	0.983	1.118
No. of goats	-0.009	0.023	0.151	1	0.698	0.991	0.947	1.037
No. of sheep	-0.032	0.019	2.903	1	0.088	0.968	0.933	1.005
Time in keeping Livestock	-0.133	0.108	1.54	1	0.215	0.875	0.709	1.08
Constant	**3.396**	**2.888**	**1.383**	**1**	**0.24**	**29.856**		
Tests:			**χ^2**	**df**	**P**			
Likelihood ratio test (Omnibus Tests of Model Coefficients)			11.218	12	0.51			
Goodness-of-fit test: Hosmer - Lemeshow test			1.636	7	0.97			
Percentage Accuracy in Classification: Null model = 73.7; Model with predictors = 93.7								
Cox & Snell R^2 = 0.111			Negelkerke R^2 = 0.296			Sample size (n) = 120		

In Table 9, sex has a negative regression coefficient (b) of -0.509 and the odds ratio (Exp b) of 0.601. This implies that a unit decrease in this variable, which was statistically insignificantly at probability of 5% (p = 0.693) decrease influencing by a factor of 0.739. Sex may influence the role of TEK in natural resources management depending on ownership of resources at the household level such as land and livestock, all of which are important in determining the role played by TEK.

Age has a positive regression coefficient (b) of 0.135 and the odds ratio (Exp b) of 1.144. This implies that an increase in age, which was statistically insignificant at probability of 5% (p = 0.208), increases adherence to TEK practices by a factor of 1.144. In this study, the mean age of respondents was 48 years as noted previously, and age influences knowledge of various things in a place. This is vital in explaining experiences and benefits of various TEK practices that have been undertaken in the area for many years.

Education level has a negative regression coefficient (b) of -1.252 and the odds ratio (Exp b) of 0.286. This implies that a unit increase in this variable, which was statistically insignificantly at probability of 5% (p = 0.319), increases the rate of adhering to TEK practices by a factor of 0.286. In a pastoralist setting, people who are educated would like to keep livestock differently, say for example the ranching systems and neglect the usefulness of TEK practices.

Household size has a negative regression coefficient (b) of -0.111 and the odds ratio (Exp b) of 0.895. This implies that a unit increase in this variable, which was statistically significant at probability of 0.05 (p = 0.493), influenced negatively the role played by TEK by a factor of 0.895. Household size in a pastoralist setting influences a number of factors. Large household size may influence income earnings and expenditure; it may

influence the level of labour force and may as well increase livestock activities concentration and diversification.

Total income earning per year has a positive regression coefficient (b) of 0.0001 and the odds ratio (Exp b) of 1.000. This implies that a unit increase in this variable, which was statistically insignificantly at probability of 5% (p = 0.690), increases perceived adherence of TEK practices by a factor of 1.000. Income influences a number of factors. People with high earnings from livestock and their products would prefer to keep more livestock and adhere to TEK practices that favour pastoralism in their locality. Natural vegetation and wildlife species observed in the study areas indicated that pastoralists' TEK practices influenced the management of these natural resources.

4.3 TEK practices existing in the study villages

Results from focus group discussions in the two study villages revealed several TEK practices. The practices in Table 10 were based on livestock keeping as a major economic activity and the management of natural resources that this activity relied upon. The practices constituted the daily routine of pastoralists' life style in taking care of their precious livestock while ensuring the sustainability of the scarce resources in the rangelands. As pointed out earlier, pastoralism was the dominant mode of livelihood that depended entirely on availability of natural resources such as pasture, water, salt licks and livestock routes to access these resources.

Table 10: TEK practices perceived to promote dry land ecosystems management in the study are

S/N	Type of NR	TEK Practice	Traditional name	Description	Usefulness in dry land management
1.	Grazing land	Herd splitting	*Iloho, Alaram and Irmong'i*	Separating calves from adult cattle;	To control breeding Easy feeding, avoid physical injuries to young and weak animals.
2.	Grazing land	Set aside portions of grazing areas	*Alalili*, sing, *Ilaliliak* plr	For young and weak animals For different seasons of the year	Avoid overgrazing Reserving pasture for the dry season
3.	Grazing land	Moving livestock to access water and pasture away for a specific period	*Ronjo*	Seasonal movement to feed livestock away from permanent Settlement	Reserving dry season pasture Fatten livestock
4.	Grazing land	Herd diversity;	*Iltimito*	Keeping varieties of livestock herds such as cattle, goats, sheep and donkeys.	Each herd feeds differently on available type of vegetation. Reserve in case of severe drought or disease
5.	Water sources	Water sources owned by clan heads;	*Engishomi*	Hand dug wells owned by kinship	Every water source has someone to take care of.
6.	Water sources	Prohibition to cut down trees/establish settlement close to water sources.	-	No specific distance given.	To avoid drying the water sources and siltation
7.	Water sources	Ritual to cleanse the water sources *(Orkeju).*	*Emayian*	Prayer is said at the beginning of the dry season *(Alameyu)* as sign of inauguration.	Prior to this prayer, no one is allowed to utilize the water
8.	Forests	Construction of Kraals *(bomas)*and huts	*Engang'*	It's a circular cluster of dwellings enclosed by a fence	Constructed using tree tops and branches (for boma), withies and poles (for huts)
9.	Forests	Use of medicinal plants	*Olchani*	To cure people and livestock ailments	
10.	Wildlife	Maasai do not consume game meat	-	Beef is considered better than game meat	Wildlife available in rangelands than other areas
11.	Wildlife	Maasai allow wild animals, ungulates, to graze with livestock without killing them	-	Co-existence of livestock and wildlife is common in the rangelands	Rangelands are safer breeding sites for wildlife
12.	Beekeeping	Beekeeping is not a cash earning business	-	Bees honey is used in performing rituals.	Extraction is by using fire that is detrimental
13.	Grazing lands	Burning rangelands	*Embejeto*	Aim is to eliminate ticks and other parasites Allows sprouting of new and palatable grass for livestock	This is detrimental to fauna and flora (biodiversity)

From the study, *Alalili* was a mechanism used to reserve pasture for young animals and ensure that pasture was available for different seasons. Hauff (2003) also states that a communal tenure system practiced by the Maasai do control grazing by regulating access to users and sanctioning abusers, have mechanisms in place to conserve resources at certain times of the year to guard against mismanagement, and are more effective than privately owned land strategies.

Regarding *Ronjo,* pastoralists move their livestock to access distant pasture and water. This is in line with what was reported by Temesgen (2015) in the African pastoral development policy framework principles and strategies that pastoralist mobility is the basis for efficient use and protection of rangelands, and, that mobility is key to appropriate adaptation to climatic and other trends. Fratkin (2001) also described that traditional pastoral production demands mobility, the *sine qua non* of dry land cattle keeping. Descriptive analysis by Mlekwa (1996) on the government idea of permanent settlement without the necessary infrastructural development of water and grazing to support their cattle was too suicidal to contemplate.

Livestock could not be confined in one point without moving to access pasture and water where it may be available. This is asserted by Fratkin (2001) and Kasika (2017) that pastoralists, more than other populations have historically adapted to conditions of low and erratic rainfall, patchy resources, and recurrent drought. Box 1 highlights the reasons for mobility in a pastoral context as noted during the study.

BOX 1

Maasai saying on Mobility; "***Naari ekwet naata ormong'o"***

Literal translation is that ***"One whipped while running will rescue itself".***

"It is pretty much better to go to distant areas searching for pasture and water than being stationed in one place, death is an ultimatum"

Daniel Ole Loorkiding'a, Irng'abolo village

20/02/2017

To manage natural resources in the dry lands, pastoralists expressed that there were various landscapes used to graze livestock at different seasons of the year namely the uplands, *Orkung'u* for the wet season and grasslands, *Engusero* for the dry season. Availability of grazing resources in and outside the villages controlled livestock movements during different seasons of the year and knowledge on ecology of the area has been vital for pastoralists to utilize the resources available.

The system practiced by the Maasai pastoralists is centripetal kind of grazing, that during the wet seasons, livestock were grazed at the uplands (*Orkung'u*) and reasons given were to preserve dry season water and pasture and allow for regeneration, also livestock recovered quickly at the uplands, pasture and water were available everywhere during the wet season (*Iturot*) as explained in Box 2.

BOX 2

"Livestock recovered quickly at the uplands because pasture and water were available everywhere during the wet season (Ilturo), they feed well and fatten. And when livestock have enough pasture at Ronjo, mating is enhanced"

Mokia Rokoine, Irkiushioibor village.

19/01/2017

During the dry season livestock grazed at the grasslands *Engusero*. Reasons given were that all the water sources for dry season were situated around the grass lands and therefore livestock come down to the grasslands and lowlands (Plate 2).

Plate 2: Livestock grazing in grassland at Irkiushioibor village
(Photo: Samwel Olekao**)**

Table 11 shows various grass types available in the landscapes that were used by livestock during wet and dry seasons. It was also explained that the pasture reserved for the dry season was utilized at that time therefore; livestock accessed both pasture and water easily. These grazing arrangements were supervised by Council of elders, (*Ilaigwanak*) as seen in Box 3, who took this task seriously and without biasness. They were trusted elders of the pastoralist Maasai community elected by virtue of their righteousness and charisma.

BOX 3

"We agreed in the village meeting comprising of Ilaigwanak that livestock should be moved away from dry season water sources upon the onset of rainfall, specified distance was approximately 8km away. It was also agreed that each family was allowed to retain only 5 cattle for milking and a bull, everybody adhered to that"

Lazaro Ole Ngulla (Alaigwanani), Irkiushioibor village

21/01/2017

Table 11: Grass species available in landscapes for livestock in the study area

Landscape	Grass type	
	Vernacular name	**Botanical name**
Upland (Orkung'u)	*Errube*	*Themeda triandra*
	Arpau	*Echinochloa colona*
	Endiamosero	*Dyschoriste hilderbrandtii*
	Orkujita onyokie	*Chloris virgata*
	Orkirriany	*Setaria pumila*
	Emurwa	*Cynodon dictylon*
	Enemeregeshi	*Aspilia mossambicensis*
Grassland (Engusero)	*Orkereyian*	*Acrocerus macrum*
	Orkirriany	*Setaria pumila*
	Ologor aing'ok	*Cenchrus ciliaris*
	Oseyiai	*Sirpus maritimus*
	Erikaru	*Brachiaria brizantha*
	Endiamonywa	*Dyschoriste hildebrandtii*
	Emuketia	*Unidentified*
	Orgume	*Unidentified*

Regarding herd variability (diversity), findings showed that pastoralists kept cattle (zebu type), sheep, goats and donkeys. The findings agree with Markakis (1993) that most pastoralists keep a mix of livestock species to maximize benefits and minimize risks. This takes advantage of variations among species with respect to drought tolerance and utilization of different types of vegetation and supplied nomads with milk, meat, transport, investment, and income.

Water sources were owned by Clan heads, *Engishomi*. Fratkin *et al.* (2003) stated that in traditional Maasai society, no individual "owned" grazing or water resources; rather all members of the *olosho* (territorial section) shared land and water in a given area. Pastoralists who did not own wells, (*Ilchorroi*) accessed water or 'came after the owners' *Esujare*. Miller and Doyle (2014) described that Maasai held *de facto* rights to resources within their section's territory, regardless of their village membership. Within these territories, particular wells were managed by households or groups of households that decided who was included/excluded from resource access and withdrawal. It is strictly prohibited to clear cut trees and establish settlement close to water sources (there was no specific distance given). Practices such as grazing away from water sources, prohibiting clearing vegetation around water sources and establishing settlements away from water sources aimed at protecting water as a resource to minimizing water loss and siltation. Pastoralists perform cleansing rituals of the water sources *(Emayian)* at the beginning of the dry season *(Alameyu).* Prior to *Emayian,* no one is allowed to utilize the water sources until the prayer is performed as described in Box 4.

BOX 4

"*At the end of the rainfall season and beginning of the dry season, normally between June and July, we (elders) meet to say a special prayer, Emayian, at the water sources, Orkeju as a sign of inauguration for everyone to start using the dry season water"*

Yohana Ole Masai, Irng'abolo village, 20/02/2017

Regarding forest conservation, the research found that Maasai pastoralists do not clear cut trees and forests. It is described by Searle (1999) that local plant species are used for many purposes including firewood, fence construction, house construction and medicinal. Other purposes include toys, utensils, tools, weapons, ceremonial and sacred purposes, animal browse, walking sticks and many species have more than one purpose in Maasai

society. They constructed their kraals, *Engang'* by only using tree branches and tops. Kisoza (2007) defined *Enkang' as* a group of people who normally share dwelling houses or encampment, claim a kinship relationship, sharing responsibilities for managing a communal herd and may or may not eat from a common pot, but they are under the authority of one person. A kraal, also called *boma*, is a circular cluster of dwellings enclosed by a fence (Homewood and Rodgers, 1991, Ndagala, 1992, Hauff, 2003), as seen in Plate 3. Pastoralist women construct huts, *Ngajijik*, (Ndagala, 1982) by using poles and withies then thatched with grass and herbs.

Plate 3: Cattle (left), sheep and goats (right) in a Maasai kraal, *Engang'*
(Photo**: Samwel Olekao**)

Maasai pastoralists use medicinal plants to cure people and livestock ailments in the study area. Despite this, medicinal trees were not over - exploited, endangered trees (those facing desiccation) are encircled and earmarked to prevent further extraction. Use of medicinal plants as a practice among the Maasai pastoralists will be discussed when examining plants used and their effectiveness.

Regarding wildlife in the rangelands, Maasai pastoralists do not consume wild meat and therefore do not aspire to kill wildlife that grazing close to their livestock. They allow wild animals, especially the ungulates to graze with their animals without any disturbances. The findings collaborate with Msoffe (2010), who reported that for millennia, pastoralists have shared landscapes with wildlife throughout Africa (also Homewood and Rogers, 1991). Conroy (2002) echoed by puting that the traditional Maasai system of livestock and land management has also been admired for its tolerance of wildlife. Maasai herds and flocks are locked in the corral each night, leaving the unfenced grazing areas exclusively to the wildlife. Even during the day wildlife can be seen near the herds of cattle and flocks of sheep and goats. Study by Voeten (1999) found that throughout the 20th century the co-existence of livestock and wildlife has been in decline as conservation policy excluded people and livestock from protected areas and, expanding agriculture excluded wildlife and livestock use.

The study by Msoffe (2010) demonstrated that protected areas alone are not sufficient to conserve wildlife populations, particularly migratory species. It stressed therefore that, the importance of involving local communities in monitoring programs across landscapes that incorporate communal lands as well as protected areas is inevitable under the current observed land-use change and wildlife trends. In Irkiushioibor village, beekeeping is not an economic business although bees honey, Enaiho, was used in performing rituals and practices such as initiation and blessings. There were no apiaries and no areas set aside for beekeeping activities. Honey extraction was done locally and the practice noticed was that extraction was done by using fire which kills more than half of the bees colony.

4.4 TEK practices that promote or hinder management of dry lands

Findings showed that TEK practices promoted the management of dry land resources by 92.5% in the study area (Fig. 5). However, some pastoralists (7.5%) urged that certain practices were detrimental to the environment and other natural resources.

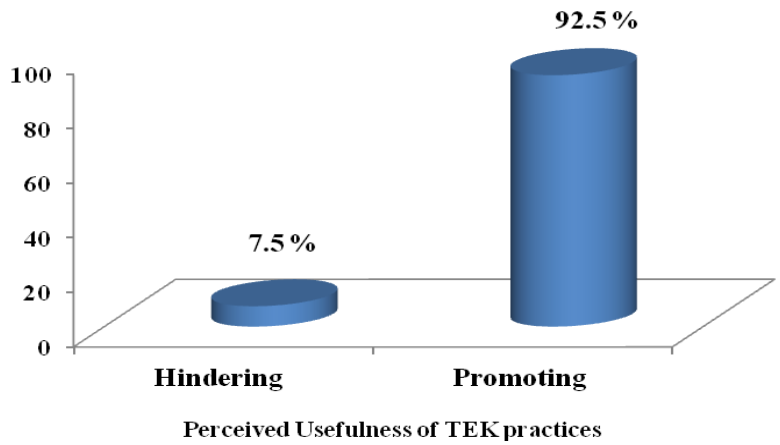

Figure 5: Perceived usefulness of TEK practices in the study area

This study examined both sets of practices to see their contribution in either promoting or hindering the management of the dry land resources in the study area.

4.4.1 TEK practices perceived to promote dry land ecosystems management

Interviewed pastoralists perceived that TEK was useful in managing dry land ecosystems in the study area (Table 12). Usefulness is based on the reasons that TEK practices provide guidelines on utilizing and managing land and natural resources available.

Table 12: Perceived TEK practices promoting management of dry land ecosystems in the study area

S/N	Practice identified	Usefulness in the study area
1	Livestock mobility	Promotes regeneration of new vegetation when degraded environments are left un-grazed
2	Herd splitting	Reduces trampling on land and suppression of vegetation
3	Seasonal grazing patterns *(Ronjo)*	Reserving pasture and water resources for the dry season
4	*Alalili, Sing. Ilaliliak, Plural.*	Ensures availability of pasture resources for young and weak animals all year round
5	Herd diversity	Ensures that one type of vegetation was available for at least one herd type (cattle, sheep, goats)
6	Cleansing of water sources	Preserving water sources for dry season
7	Rotational watering of livestock	Sustaining the available water for the dry season
8	Conservation of water sources	To avoid evaporation and drying up of water sources
9	Prohibit establishing settlement near water sources	To avoid siltation and contamination of water sources
10	Conservation of wildlife	Ensures that rangelands are safer environments for wildlife
11	Use of medicinal plants	Ensures sustainable use of plants and avoid cutting down trees unnecessarily
12	Construct *bom*as and huts using twigs and poles	Ensures sustainable use of plants for these specific variable use

From the study, findings in Table 13 show information/perception of pastoralists on how TEK was perceived to restore or protect degraded lands in the villages.

Table 13: Responses on how TEK restores degraded grazing sites in the study area

Restoration technique	Frequency	Percent
Mobility of livestock	65	54.2
Conservation of forests and water sources	6	5
Conservation of fragile sites using local institutions, *Ilaigwanak*	9	7.5
Apportioning grazing areas, *Alalili* to ensure sustainability	25	20.8
Herd splitting to reduce feeding pressure	5	4.2
Seasonal grazing patterns, *Ronjo*, to preserve pastures	10	8.3
Total	**120**	**100**

Results indicate that 54.2% of respondents strongly agreed that mobility promoted regeneration of new plants when the area is left untouched for certain period of time. This was explained to be the reason for pastoralists to have the kind of grazing patterns that enabled them to move from one place to another to allow for regeneration. These results are in agreement with those reported by Tenga *et al.* (2008) who described that transhumance (livestock mobility and rotational use of pastureland) minimizes land overuse and allows vegetation to recover after grazing, thereby protecting marginal lands from degradation.

Herd splitting reduced pressure on grazing resources and therefore conserves land against degradation. Observation revealed that livestock were divided into smaller groups based on cohort that could feed with ease and with less suppression on the land cover. The findings are similar to those of Mangara *et al.* (2017) stating that herd splitting was done to reduce competition and allow the disadvantaged animals (small/weak) to graze. Also, herd splitting was a strategy to mitigate inadequate feed supply in dry and drought periods.

Regarding conservation of wildlife, pastoralists had no habit of killing wildlife unnecessarily although they rarely consumed ungulates such as eland, giraffe, buffalo and

antelopes. Wildlife, especially ruminants, grazed together with livestock quite comfortably without disturbance, and this undisturbed co-existence of wildlife and livestock in the Tarangire - Manyara Ecosystem (TME) (the study area is in this TME) could be the reason for the presence of wildlife in pastoralist areas as compared to other non-pastoralist areas. Aboud *et al*. (2012) stated that the Maasai-Steppe of Tarangire is one of the richest wildlife areas in Tanzania. It is well known for its migration of wildebeest, zebra and elephant. Homewood and Rodgers (1991) also reported that, despite decades of studies on the vegetation and wildlife species of the NCA/Serengeti area little was known until recently of the ecology of the Maasai or their livestock, that little or no ecological evidence has ever been presented to back up the argument of ecological damage.

When asked about forest conservation and plant uses in a pastoralist set-up, respondents strongly agreed that using plants during traditional ceremonies (Plate 4) and in other ways promoted dissemination of the resource use knowledge and management to youngsters and the community at large. It was found that from youthfulness, resource use knowledge and management is implanted to young people and so required to adopt and maintain this manifestation received. The findings were similar to those of Mlekwa (1996) on elders maintaining and restoring social order in the community, they transmit their accumulated experience related to herding and resource management to the younger generation, they served as spiritual guardians and sponsors of religious ceremonies, passing on cherished traditions and customs of the people to youths and children.

Pastoralists do not cut down trees and clear bushes for the purposes of establishing crop fields. They mostly utilized plants in many ways including performing rituals (Plate 4) and constructing their *Manyatta* (kraal) but only tree tops were used for these purposes,

leaving tree trunks standing. Also, when constructing huts, only poles and withies were used and trees left un-cleared. In the study area (dry land), shrub lands, thickets and tall trees were standing despite the reasons that the area is semi-arid, no cleared bushes.

Plate 4: Twigs of *Grewia bicolo*r (*Esiteti*) used during the *Il Mirihi* age mate retirement ceremony, *Orng'eherr*
(**Photo:** Samwel Olekao).

4.4.2 TEK practices perceived to hinder dry land ecosystems management

Criticism on the mode of livestock by Maasai and other pastoralist groups is centered on mobility, whereby movement of livestock is claimed to compromise with other land uses and causes the never-ending conflicts. Practices identified to hinder management of natural resources in the dry lands are shown in Table 14.

Table 14: Perceived TEK practices hindering dry land ecosystems management in the study area

S/N	Practice	Detrimental effect
1	Mobility *(Enaidurra)* to access distant pasture	When used unwisely may interfere with other land uses in the rangelands such as conservation areas and croplands and leads to conflicts with other land users Nomadic lifestyle may be the cause of loss of land for pastoralists; when they come back they find that land is occupied by other land users
2	Keeping large herds of livestock	Causes trampling and overgrazing when livestock are confined in one place sacrificial areas
3	Burning rangelands to remove ticks and parasites	Kills fauna and flora in the rangelands and especially plants and slow moving animals
4	Use of fire to extract honey in rangelands	Kills more than half of bee colony and may escape and become wildfire

Village records of 2017 showed that there were about 13 017 cattle in Irkiushioibor village that moved across landscapes. Respondents associated large herds with depletion of vegetation cover in the rangelands and the death of about 400 cattle in the village during the 2016 long dry spell. Large herds of livestock were claimed to cause overgrazing, trampling and soil compaction (Hardin, 1968). According to Nyinondi (2011), overgrazing was considered to be important causes of forest degradation in Tanzania (as in Chamshama, 2010). The consequences of overgrazing have been land degradation (soil compaction, broken soil crust and erosion) as well as reduced species diversity and density.

Mobility is criticized by the government of Tanzania today than in the past, Benjaminsen *et al.* (2014), puts that there was complementarity between farmers and migrating pastoralists in many parts of Africa but the complementarity is being replaced by

competition due to population growth and agricultural policies. Pastoralists are faced with the expansion of agriculture in modern States that do not appreciate mobile livestock keeping as a valid way of life or production system. African pastoralists tend to be the losing party. Also, there is perception of farmers, politicians and local administrators on pastoralists claiming that the main cause of farmer – herder conflicts was the tendency of herders to overgraze their own village land and subsequently enter the farmers' village territories to feed their ever-growing herds of livestock *(Ibid).*

Burning up the rangelands for reasons to eliminate ticks and tsetse fly in Irkiushioibor grassland was perceived to be detrimental to the rangelands. Although the intention was to allow for regeneration of new pasture, the practice causes deaths of flora and fauna specifically slowly moving animals and when it is done in the dry season.

Beekeeping was reported not to be a cash earning activity by the Maasai pastoralist in Irkiushioibor village but bees honey, *Enaiho*, was used when performing rituals like initiation and blessings. Despite this, extraction of honey was done entirely by using fire/smoke to deter the bees. This practice was reported detrimental because it wipes away almost all the bees by killing them before getting their honey. In most cases, fire remains could escape and cause wildfire.

4.5 Effectiveness of medicinal plants in curing livestock and people

4.5.1 Medicinal plants for humans

Table 15 shows the most dominant tree species identified in the study area. Interest in studying about medicinal plants has increased dramatically in recent years. The search for medicinal herbs as opposed to conventional treatment by the people in towns has turned to plant natural products. Studies on medicinal herbs make a valuable acknowledgement

to traditional knowledge of biological diversity, conservation of endangered ecosystems and the human societies which depend upon them as well as providing the potential for new drug discoveries. Use and effectiveness of medicinal plants in curing diseases is here discussed as one of the TEK practices among the Maasai pastoralists. It is now common to see the Maasai tribesmen in major cities and towns with the herbs with a view to cure a number of diseases and illnesses. The reason for this was to see what plants were mostly used by pastoralists to cure common human and livestock ailments in the study area.

Table 15: Dominant vegetation in ecological landscapes in the study area (n = 120)

Dominant vegetation	Botanical name	Frequency	Percent
Ositeti	*Grewia bicolar*	62	51.7
Oltepesi	*Acacia tortilis*	73	60.8
Osilalei	*Commiphora africana*	74	61.7
Olpopong'i	*Euphobia candelabra*	17	14.2
Ormukutan	*Albizia anthelmintica*	5	4.2
Oldorko	*Cordia sinensis*	29	24.2
Oltepeleki	*Grewia similis*	7	5.8
Oloiborbenek	*Croton dichogamus*	53	44.2
Olng'oswa	*Balanites aegyptiaca*	3	2.5
Oltemway	*Commiphora swynnertonii*	10	8.3
Orbili	*Commiphora spp*	3	2.5

It was also important to know the common ailments in the area that were cured by using local herbs identified. Table 16 shows that Malaria was the most common disease cured by medicinal plants and was reported by all respondents interviewed (100%), other common diseases and ailments included coughs, stomach disorders, intestinal worms, skin diseases and wounds. The most usable plants were those in their vicinity, unless it was not found in their locality. There was many other plant species mentioned by respondents and observed during data collection but had low frequencies.

Table 16: Human illnesses cured by using medicinal plants in the study area (n = 120)

Disease	Frequency	Percent
Intestinal worms	80	66.7
Malaria	120	100
Diabetes	4	3.3
Ulcers	22	18.3
Skin diseases	60	50
Coughs	115	95.8
Colds	54	45
Stomach disorders	101	84.2
Wounds	29	24.2

Different medicinal plant species used by the Maasai in the study area were identified and their effectiveness in curing various ailments was examined using the Likert scale method. According to Searle (1999) the Maasai use leaves, roots, bark, shoots, saplings, seeds, fruits, berries, gums, stems, trunks, Iimbs, fibers. The passing on of Maasai plant knowledge is through oral tradition since the majority are illiterate. Medicinal plants were effective by 60% in treating malaria, moderately effective (56.9%) for skin diseases, moderately effective (70%) in treating diabetes, also effective by 52.5% in treating coughs as in Table 17. The results closely conform to findings by Searle (1999) who conducted studies on plants used by the Maasai in Loliondo Tanzania and Turkana Kenya and found that Maasai used about 67 species of local plants for medicinal purposes.

Medicinal plants have long played important roles in the treatment of diseases in East Africa (Ruffo *et al*., 2002) and all over the world (Rafieian-Kopaei, 2012) and therefore, medicinal plants are a source for a wide variety of natural antioxidants and are used for the treatment of diseases throughout the world. Some of these properties are antimicrobial, anti-cancer, anti-diabetic, anti-atherosclerosis, immuno - modulatory, and even reno-protection or hepato-protective effects (Rafieian-Kopaei, 2012).

Table 17: Plant species used to treat human ailments and their effectiveness in the study area

Disease/ Ailment	Effectiveness (%) based on number of respondents	Plant species and part used		
		Vernacular name	Scientific name	Plant part used
Malaria	60	*Ormukutan*	*Albizia anthelmintica*	Bark, roots
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots
		Endulelei	*Solanum incanum*	Fruits
		Oltirkish		Fruits
		Kabuya		Fruits
		Orgilai	*Teclea simplicifolia*	Bark
		Oremit	*Salvadora persica*	Roots
Intestinal worms	41.8	*Orkitarwo*	*Croton spp*	Bark
		Orkelelwet	*Croton spp*	Bark
		Osingwai		Bark
		Oloiborbenek	*Croton dichogamus*	
		Ormukutan	*Albizia anthelmintica*	Bark, roots
		Osukuroi lenkiok	*Aloe vera*	Leaves
Ulcers	34.5	*Olkiloriti*	*Acacia nilotica*	Bark
		Orkitarwo	*Croton spp*	Bark
		Alamuriaki	*Carissa edulis*	Bark, fruits
Skin diseases	56.9	*Oltemway*	*Commiphora swynnertonii*	Oil
		Embalwa		Roots
		Olchilichili	*Commiphora ssp.*	Oil
Diabetes	70	*Orkokola*	*Rhamnus staddo*	Bark
		Olodwai		Fruits
		Oltemway	*Commiphora swynnertonii*	Oil
		Alamuriaki	*Carissa edulis*	Bark, fruits
Coughs	52.5	*Arparrarruay*		Leaves
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots
		Olodwai		Fruits
		Osukuroi	*Aloe vera*	Leaves
		Orbukoi	*Terminalia brownii*	Bark
		Oltemelwa	*Solanum spp*	Roots
Gouts	77.8	*Arparrarruay*		Leaves
		Oldarpoi	*Kigelia africana*	Leaves
Colds	48.8	*Alamuriaki*	*Carissa edulis*	Bark, roots
		Endulelei	*Solanum incanum*	Fruits
		Engilelo		Roots
		Orkitalaswa	*Myrica salicifolia*	Bark
		Oltemway	*Commiphora swynnertonii*	Oil
Stomach disorders	46.8	*Oiti*	*Acacia melifera*	Bark
		Orkelelwet	*Croton spp*	Bark
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots, fruits
		Ormukutan	*Albizia anthelmintica*	Bark, roots
		Orpel	*Markahamia lutea*	Roots
		Olng'oswa	*Balanites aegyptiaca*	Roots
		Osingway		Bark

A study conducted in Kenya by Tolo, *et al.* (2006) revealed that an aqueous total extract preparation from the roots of *Carissa edulis* (Apocynaceae), a medicinal plant locally growing in Kenya exhibited remarkable anti-viral (Herpes Simplex Virus) activity in vitro and in vivo for both wild type and resistant strains of HSV. It was reported that the extract significantly inhibited formation of plaques in Vero E6 cells infected with 100 PFU of wild type strains of HSV-1 & HSV-2) or resistant strains of HSV (7401H HSV-1 & 7401H HSV-1) by 100% at 50 ml in vitro with minimal cell cytotoxicity. The research concluded that the results suggest that the herbal extract has potent anti-viral agents against herpes simplex viruses that can be exploited for development of an alternative remedy for HSV infections *(Ibid).*

In this study, it was noticed that pastoralists used plants for many ways including construction of kraals and huts, making clubs, spiritual and traditional rites, but mostly for medicinal values. Hauff (2003) stated that all Maasai pastoralists have medicinal knowledge. In curing ailments, decoction from pieces of bark, roots, or leaves Alchani, was used as medicine, taken without being processed (Mbuya et at., 1994) and sometimes added to foods (Hauff, 2003). Certain trees were used for particular ailments (Arhem, 1989), studies attributed the low incidences of heart disease among Maasai with cholesterol lowering substances found in bark extracts used by the Maasai in their foods (milk, soup and blood) (Saibull and Carr, 1981) given the reliance on meat and milk.

Msogoya (MWANACHI Newspaper, 2017) stated that WHO statistics show that 80% of people in the developing countries use herbal medicines and 60% of people in Tanzania use herbal medicine to cure various diseases and that every village has a provider. Also, 60% of people in Tanzania mainly in rural areas start to use herbal medicines when they fall sick prior to visiting health centers.

In major cities in Tanzania, The Maasai tribesmen deal with herbal medicines and statistics show that a provider receives ten to twenty (10 - 20) clients a day with various problems ranging from BP, kidney failure, asthma and stomach ulcers *(Ibid)*.

4.5.2 Medicinal plants for livestock

When interviewed on the types of livestock diseases common in the study area which were treated by using medicinal plants, respondents identified diseases and ailments as shown in Table 18. The most common problem mentioned was the retention of placenta after the animal has given birth, others included ticks and other parasites which were the causes of deaths of livestock, wounds and eye related problems and injuries.

Table 18: Livestock illnesses treated by medicinal plants in the study area (n = 120)

Disease	Frequency	Percent
Eye problems	76	63.3
Retaining placenta	97	80.8
Wounds	92	76.7
Ticks and other parasites	94	78.3
Skin diseases	66	55.0

Effectiveness of medicinal plants in curing livestock illnesses was also examined. Findings in Table 19 show that medicinal plants were effective to about 84.2% when provided orally to livestock that retain placenta after delivery. Also, were effective by 54.2% when applied on livestock skins to remove ticks and other parasites that were the causes of most livestock diseases. A decoction from medicinal plants was used to cure livestock eye problems and injuries and was effective to about 53.5% and when used to treating skin diseases was moderately effective for about 42.9%. Fatima *et al.* (2013) explained that the roots of *Carissa spinarum* are reported to be many medicinal uses. They are ground and put into the wounds of cattle to kill worms. It is also used in combination with the roots of some other medicinal plants to treat rheumatism.

Table 19: Plant species used to treat livestock ailments and their effectiveness in the study area

Disease/ Ailment	Effectiveness (%) based on number of respondents	Plant species and parts used		
		Vernacular name	Scientific name	Plant part used
Retention of placenta	84.2	*Armame*	*Solanum nigrum*	Roots
		Orkobobit	*Unidentified*	Roots
		Osingwai	*Unidentified*	Roots
Ticks and other parasites	54.2	*Oltemway*	*Commiphora swynnertonii*	Oil/exudates
		Oloisuki	*Zanthoxylum chalybeum*	Bark, roots
Eye problems	53.5	*Oltemway*	*Commiphora swynnertonii*	Oil/exudates
		Orbukoi	*Terminalia brownii*	Bark
Skin diseases	42.9	*Olchilichili*	*Commiphora spp*	Oil/Exudates
		Oltemway	*Commiphora swynnertonii*	Oil/exudates
Wounds	30.9	*Oltemway*	*Commiphora swynnertonii*	Oil/exudates
		Oloisuki	*Zanthoxylum chalybeum*	Bark

A study by Chacha (2015) revealed that tick-borne infections resulting from tick infection in livestock are common veterinary health problem in Tanzania. Tick infections were the cause of reported cattle deaths and were estimated to account for 68% of the 364 million USD annual total losses resulting from tick-borne diseases in Tanzania.

Another study by Nagagi *et al.* (2016), added *Commiphora swynnertonii* Burtt to the list of plant species of similar genus (genus *Commiphora*) that were previously tested in *vitro* and found to possess anti-trypanosomal activity.

Use of medicinal plants by the Maasai pastoralists on livestock may indicate limited availability of extension services or availability and high costs of veterinary medicines in their localities.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

It is concluded that pastoralism as a livelihood strategy is part and parcel of the Maasai traditions and culture. Although the Maasai pastoralists live in dry lands with scarce resources, shorter rainfall seasons and long dry spells, use of traditional ecological knowledge (TEK) has been vital for their existence. Socio - economic factors such as sex, age, number of cows owned had positive coefficients such that males, adults and those with large herds of livestock influenced the usefulness of TEK in managing natural resources.

Practices such as herd splitting, setting aside areas of grazing lands for different seasons of the year and for young and weak animals, *Ilaliliak*, water resources *Ilchorroi*, being managed traditionally, pre-determined and planned transhumance, *Ronjo*, and conservation of wildlife and forest resources are the TEK practices identified to play key role in management of dry land ecosystems in Kiteto district. There is therefore a positive link of pastoral ways of life and natural resources management.

For many decades, medicinal plants have long played important roles in curing diseases and ailments (human and livestock) instead of conventional medication in Kiteto. Common ailments cured by using herbal plants included malaria, coughs, stomach disorders, intestinal worms, skin diseases and wounds. Decoction from pieces of bark, roots, or leaves was used as medicine, (*Olchani)* taken without being processed or added to foods (milk, soup and blood). In livestock, the most common diseases mentioned were retention of placenta after the animal has delivery, wounds and eye problems, removal of

ticks and other parasites which were the causes of most livestock deaths. Findings of this study have therefore indicated that TEK has a role to play in management of dry land ecosystems of Kiteto District.

5.2 Recommendations

Maasai pastoralists' ecological knowledge could be used to test specific dry land management mechanisms as well as putting in place specific management plans that are workable and solution oriented for arid and semi-arid lands (ASALs). Pastoralists understood why they moved their livestock to certain parts of their lands and at specific seasons of the year, the ecological knowledge enables them live on scarce vegetation resources and water. Due to this, the following are recommended;

i. Government and actors should work on policies that undermine pastoral ways of life and range ecologists should design a model that integrates TEK and scientific/expert based knowledge to be used in dry land ecosystems management.

ii. Since communities have lived in the drier environments for many years and have developed necessary skills necessary for sustainable utilization of natural resources, it is recommended that skillful engagement of TEK practices be enhanced in formulating the district land use planning framework.

iii. The Government of Tanzania should strengthen institutions dealing with herbal medicines as well as conducting more medical researches on particular plants that have healing potentials and medicinal values. The Government of Tanzania need to register on its database herbal medicine providers to ease important capacity building for practitioners.

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APPENDICES

Appendix 1: Household questionnaires

HOUSEHOLD QUESTIONNAIRE FOR THE STUDY ON THE ROLE OF TRADITIONAL ECOLOGICAL KNOWLEDGE OF THE MAASAI PASTORALISTS IN KITETO DISTRICT, TANZANIA

1	SURVEY IDENTIFICATION	
1.1	Household number	
1.2	Date:	
1.3	Name of interviewer	
1.4	Name of interviewee	
1.5	Name of district and division	District: **Kiteto** Division:
1.6	Name of location and village	Ward: Village:
1.7	Name of sub village	Sub village:

2	RESPONDENT DETAILS AND NATURE OF THE HOUSEHOLD				
2.1	Sex and age of respondent	☐ 1.Man ☐ 2.Woman	Age:		
2.2	Are you the head of household?	☐ 1.Yes	☐ 2.No		
2.3	Marital status of respondent	☐ 1. Married (single wife) ☐ 4. Widow/widower ☐ 2. Married (multiple wives, specify…… ☐ 3. Single ☐ 5. Divorced/separated ☐ 6. Cohabitating			
2.4	Education level of respondent	☐ 1. None ☐ 4. Secondary (A-level) ☐ 2. Primary ☐ 5. College ☐ 3. Secondary (O-level) ☐ 6. University			
2.5	Education level of spouse	☐ 1. None ☐ 4. Secondary (A-level) ☐ 2. Primary ☐ 5. College ☐ 3. Secondary (O-level) ☐ 6. University			
2.6	Household composition	Age categories	Male	Female	Total
		Under 5			
		6 - 17			
		18-45			
		46-60			
		Above 60			
		Total			
2.7	For how long have you lived in this village (years)?				

3	SOCIO - ECONOMIC ACTIVITIES			
3.1	What is the main source of your household income? (Tick all that apply)			
	Livestock keeping			
	Farming			
	Buying and selling crops (crop trading)			
	Buying and selling livestock (livestock trading)			
	Casual labour: specify……			
	Salary (formal employment)			
	Pension			
	Remittances			
	Petty business: specify……			
	Collection and selling forest products			
	Handicraft			
	Others (specify):			
3.2	If keeping livestock, what type of cattle do you keep? (Tick all that apply)	☐ 1. Short-horned zebu ☐ 4. Ankole ☐ 2. Borana ☐ 5. Others: ☐ 3. Tarime/Mara		
3.3	How many of the following animals do your household own?	**Animal** **Number** 1. Local cows _____ 2. Dairy Cows _____ 3. Goats _____ 4. Sheep _____ 5. Donkeys _____		
3.4	How do you feed your livestock? (Tick all that apply)	☐ 1. Zero grazing ☐ 2. Open grazing		
3.5	How long have you been keeping livestock?			
3.6	Do you milk any of your livestock?	☐ 1.Yes ☐ 2.No		
3.7	If yes above, how much liters of milk do you get per day per one cow?			
3.8	Do you sell the milk you get from your livestock?	☐ 1.Yes ☐ 2.No		
3.9	If yes, where do you sell the milk? (Tick all that apply)	☐ 1. Neighbors ☐ 2. Hotels/restaurants ☐ 3. Any other (Mention)……		
3.10	On average, what was the income obtained from sales of the following livestock products for the last 12 months?			
	Animal type	Number sold/slaughtered	Market price (TZS)	Total Income (TZS)
	Cattle			
	Goats			
	Sheep			
	Donkey			
	Milk (litres)			

4	**IDENTIFICATION AND PRIORITIZATION OF EXISTING TEK PRACTICES**			
4.1	Of the following natural resources, which do your households use in day to day life, from where and who manages those found within the village?			
	Type of natural resource	Sources (Tick all relevant)		Who manages*
		Within the village	Outside the village	
	☐ 1. Water for domestic use			
	☐ 2. Water for livestock use			
	☐ 3. Water for irrigation farming			
	☐ 4. Grazing land			
	☐ 5. Salt licks			
	☐ 6. Forests			
	☐ 7. Agricultural land			
	☐ 8. Others:			
	*1. Managed by Head of household 2. Managed by clan		3. Managed by village elders 4. Freely available for anybody	
4.2	What products or services does your household get from NRs mentioned in 4.1 above?			
	Water	☐ 1. Water	☐ 3. Reeds	
		☐ 2. Fishes	☐ 4. Others:	
	Forests	☐ 1. Timber	☐ 6. Wild life	
		☐ 2. Local medicine	☐ 7. Fodder	
		☐ 3. Firewood	☐ 8. Withes/poles, etc	
		☐ 4. Honey	☐ 9. Thatching grasses	
		☐ 5. Charcoal	☐ 10. Spiritual or cultural purposes	
4.3	In your household, who makes decision on the use of the NRs and why?			
	Type of natural resource	**Who makes decision***	**Why is it so?****	
	Water for domestic use			
	Water for livestock use			
	Water for irrigation farming			
	Grazing land			
	Salt licks			
	Forests			
	Agricultural land			
	Others:			
	*1) Father 2) Mother 3) Herders 4) Clan Heads etc **1) experienced on the use 2) norms and customs 3) have acquired formal knowledge on its use, etc			
4.4	Which of the following TEK practices are very common in your household?			
	Most common practices for **grazing land and salt licks**		Tick all that apply	

	1.	
	2.	
	3.	
	Most common practices for **water for domestic use**	
	1.	
	2.	
	3.	
	Most common practices for **water for livestock use**	
	1.	
	2.	
	3.	
	Most common practices for forests	
	1.	
	2.	
	3.	
4.5	What form of livestock grazing do you use?	☐ 1. Nomadic ☐ 2. Zero grazing ☐ 3. Settle portion farm

4.6	If nomadic, where do you graze your animals during different seasons of the year and why?		
	Season of the year	Where (landscape)	Why (Reasons)
	Rainy season	☐ 1. Upland ☐ 2. Lowland	
	Dry season	☐ 1. Upland ☐ 2. Lowland	

4.7	What local institutions are in place to govern grazing patterns in your village?	☐ 1. Livestock not allowed to graze near water sources during wet seasons ☐ 2. Herd splitting to access pasture and water away from the settlement ☐ 3. Restricting livestock from other villages ☐ 4. Others:
4.8	What role do the customary practices mentioned in 4.7 above play in management of natural resources available in your area?	1. 2. 3.

4.9	Where do you take your livestock for water at different seasons of the year?	
	Season	Water sources used*
	Rainy season	
	Dry season	
	*1. Various sources of water in the village 2. Natural ponds in the village 3. Hand-dug wells within the village 4. Drilled pump wells in the village	
4.1	How do you cope with natural disasters happening in the village?	
	Natural disasters	**Coping strategies***

0	Floods		
	Drought		
	Shortage of pasture		
	Animal diseases		
	*1. Herd splitting 2. Shift to other areas with pasture and water 3. Rotational watering 4. Settling grazing portions for young and weak animals 5. Others:		
4.11	What local institutions are in place to govern the management of NRs in your village?		
	NR	**Formal institutions**	**Informal institutions**
	Water for domestic use		
	Water for livestock use		
	Water for irrigation farming		
	Grazing land and salt licks		
	Forests		
	Agricultural land		
	Others:		

5	**EXAMINING HOW PRACTICES PROMOTE OR HINDER CONSERVATION OF DRY LANDS**		
5.1	Using a scale of 1 to 5, rate how the following practices promote conservation in your area, and briefly state how?		
	Practices for grazing land	**How***	**Score**
	Mobility		
	Herd splitting during dry and wet seasons		
	Settling aside paddocks for young and weak animals		
	Customary procedures to govern pasture use		
	Practices for use and management		
	Rotational watering		
	Not to clear around water sources		
	Grazing away from water sources		
	Customary arrangements for water use		
	Not to establish settlements close to water sources		
	Practices for forests and wildlife		
	Not cutting down trees		
	Practices that prohibit consuming game meat and killing of wild animals		
	Plant use during traditional ceremonies and rites, traditional foods, etc		
	*1) reduce pressure to the resources 2) reduce siltation of water sources 3) promote regeneration of plants 4) disseminate resource use and management to youngsters 5) Others:		
5.2	Which of the following landscape features are available and useful in pastoral activities in your area?		
	Landscape feature	**Tick all that apply**	
	Upland		
	Lowland		
	Grassland *(Mbuga*)		
	Shrub lands		
	Swampy areas		
5.3	How are the landscape features listed above useful in managing dry lands available resources? Use the scale below.		
	Landscape features	**Very useful**	**Useful**	**Moderately useful**	**Not useful**
	Upland				
	Lowland				
	Grassland *(Mbuga*)				
	Shrub lands				
	Swampy areas				
5.4	Overall, do you think TEK practices are useful in managing dry land ecosystems in your area?	☐ 1.Yes ☐ 2.No			
5.5	Overall, do you think TEK practices hinder or promote management of dry land ecosystems in your area?	☐ 1. Hinder ☐ 2. Promote			

6	**EXAMINING HOW THE PRACTICES ACCOMMODATE CHANGES IN NATURAL RESOURCES MANAGEMENT WITH TIME**		
6.1	Is there any change over time on NR management practices?		☐ 1. Yes ☐ 2. No
6.2	If YES, what are those changes?		
	Natural resources	**Existed practices (practices in the past)**	**Existing practices (current practices**
	Grazing land		
	Water		
	Forests		

6.3	What do you think are factors interfering with the traditional ecological knowledge in your village		
	Factors interfering with TEK	**Tick as appropriate**	**Rank them (Use scale of 1 - not interfering to 5 - highly interfering)**
	Education level of an individual		
	Economic status of a person		
	Population increase		
	Technological advancement		
	Religious beliefs		
	Land-use based conflicts		
	Climate related factors (increasing temperature, unreliable rainfalls)		

6.4	How do TEK practices accommodate changes brought about by the factors mentioned in 6.3 above?		
	Factor	Coping strategies	Who is responsible
	Education level of an individual		
	Economic status of a person		
	Population increase		
	Technological advancement		
	Religious beliefs		
	Land use based conflicts		
	Climate related factors (increasing temperature, low rainfall)		

6.5	How do changes happening affect livestock productivity and natural resource management in your village?
6.6	Who regulates livestock movements in your village and how is it done?
6.7	How does TEK help to restore or protect degraded dry lands in your village?

7.0	**ASSESSING EFFECTIVENESS OF MEDICINAL PLANTS IN CURING LIVESTOCK AND PEOPLE IN THE STUDY AREA**	
7.1	Which type of vegetation is dominant in ecological landscapes and why? Mention	
	Type of vegetation	Reasons to why
	1.	
	2.	
	3.	
7.2	**What diseases/ailments/wound/disorders are cured by using medicinal plants?**	
	Disease/ailments	Rank them
	Intestinal worms	
	Malaria	
	Diabetes	
	Ulcers	
	Skin diseases	
	Coughs	
	Colds	
	Stomach disorders	
	Gouts	
	Others (specify)	
7.3	What are the most common plant species used to treat the diseases mentioned in 7.2 above?	
	Diseases/ailments	Plant species
	Intestinal worms	
	Malaria	
	Ulcers	
	Skin diseases	
	Diabetes	
	Coughs	
	Colds	
	Stomach disorders	
	Gouts	
	Other (specify)	
7.4	What plant parts are normally used to treat the diseases/ailments mentioned in 7.2 above?	
	Diseases/ailments	**Plant part (bark, leaf, root, fruit, flower)**
	Intestinal worms	
	Malaria	
	Peptic Ulcers	
	Diabetes	
	Skin diseases	
	Coughs	
	Colds	
	Stomach disorders	
	Gouts	
	Other (specify)	
7.5	How effective are the medicinal plants in curing the diseases/ailments mentioned in 7.1 above? (Use the scale: 1. Very effective 2. Effective 3. Moderately effective 4. Not Effective)	
	Disease/ailment	Scale (1 - 4)
	Intestinal worms	
	Malaria	
	Ulcers	
	Skin diseases	
	Diabetes	

	Coughs	
	Colds	
	Stomach disorders	
	Gouts	
	Other (specify)	
7.6	What livestock diseases are treated by using medicinal plants? Rank them	
	Diseases/Disorders/Wounds	**Rank**
	Eye problems	
	Removal of placenta	
	Wounds	
	Removal of ticks and other parasites	
	Skin diseases	
	Other (specify)	
7.7	How effective are the medicinal plants in curing various livestock diseases/ailments mentioned in 7.6 above? (Use the scale: 1. Very effective 2. Effective 3. Moderately effective 4. Not Effective)	
	Disease/ailment	Scale (1 - 4)
	Eye problems	
	Removal of placenta	
	Wounds	
	Removal of ticks and other parasites	
	Skin diseases	
	Other (specify)	

8	**END OF SURVEY**	
8.1	Additional information from respondent including questions/suggestions	
8.2	Is a respondent is ready and willing for interview?	☐ 1.Yes ☐ 2. No
8.3	If Yes, record his/her phone number	

'THANK YOU FOR YOUR RESPONSE AND VALUABLE TIME'

Appendix 2: Checklist for focus group discussion on TEK (Knowledgeable individuals selected purposively)

i. Which natural resources are available and commonly used by villagers here? Can you rank them in the order of importance?
ii. What are the traditional ecological knowledge practices common in your area for each of the NR mentioned above?
iii. Which and in what extent do you think the practices promote conservation of aforementioned resources in your area?
iv. Which and in what extent do you think the practices hinder conservation aforementioned resources in your area?
v. What natural disasters are very common here and how do you predict its occurrences using traditional knowledge?
vi. How do you predict occurrence of different natural phenomena such as year with good rains/*El Nino*, year with good pasture, occurrences of certain diseases, extreme draught, etc?
vii. How useful/practical are the TEK practices today?
viii. What factors seem to be the threats of the TEK in your area?
ix. What changes over time have happened with regard to TEK practices?
x. How has TEK been able to accommodate changes taking place in your area?
xi. What livestock and people diseases/ailments/wound/disorders are cured by using medicinal plants?
xii. How effective are the medicinal plants in curing the livestock and peoples' diseases/ailments?
xiii. What local institutions are in place to govern the management of NR mentioned above in this village?
xiv. What are your opinions on the fate of this knowledge?

'THANK YOU FOR YOUR TIME'

Appendix 3: **Checklist for key informants**

(District Livestock Officer, District Forest Officer, NGO Officials)

1. What are the traditional ecological knowledge practices common in the area?
2. In what extent do you think the practices promote conservation in the area?
3. In what extent do you think the practices hinder conservation in the area?
4. How useful/practical are the TEK practices today?
5. What role does TEK play in the land use planning process in this district?
6. In your opinion, does this knowledge worthy promoting or prohibiting?
7. In your opinions what is the fate of this knowledge?
8. What are the observed changes for the past ten years in your area? (policy changes, climatic changes, vegetation changes e.t.c)
9. What has been your response in regards to the stated changes above?

'THANK YOU FOR YOUR TIME'