Thesis by
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Doctor of Philosophy of the University of Dar es Salaam

THE CONTRIBUTION OF INDIGENOUS AGRO-BIODIVERSITY KNOWLEDGE MANAGEMENT PRACTICES FOR IMPROVING LIVELIHOODS OF LOCAL COMMUNITIES

A Case Study of Masasi and Nachingwea Districts in Tanzania

June, 2016

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Andrew Watson Malekani

A Thesis submitted in Fulfillment of the Requirements for the Doctor of Philosophy of the University of Dar es Salaam

University of Dar es Salaam

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CERTIFICATION

The undersigned certify that they have read and hereby recommended for acceptance by the University of Dar es Salaam a dissertation/thesis entitled: "***The contribution of indigenous agro-biodiversity knowledge management practices to improving the livelihoods of local communities: a case study of Masasi and Nachingwea districts in Tanzania"*** in fulfilment of the requirements for the degree of Doctor of Philosophy of the University of Dar es Salaam.

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DECLARATION AND COPYRIGHT

I, Andrew Watson Malekani, declare that this thesis is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature .....

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I would like to extend my sincere thanks to God the Almighty for keeping my family and myself in good health throughout the four years of my studies at the University of Dar es Salaam. I would also like to express my sincere gratitude to the Commission for Science and Technology (COSTECH) for financial support. To the glory and honour, I would like to express my foremost sincere thanks to my supervisors, Prof. Alice Nkhoma-Wamunza of the University of Dar es Salaam and Dr. Angella Mashauri Chailla of Sokoine University of Agriculture for their assistance, supervision, encouragement, guidance, constructive ideas and criticisms and concerns in the course of this study. I feel privileged to have had a chance to work under them. I also extend my special thanks to my family at large for their patience and understanding for the times I spent away from them when working on my thesis.

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I am also indebted to the Regional Administrative Secretaries (RAS) and District Administrative Secretaries (DAS) in Lindi and Mtwara regions for giving me clearance to undertake the research within the villages in the two regions.

DEDICATION

This study is dedicated to my children (Jemima, Irene and Janet) and my wife Judith for their patience and prayers while working on this thesis.

LIST OF ABREVIATIONS AND SYMBOLS

AIDS	Acquired Immune Deficiency Syndrome
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASDS	Agricultural Sector Development Strategy
CFAC	Coopération financière en Afrique central (Financial Cooperation in Central Africa)
CIA	Criminal Investigation Agency
CoPs	Communities of Practices
COSTECH	Commission for Science and Technology
DADP	District Agricultural Development Plan
DAS	District Administrative Secretary
DPP	District Participatory Plan
EAM	Eastern Arc Mountains
EK	External Knowledge
FAO	Food and Agricultural Organization
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
GIS	Geographical Information Systems
HIV	Human Immune Virus
HSRC	Human Science Research Council
ICTs	Information and Communication Technologies
IIRR	International Institute for Rural Reconstruction
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems

IPR	Intellectual Property Rights
KA	Knowledge Assets
KM	Knowledge Management
LK	Local Knowledge
LKC	Learning Knowledge Cycle
MNRT	Ministry of Natural Resources and Tourism
MVIWATA	Mtandao wa Vikundi vya Wakulima Tanzania
NBS	National bureau of Statistics
NGOs	Non Governmental Organizations
NSGRP	National Strategy for Growth and Reduction of Poverty
NTFPs	Non Timber Forest Products
PAC	Percentage Accuracy in Classification
PIP	Policies, institutions, and processes
RAS	Regional Administrative Secretary
SECI	Socialization, Externalization, Combination and Internalization
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
TV	Television
TZS	Tanzanian Shillings
UMADEP	Uluguru Mountains Agricultural Development project
UNCCD	United Nations Convention on Combating Desertification
UNEP	United Nations Environment Program
URT	United Republic of Tanzania

USD	United States of America Dollar
VEO	Village Executive Officer
WHO	World Health Organization
WIPO	World Intellectual Property Organization

ABSTRACT

The study was conducted in Lindi (Nachingwea district) and Mtwara (Masasi district) to investigate and document existing indigenous knowledge practices on management of agro-biodiversity and show how Nonaka and Konnos' 1998 KM model (Socialization, Externalization, Combination and Internalization (SECI)) can be applied to manage indigenous knowledge related to agro-biodiversity in local communities. Combined with Adapted Sustainable Livelihood model, the study also sought to investigate how such knowledge contributes to livelihoods of local communities.

This study employed a mixed research design, using cross-sectional and case study designs. The study population was drawn from small holder farmers, village leaders, and Indigenous Knowledge (IK) intermediaries. Purposive sampling was used to select districts, villages, key informants and participants for Focus Group Discussions (FGD). Systematic sampling was used to select heads of households. Their names were picked from the village government register. The total sample for this study was 230 heads of households, 16 key informants (village leaders), 4 indigenous knowledge intermediaries (extension and forest officers) and 80 participants from Focus Group Discussions (FGDs). A Statistical Package for Social Sciences (SPSS) software Version 16.0 was used to generate frequencies and percentages. Quantitative data was analyzed quantitatively. Qualitative data was analyzed using content analysis. Key findings revealed that local communities possess a wide range of indigenous knowledge on soil fertility, intercropping, seed storage, cultivation methods, moisture preservation, and crop preservation.

Findings further revealed that fire, fallow and buffer zones are used to demarcate protected areas and village by laws to guide land usage. Findings further revealed that farmers rely heavily on tacit knowledge as opposed to recorded knowledge. The study concluded that farmers create new knowledge through face-to-face and group interactions, folklore, carvings and initiation rites and that IK is largely transferred through oral tradition and demonstrations and is preserved in human minds. The study recommends that KM practices on management of agro-biodiversity should be the responsibility of communities, village authorities, public and private sectors and that the government and private agro-biodiversity actors should foster KM practices on management of agro-biodiversity by engaging communities in the identification, mapping, dissemination and preservation of IK and should conduct user studies to determine areas for intervention. These will help local communities to sustain their farming systems and hence ensure their livelihoods.

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CHAPTER ONE

INTRODUCTION AND BACKGROUND TO THE STUDY

1.0 Introduction

1.1 Indigenous knowledge and agro-biodiversity

Indigenous Knowledge (IK) is knowledge that is tacit, orally communicated, experiential, unique and embedded in the heads, activities and practices of communities with long histories of close interaction with the natural environment across cultures and geographical spaces. IK is largely used by local communities to make decisions (Du Plessis, 2002; Ngulube, 2002; Ellen and Harris, 2000; World Bank, 1998).

Agro-biodiversity comprises the whole plant resource diversity that human societies use and manage for agriculture, food, healthcare, and livelihood. It includes the enormous diversity of crops and crop varieties that small-scale farmers conserve and cultivate, representing both the basis for their subsistence and source of income (Gari, 2002). It also embraces wild food and medicinal plants that rural populations use for nutrition, healthcare and livelihood purposes. The maintenance and use of agro-biodiversity relies on extensive indigenous knowledge systems, which address aspects such as cultivation practices, uses, and genetic resource management of such plant species (Gari, 2004). Thus, indigenous agro-biodiversity knowledge embraces knowledge that indigenous people have on agriculture and biodiversity.

Due to domination of processes of globalization in the present era, millions of marginalized rural people face economic, social, environmental and health problems

that impair their lives and development prospects. Thus, food insecurity and malnutrition distress countless rural households and communities globally (Gari, 2004). Further research indicates that a majority of rural populations remain trapped in poverty and social exclusion, whilst policies and investments predominantly focus on urban areas, industrial endeavors and agribusiness development (Gari, 2004).

Therefore, this study sought to investigate and document existing indigenous knowledge practices on management of agro biodiversity and prove how Nonaka and Konnos' 1998 KM model (Socialization, Externalization, Combination and Internalization (SECI)) can be utilized to manage indigenous knowledge related to agro-biodiversity in local communities. Combined with Adapted Sustainable Livelihood model, the study also sought to investigate how such knowledge contributes to livelihoods of local communities.

1.2 Background to the Study

The domination of globalization processes such as modernization of agriculture have impacted negatively on IK. For example, while modernization of agriculture may increase availability of food and the levels of food trade, it does not meet the basic agricultural, nutrition and livelihood needs of most small farmers (Gari, 2004 and Koda, 2003). It is estimated that around 1,500 million small farmers live in marginal environments and lack policy and technical support for their indigenous farming systems (Altieri, 2002). Agricultural modernization also accelerates environmental degradation and dislocates the cultural dynamics that have sustained the agriculture

of farmers where agro-biodiversity and indigenous knowledge have become the main victims (Gari, 2004).

Agriculture is the backbone of many African economies and in 2007 the agricultural sector employed approximately 80 percent of the work force in these countries (CIA, 2007). In Tanzania in particular, agriculture (crop and livestock) contributed 20.8 percent of the Gross Domestic Product (GDP) in 2010 (Bank of Tanzania, 2013). Despite the importance of agriculture, particularly in rural areas, about 40 percent of rural household income is derived from sources outside the household-farm products which include biodiversity components such as forestry, wildlife, fisheries, and tourism (Tanzania, Vice President's Office 2005a). In 2010, the biodiversity component of forestry and hunting activities alone contributed 2.4 percent to Tanzania's GDP (URT, Economic survey, 2010).

However, the vast majority of Africans including Tanzanians depend on resource-poor agriculture, without modern inputs, and they rely almost exclusively on locally available resources for their livelihoods (HSRC, 2005). Production is low and studies attribute this to inadequate utilization of Indigenous Knowledge (IK), inability to adapt to changing circumstances and lack of local innovations (Hart and Mouton, 2005; Magoro and Masoga, 2005; Makenzi, 2002). Moreover, farmers do not earn high income because their innovations and discoveries are mostly incremental, and because indigenous technologies are applied in isolation (Hart, 2007; Akiiki, 2006). Nonetheless, if properly harnessed, IK can be used to ensure that agricultural developments are viable within the local environment (Magoro and Masoga, 2005).

With increased realization of the importance of indigenous knowledge, most developing countries are paying more attention to management of indigenous knowledge (IK) in rural societies for sustainable development (Hens, 2006; von Liebenstein, 2000). To efficiently manage IK, Kaniki and Mphahlele (2002) emphasize the need for a holistic approach namely; knowledge management (KM), with its theories, principles and practices. Nevertheless, KM has been gradually established as a strong methodology to support business viability, competitiveness and growth (Diakoulakis, *et al.*, 2004). Scholars argue that KM should not be restricted to closed business systems with formal structures but should be practiced in local communities as well (Mosia and Ngulube, 2005). Thus, the applicability of these KM models in managing IK for agro-biodiversity is called into question.

1.3 Statement of the Problem

Despite its overwhelming potential in improving agricultural productivity and livelihoods of local communities, indigenous knowledge harnessed by farmers is not accorded the same importance as conventional knowledge. Consequently, the knowledge possessed by farmers in most developing countries is not recognised as formal and reliable sources of knowledge (Kilongozi, Kengera and Leshongo, 2005). The transfer of IK from generation to generation is mostly done through oral tradition and demonstrations. Similarly IK is not equally shared due to power and cultural differences. Instead, IK is stored in the minds of people who may die with the knowledge they have accumulated over a long period of time (Ikoja-Odongo, 2006; Meyer, 2003). As a result of this, IK is not documented in most developing countries including Tanzania (Mascarenhas, 2004; Dube and Musi, 2002, Magara, 2002). Contemporary farming systems in Tanzania which guarantee food security

evolved from Indigenous Knowledge Systems (IKS). Examples include the case of the Matengo "pit" system (Ngoro) in Mbinga District Tanzania, the Ukerewe farming system in Mwanza, the Iraqw farming system in Babati (Arusha region) and the Ufipa plateau mounds cultivation system in Rukwa region (Kikula and Mwalyosi, 1994). Many of these IKS have eroded and continue to deplete due to modern agricultural and development forces which have persistently neglected and eroded, agro-biodiversity and indigenous knowledge (Gari, 2002). They have also accelerated their depletion and depreciation of IK at grassroots level. As a consequence, farmer's ability to control their subsistence systems, including their food security and nutrition have been reduced (Gari, 2002). Therefore, the present study sought to document existing indigenous knowledge practices and apply Nonaka and Konnos' 1998 KM model (Socialization, Externalization, Combination and Internalization (SECI)) in managing indigenous knowledge related to agro-biodiversity management in local communities and how such knowledge contributes to livelihoods of local communities.

1.4 Objectives of the Study

1.4.1 Overall objective

The main objective of this study was to investigate and document existing indigenous agro-biodiversity knowledge management practices and their contributions to improving livelihoods of local communities in Masasi and Nachingwea districts in Tanzania.

1.4.2 Specific objectives

The specific objectives for this study were to:

1. identify existing indigenous knowledge related to agro-biodiversity management among local communities;
2. determine how local communities access and share indigenous knowledge related to agro-biodiversity;
3. examine the barriers constraining access to and use of indigenous knowledge when managing agro-biodiversity at local levels;
4. Assess the extent to which use of indigenous knowledge on agro-biodiversity management contributes to livelihoods of local communities.

1.4.3 Research questions

The study was guided by the following research questions:

(i) What indigenous knowledge related to agro-biodiversity management exists in local communities in Masasi and Nachingwea districts?

(ii) How do local communities access and share indigenous knowledge on agro-biodiversity management?

(iii) Which barriers constrain access to and use of indigenous knowledge related to agro-biodiversity management at local levels?

(iv) What are the contributions of indigenous agro-biodiversity knowledge to the livelihoods of local communities?

(v) What are the best ways to preserve IK related to agro-biodiversity management for its continued survival?

1.4.4 Significance of the study

Not much has been done in terms of collecting, recording, preserving and sharing of indigenous knowledge for sustainable agro-biodiversity management and development in Tanzania (Kilongozi, Kengera and Leshongo, 2005; Kweka, 2004). The findings of this study have contributed to a body of existing knowledge on the topic. Findings of this study will become a basis for improving the management of IK and exogenous knowledge and its application for improved agro-biodiversity activities in rural areas. The findings will also create awareness among policy makers and agricultural development planners on the importance of understanding existing IKS and influence its integration in decision-making processes.

The rapid change in the lives of local communities can be attributed to the loss of IK. Younger generations for instance underestimate the utility of indigenous knowledge systems (IKSs) because of the influence of modern technology and education (Ulluwishewa, 1993 cited in Ngulube, 2002). It is evident that if IK is not recorded and preserved, it will be lost and remain inaccessible to other indigenous systems as well as to development workers. Development projects cannot offer sustainable solutions to local problems without integrating local knowledge (Warren, 1991 cited in Ngulube, 2002). This study therefore is useful because it has produced a document that will serve as a record of IK for use by researchers and project development planners. The use of IK is also emphasized by international organizations such as the United Nations Convention on Combating Desertification (UNCCD). For example Article 18 *(UNCCD, 1995 cited in Schaaf, 2005) states:*

> *"The Parties shall ... protect, promote and use in particular relevant traditional and local technology, knowledge, know-how and practices and, to*

> *that end, they undertake to: make inventories of such technology, knowledge, know-how and practices and their potential uses with the participation of local populations, and disseminate such information, where appropriate, in cooperation with relevant intergovernmental and non-governmental organizations; ensure that such technology, knowledge, know-how and practices are adequately protected and that local populations benefit directly, on an equitable basis and as mutually agreed, from any commercial utilization of them or from any technological development derived there from; encourage and actively support the improvement and dissemination of such technology, knowledge, know-how and practices or of the development of new technology based on them; facilitate as appropriate, the adaptation of such technology, knowledge, know-how and practices to wide use and integrate them with modern technology, as appropriate (UNCCD, 1995 cited in Schaaf, 2005)".*

The findings of this study are useful to Tanzania in the sense that they are inventory of existing IK in Tanzania and will spearhead the country's obligation to meet the agreements signed with UNCCD. Moreover, this study has contributed the following to the scientific community: it has produced a detailed inventory of IK related to agro-biodiversity management practices in Masasi and Nachingwea districts which will be useful for researchers and project development planners working in related areas now and in future. It has created awareness on the importance of understanding the existing IKS and their integration with exogenous knowledge systems by development actors and it has generated information that can be used as baseline by later studies in the study areas and elsewhere.

1.5 Limitations of the Study

The present study was cross sectional (due to limitations in time and financial resources), it was not possible to include all components of agro-biodiversity. During questionnaire survey and interviews, responses relied primarily on memory of respondents. Therefore some responses might have suffered low precision or accuracy. In some instances respondents failed to provide answers on the account

that they neither had records nor could properly recall. In addition, there was a possibility for respondents to deliberately underestimate or overestimate quantities for some agro-biodiversity products and estimated prices, especially crops and Non Timber Forest Products (NTFPs). Lastly, the study was done in August, a month that is characterized by several folklore activities in the study area because it is the season that people have just harvested crops. It was somehow difficult to get all respondents within the villages in a single day. It required visiting the villages at least twice to get a good number of the required sample size.

1.6 Operational Definition of Terms

Knowledge

The terms “knowledge”, “information” and “data” are often used inter-changeably in the literature but a distinction between the terms is helpful. It is therefore important to define them in order to show the differences that exist between these terms. Data is a representation of observations or facts out of context, and therefore, they are not directly meaningful (Zack, 1999). Data also refers to unorganized and unprocessed facts (Awad and Ghaziri, 2004). Davenport and Prusak (1998) viewed data as the raw material for creating information that by itself carries no judgment or interpretation, and no meaning.

Unlike data, information has a meaning, purpose and relevance. Information is an aggregation of data that makes decision making easier (Awad and Ghaziri, 2004). Information is also the result of placing data within some meaningful content, often in the form of a message (Zack, 1999). Davenport and Prusak (1998) described

information as data that makes a difference. Wiig (1999) also illustrated information as facts and data organised to characterize a particular situation. Joia (2000) was also of the opinion that information is data with attributes of relevance and purpose, usually having the format of a document or visual and/or audible message.

Wiig (1999) defines knowledge as a set of truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know-how. Similarly, Joia (2000) linked knowledge to the capacity for action. It is intuitive, and therefore hard to define. It is linked to the users' values and experience, being strongly connected to pattern recognition, analogies and implicit rules.

Thus, there is no smooth, linear passage from data to information and knowledge. Data can be viewed as a set of discrete facts which are not directly meaningful, information as processed data which has meaning, purpose and relevance, and knowledge as contextualized information which guides action. This definition was applied in the context of this study.

Knowledge Management (KM)

Knowledge management (KM) is rooted in many disciplines, including business, economics and psychology and information management. While it contributes to the ultimate competitive advantage for today's business environment, researchers as well as practitioners have yet to agree on a definition for KM. To some, KM is defined as a process that creates or locates knowledge and manages the dissemination and use of knowledge within and between organizations (Darroch, 2003). Similarly, KM

contains the following integral parts: using accessible knowledge from outside sources; embedding and storing knowledge in business processes, products and services; representing knowledge in databases and documents; promoting knowledge growth through the organization's culture and incentives; transferring and sharing knowledge throughout the organization; and assessing the value of knowledge assets and impact on a regular basis (Awad and Ghaziri, 2004).

Parallel to other authors, Morden (2004) also viewed KM as a process by which knowledge and experience of the organization (its "intellectual capital") is systematically accumulated, formalized, disseminated and applied as key value – adding corporate assets. In a similar vein, though broadly defined, KM is what the organizations do to accomplish their goals faster and more effectively by delivering the right knowledge to the right person at the right time and in the right context (Eknowledgecentre, 2005). For others, KM is defined as the art of creating value from an organization's intangible assets (Sveiby, 2001). KM is also defined as the strategic management of people and knowledge representation along with associated content and information in an organization, using technology and processes, so as to optimize knowledge sharing and utilization, by transferring knowledge directly between people or indirectly through systems, to derive overall benefits in all aspects of the functioning of the organization (Suresh and Mahesh, 2006).

From these definitions, it can be concluded that all KM definitions provide a framework that builds on past experiences and create new approaches for managing knowledge within a community or an organization. Most of these definitions emphasize the processes of discovering, capturing, sharing, preserving and utilizing

the available knowledge for the organizational achievements over its competitors. Thus, for the purpose of this study, the definition by Robertson (2003) was adopted which describes KM as a conscious strategy of harnessing tacit and explicit knowledge into action by creating context, infrastructure and learning cycles that facilitate finding and using the collective intelligence of society. In this context, the study sought to show that KM can be an effective function for managing not only the organizational knowledge, but also farmers' knowledge in a rural setting.

Indigenous knowledge (IK)

The term, indigenous knowledge (IK) is used interchangeably by various scholars from different school of thoughts to either refer to one of the following concepts, that is traditional knowledge, community knowledge, traditional ecological knowledge, local knowledge, traditional environmental knowledge, aboriginal tradition, cultural patrimony, folklore, expressions of folklore, cultural heritage, traditional medicine, cultural property, indigenous heritage, indigenous cultural and intellectual property rights, indigenous intellectual property, customary heritage rights, innovations and practices, and popular culture or intangible component (WIPO, 2002).

The term local knowledge is often used to refer to indigenous knowledge. Local knowledge refers to the knowledge possessed by any group living off the land in a particular area for a long period of time (Langill, 1999). IK on the other hand, tends to emphasize the knowledge internal to a particular setting and thus differing from local knowledge, which embraces exogenous knowledge, which entered into the local community over time (vanVlaenderen, 2000). In this situation, it is not important whether the people under the study are the original inhabitants of an area

or not. The major aim is to learn how people interact with the environment to improve their knowledge base and farming activities. Thus, this study used two terms (indigenous and local knowledge) interchangeably to encompass all the above mentioned terms.

IK is defined as the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area (Grenier, 1998). Kaniki and Mphahlele (2002) viewed IK as a cumulative body of knowledge generated and evolved over time, representing generations of creative thought and actions within individual societies in an ecosystem of continuous residence, in an effort to cope with an ever-changing agro-ecological and socio-economic environment. Payle and Lebakeng (2006) described IK as a local knowledge, which is born out of the environment and a result of people interacting with their environment.

IK is also described as the information, wisdom and technical know-how of a particular group of people developed over a long period of time and bequeathed to successive generations through oral and other forms of cultural self-perpetuation (Mchombu, 1995). IIRR (1996) defined IK as the knowledge that people in a given community have developed over time, and continue to develop. It is based on experience, often tested over centuries of use, adapted to local culture and environment, and dynamic and changing environment. Various scholars (Abrahams, 1987; Munyakho, 1994; Warren, 1991) described IK as knowledge which is used as the basis for local level decision making in socio-economic, engineering, health, food

preparation, education, natural resource management, political, agriculture, sports and a host of other activities in rural communities.

For the purpose of this study, IK definition was taken from the most agreed definition that IK is largely tacit, orally communicated, experiential, unique and embedded in the heads, activities and practices of communities with long histories of close interaction with the natural environment across cultures and geographical spaces. It is largely used by local communities for decision-making (Ngulube, 2002; Ellen and Harris, 2000; World Bank, 1998). For the agricultural sector, solutions to farmers' problems are developed by farmers themselves and their technological knowledge is specific to their farms' environmental conditions and their own needs.

Tacit knowledge is defined as non-verbalized, intuitive and unarticulated (Polanyi 1962). It resides in people's minds, behavior and perception and evolves from social interactions (Nonaka and Takeuchi 1995). This definition was applied in the context of this study.

Explicit knowledge is knowledge that can be expressed in formal and systematic language and shared in the form of data, scientific formulae, specifications and manuals (Nonaka, Toyama, and Konno 2000). This definition was applied in the context of this study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section reviews related literature in line with the objectives of this study. It covers the following: knowledge management practices and application in agro-biodiversity management, indigenous knowledge in developing countries, agro-biodiversity IK resources collected from local communities in Tanzania, the role of Indigenous knowledge Systems (IKS) in food security, the linkages between gender, agro-biodiversity and IKS, , knowledge Management models and their application in management of explicit and tacit knowledge, knowledge management application for indigenous agro-biodiversity knowledge management, indigenous knowledge and agro-biodiversity development in Tanzania, the management of indigenous agro-biodiversity knowledge in Tanzania. Lastly, the section summarizes the research gaps that the study intended to address. The literature review covers the period between 1980 and 2014.

2.1 Knowledge Management Practices and Application in Aagro-Biodiversity Management

This section reviews literature related to knowledge management practices and how it can be applied in the management of agro-biodiversity.

2.1.1 Knowledge management practices

Knowledge management (KM) is increasingly being adopted by many organizations to build their competitive advantage and to achieve sustainable growth (Ichijo and Nonaka, 2007). The need to manage knowledge emanates from problems faced by many organizations in locating, preserving and using knowledge both within and

outside their organizations (Alavi and Leidner, 2001). KM ensures that knowledge is created, built, deployed and exploited to serve the objectives and needs of the people, the enterprise and its stakeholders (Wiig, 2004). The effectiveness of a KM intervention in a particular organization is determined by the selection of appropriate tools, approaches and practices (Wiig, 2004).

KM processes of explicit knowledge are well defined and well documented. Tacit KM processes however, are not explicitly defined and are performed by individuals in the organization (Mostert and Snyman, 2007). Certain tacit knowledge can be harvested from its owner and codified to make it more readily desirable. However, much of that tacit knowledge cannot be externalized mainly due to personal implicit attributes which can never be diffused, and when transferred, are valueless. Other difficulties are linked to perception, language, time, value, and distance. Lack of trust and other political and cultural influences such as shared beliefs and values may inhibit people from harvesting their knowledge in organizations (Kausar and Paul, 2007). Hence organizations need to provide environment that is conducive for individuals to share and use tacit knowledge and expertise for improved organizational performance.

Social networks such as communities of practices (CoPs) can improve knowledge creation and sharing processes in organizations (Ichijo and Nonaka, 2000). CoPs are groups of people who share a concern for something they do and interact regularly to learn how to do it better. Organizational design is also regarded as a key enabler to effective KM processes. Drawing on Stiglitz's writing, Mchombu (2005) asserts that organizations need to shift their organizational structures from top-down hierarchical

systems to horizontal structures such as networks and semi-autonomous teams, and other forms of matrix organizations to create the right context for KM processes. Further, the organizations need to create a culture that values the creation, sharing and use of knowledge by its employees (Alavi and Leidner, 2001). Leadership as another KM enabler identifies knowledge gaps and finds ways to close these gaps to enable KM processes. It also champions innovation, creates the right context to foster dialogue and communication, and develops a reward system to promote knowledge sharing. Scholars like Mosia and Ngulube (2005) have argued that KM should not be restricted to supporting business systems in developed countries; rather the developing world should adapt KM to their local practices for future developmental agenda. Hence there is a need to assess the applicability of these KM models in managing IK among local communities.

2.2 Indigenous Knowledge in Developing Countries

Broadly defined Indigenous Knowledge (IK) is knowledge used by local people to make a living in a particular environment (Lodhi and Mikulecky, 2010; Warren, 1991). Such knowledge evolves in the local environment and is specifically adapted to the requirements of local people and conditions. It is also creative and experimental, constantly incorporating outside influences and inside innovations to meet new conditions. Lodhi and Mikulecky (2010), citing the World Bank (2004), report that “IK is usually tacit knowledge, stored in people’s, minds individual or collective memories, and often guarded jealously, hence the saying that each times an elder dies, it is as if a library has burned down”.

The potential role of IK in improving agricultural performance is widely acknowledged (Akiiki, 2006; Hart, 2007; Hart and Mouton, 2005). Statistics show

that at least 50 percent of the world's populations rely on IK for crops and other food supplies. Various empirical studies have also shown that IK usage can improve agricultural productivity particularly in developing countries (Hart, 2007; Hart and Mouton, 2005).

Farmers possess an extensive knowledge base of IK they use to solve various crop and livestock management problems. For instance, a study in Limpopo province, South Africa revealed that farmers had a broad range of criteria for classifying soil, land, livestock, weather forecasting, production practices and post-harvest technologies. The values related to this system are a basis for explaining decisions and actions taken by farmers (Magoro and Masoga, 2005).

Most developing countries promote usage of low-external inputs in farming due to the effectiveness, simplicity, reliability, safety and affordability of indigenous technologies (Adedipe, Okuneye and Ayinde, 2004). Non application of conventional agricultural techniques in different types of agro-ecological zones has also resulted in greater attention being paid to IK in developing countries (Hart and Mouton, 2005). Agricultural development interventions will continue to fail unless IKS are taken into consideration.

According to the International Institute for Rural Reconstruction (IIRR), (1996), when IK is incorporated into research projects it can empower local communities and increase the level of self-sufficiency and self-determination. IK gives legitimacy and credibility in the eyes of both local people and outside scientists, increases cultural

pride and motivates people to solve local problems using local skills, conceptualization and resource mobilization.

Despite these positive developments, IK is threatened by socialization, education systems, and influence of western cultures (Dube and Musi, 2002).Very little IK has actually been documented thus limiting its access to those who need it most (Magara, 2002). There is thus an urgent need to manage IK effectively to ensure its availability before it is completely lost.

2.3 Agro-biodiversity IK Resources Collected from Local Communities in Tanzania

Agro-biodiversity represents locally available resources with enormous value and potential for food security and rural development. According to Akuja (2010), the only assets in poor rural communities for livelihoods and even survival are local biodiversity, which assume increasing significance when other resources dwindle or disappear. Some of the common agro-biodiversity resources collected from the wild or from trees outside forests or forest plantations include the following:

2.3.1 Wood fuel

In sub-Saharan African countries fire wood is the main source of energy and accounts for over 85% of energy used in Namibia, 90% in Malawi, 70% in Zambia and 80% in Mozambique (Mogaka, *et al.*, 2001). In Tanzania, wood fuel accounts for about 90% of the total energy utilized (MNRT, 2001). About 92% of total energy in Tanzania is generated from miombo woodlands (Shechambo, *et al*., 2001). Charcoal is the single largest source of household energy in urban areas, because it is cheap to

transport, distribute and store (URT, 2011). Approximately 75% of urban residents use charcoal as a source of fuel although others use kerosene, fire wood, and gas (Monela, *et al*,. 1993).

2.3.2 Poles

Poles are mostly used in construction activities in rural and urban areas , building requirements of communities living near forests are met from forests (Abdallah, 2001). Maximillian (1998) reported that about 90% of houses in Northern Ruvu Forest Reserve in Kibaha district are built with poles. Similarly, Madofe and Munishi (2005) found that communities surrounding Chambogo Forest Reserve in Same District depend on the forest for building poles. Poles are major non timber forest products (NTFPs) across Tanzania with few commercial markets and are used primarily for construction of low cost housing in rural areas (Gunning, 2008). The construction sector includes residential, commercial buildings and infrastructure development projects.

2.3.3 Bee products

Tanzania has a high base of bee resources estimated to be 9.2 million colonies capable of producing about 138 000 tons of honey and 9,200 tons of bees wax a year (Kajembe, *et al.*, 2000; URT, 2003). Beekeeping is a source of food and income. Honey has nutritional value, provides energy and is an important source of non-protenieous animal food products. It also has medicinal properties, to fight infections, promote tissue regeneration and reduces miscarring of pregnant women (Hutton, 1996). Honey treats various diseases like intestinal infections, ulcers, liver

problems, gastrointestinal disorders and is used to make local brew in most African countries (Kilonzo, 2009).

2.3.4 Mushrooms

Tanzania has 31 types of edible mushroom species. These are found in miombo woodlands, with mycorrhizal fungi in their root system (Harkonen *et al*., 2003; Kajembe *et al*., 2000). The largest diversity of edible mushrooms are found in the southern and western part of the country in the miombo woodlands.

2.3.5 Medicinal plants

Medicinal plants are agro-biodiversity resources with direct roles in health care. For poor people, medicinal plants are locally available, affordable and often the only effective resources for medicine (Gari, 2004). It is estimated by the World Health Organization (WHO) that 80% of the world's population relies on traditional medicines (Marshall, 1998). Studies on traditional medicinal plants have shown that about 1000 plant species are used in traditional medicinal practices in Tanzania. This represents 10% of the country's flora (Kajembe, *et al.,* 2000). Forests provide traditional medicinal plants to 70% of Tanzanians (Marshall, 1998; Madoffe, *et al.,* 2006). Medicinal plants derived from forests make an important global contribution to health care. In India, about 2000 medicinal plant species identified are used to treat heart ailments, cancer, stomach ulcers, and various other disorders (Karki, 2001).

2.3.6 Wild vegetables

Wild vegetable plants are utilized on a daily basis and are an important source of vitamins served as a side dish with staple food most commonly maize stiff porridge (*Ugali)* (Kajembe, *et al.,* 2000; Kilonzo, 2009). Wild vegetables are most widely consumed Non Timber Forest products (NTFPs) by most rural communities in developing countries (FAO,1997). A number of vegetable species have been recorded in different studies. Ogle and Grivetti (1985) recorded 48 species in Swaziland, Maximillian (1998) found only six species in Kibaha; Uiso and Johns (1996) identified 19 species in Tarime District, Mapolu (2002) mentioned about 20 species in Tabora District and Nyigili (2003) reported 11 species that are consumed in Mbozi District. According to McGregor (1995), only a few of the many wild vegetables eaten actually come from the woodlands, the rest are found in disturbed areas growing as weeds.

2.3.7 Wild fruits

In Tanzania a total of 83 fruit tree species have been recorded, most of which occur in Miombo woodlands. Monela, *et al.* (2000) argued that *Adansonia digitata, Brachystegia microphylla, Kigeria Africana, Sclerocarya birrea* and *Tamalindus indica* are potential wild fruit from miombo woodland. Uiso and Johns (1996), assert that out of a total of 38 species of fruits that are used in Tarime district, 21 species are wild. Out of the wild species 14 contribute to about 11% of all food consumed in the district.

2.3.8 Fodder, thatching grass and fibres

Miombo woodlands are fairly rich in browsing species. Fodder from trees and shrubs are particularly important during the dry seasons because during this period grass is markedly reduced. Most houses in rural sub-Saharan countries including Tanzania have grass roofs and dry grass is used to make fences around compounds (Kajembe, *et al.,* 2000). Kessy (1998) reported wide usage of ropes, palm leaves, bamboo and climbers in house construction and woven baskets.

It is therefore important to map the agro-biodiversity resources extracted using IK from surrounding local communities in Masasi and Nachingwea and their contribution to livelihoods of these communities.

2.4 The role of Indigenous Knowledge Systems (IKS) in Food Security

Indigenous Knowledge Systems (IKS) deserve recognition in their own right. Local knowledge (LK) is symbiotically related to poverty eradication. This school of thought concurs with the contention that 'locals' needs, values and capacities (skills) are related to both LK and development dynamics (Van Vlaenderen, 1999; Koda, 1999). Both women and men have intimate knowledge of their natural environments which has for a long time been used for agro-biodiversity management. Through this process, local communities have been empowered and have become increasingly self-reliant, self confident and have the capacity to address issues of food security, especially where the dynamics for combining old and new knowledge systems have been seriously addressed (Koda, 1999).

Many contemporary farming systems which guarantee food security at community level evolved from IKS. For example, the Matengo "pit" system (Ngoro) in Mbinga district, Tanzania, ensures soil conservation and hence soil productivity (Rutatora, *et al*., 1995). Other remarkable and sound farming systems built in indigenous agricultural practices guaranteed food security since the colonial era in Tanzania include the Ukerewe farming system in Mwanza, the Iraqw farming system in Babati (Arusha region) and the Ufipa mounds cultivation in Rukwa region (Kikula and Mwalyosi, 1994).

2.5 The Linkages between Gender, Agro-biodiversity and IKS

A majority of Tanzanian women and men largely depend on natural resources for their livelihoods, through farming, pastoralism/herding, fishing, mining and forestry activities. Rural communities depend on natural forest products such as wild fruits, herbs, firewood, building poles, ropes/fiber and thatching grass, etc to meet their food, shelter, clothing and medicinal needs for themselves and their livestock. Women and men use `local knowledge' to interact with their environment and farming systems in their daily activities and to elevate their political and socio-economic status. Knowledge on edible and cultivable fauna and flora, medicinal herbs and shrubs for instance were a basis for developing currently used agricultural systems production techniques, processing, preservation and storage technologies. Such knowledge has been accumulated over a long period of time based on practical experiences and are used as coping strategies during food shortages and hardships (Tandi, 2010, Koda, 2003).

Women's and men's knowledge of draught resistant crops, wild foods (including fruits, tubers/roots, vegetables, honey, mushrooms) and medicinal plants has equally ensured both rural-based household food security, human and animal health and agricultural development (Tandi, 2010, Koda, 2003). However, IK is unevenly distributed because it is closely tied to an activity and access is determined by participation in related activities. Traditional healers, traditional birth attendants, farmers, livestock keepers and honey collectors for instance, usually access relevant local knowledge and acquire skills through active involvement in such activities, experimentation, adaptation and propagation of new ideas gained through experience (Koda, 2003).

Tanzania has more than 120 ethnic groups and has geographical and climatic specificities, cultural norms, beliefs and practices and farming systems which are unique to each area. There is a wide variety of knowledge systems and social relations which are passed on from one generation to another through socialization. According to Koda (2003), it is primarily the principle of "access through participation" which largely influences gender dynamics in IKS. In addition, Koda (2003) explains that gender is largely used to determine gender roles assigned to women and men in society.

From time immemorial, gender has been a conspicuous variable in the allocation of roles, responsibilities and resources at both the household and public levels. In most ethnic groups, the domestic domain including household chores is confined to women. Activities such as cooking and associated activities such as firewood-collection and water totting have always been performed by women. Hence women

know best the type of trees ideal for firewood, cooking and heating purposes, while men are more knowledgeable on best trees for poles, timber and ropes/fiber for house construction as well as the best grass species for thatching and for fodder. The multi-dimensional reproductive role assigned to women also includes food processing and preservation associated to post-harvest crop losses. While girls are socialized to become wives, mothers and custodians of household food security, boys are socialized to become public leaders, decision-makers and planners in public life (Rubin 2010, Lyimo-Macha, Sife and Malekani, 2010 and Koda, 2003).

Taking the farming communities for instance, women and men will have the general knowledge on the farming systems, yet women are more conversant with food crops and vegetables and the food basket in general since they are the ones, who collect, process, prepare, preserve and cook for their families usually assisted by their daughters. Invariably, men usually know more about hunting and related activities, housing construction (except for few ethnic groups which assign this role to women) and cash earning activities (Rubin, 2010, Lyimo-Macha, Sife and Malekani, 2010 and Koda, 2003).

Lyimo-Macha, Sife and Malekani (2010) found that in Lindi and Mtwara, there is a clear division of labor for most agricultural activities along gender lines based on traditional practices and religious norms. The colonial-induced system of assigning crops to each gender as women's and men's crops is another factor signifying gendered knowledge. For example, subsistence crops especially those with small seeds such as cow-peas and millet are usually regarded as female crops while men control cash-crops and grains (Mascarenhas and Mbilinyi, 1983).

The social norms of pastoralists tune women to access and control knowledge on milking, processing of milk products and looking after calves and sick cows which remain at home (the women's domain). The young men know the best grass for cattle or best pasture land since they are the ones who move around with livestock during dry and wet seasons. Thus, gender dimension needs further elaboration since it is the least observed variable both in cultures of indigenous people and by development practitioners and policy makers (Koda, 2003).

During initiation ceremonies, for example, sufficient time is spent to train and impart useful knowledge on medicinal herbs and skills to youth in rural areas in Tanzania (Tandi, 2010 and Koda, 2003). The coastal people on the other hand have different knowledge systems since their farming system and life patterns involve knowledge on how to grow and care for coconut and cashew-nut trees, cassava and rice. For coastal regions like Lindi and Mtwara, knowledge on emerging high value crops like simsim is also imparted (Lyimo-Macha, Sife and Malekani, 2010). Necessary knowledge on diseases and cures on these issues is different from that of pastoralist and vice versa.

2.6 Knowledge Management Models and their Application in Management of Explicit and Tacit Knowledge

Some proponents of models that have been tried successfully in many organizations to manage knowledge assets include: Boisot (1987); Bouthillier and Shearer (2002); Davenport (1998); Earl (2001); Kruger and Snyman (2005); McAdam and McCreedy (1999); Nonaka and Takeuchi (1995); Nonaka and Konno (1998); Probst, Raub and Romhardt (2000); Rowley (2001); Small and Tattalias (2000).

McAdam and McCreedy (1999), and Bouthillier and Shearer (2002) put major emphasis on KM processes. Boisot (1987), proposed knowledge category model, Rowley (2001) proposed the Learning with Knowledge Cycle (LK Cycle) model, Davenport (1998) proposed ten principles that can be used to govern or guide KM processes in organizations, Small and Tattalias's (2000) proposed a two-dimensional perspective KM model at Mitre. Nonaka and Takeuchi (1995) proposed the SECI model and Nonaka and Konno (1998) modified the SECI model. Earl (2001) proposed a model that ought to help corporate executives to understand types of KM initiatives or investments that make sense in their context. Earl's (2001) schools of KM thoughts include technocratic, economic and behavioral.

Nonaka and Takeuchi's (1995) model emphasized the creation of knowledge through the conversion of tacit and explicit knowledge and vice versa. Boisot's (1987) knowledge category model supported Nonaka's model by regarding organizational knowledge as either codified or uncodified, and as diffused or undiffused. In contrast, McAdam and McCreedy (1999), Rowley (2001), and Bouthillier and Shearer (2002) put major emphasis on KM processes, even though they vary in number and sequence of KM processes they identify. While supporting the KM processes perspective, Probst, Raub, and Romhardt (1999) further identified two building blocks (knowledge goals and knowledge assessment) which influence KM processes in organizations. Similarly Probst, Raub, and Romhardt (1999), Small and Tattalias's (2000) KM model insisted that the second dimension elements (that is, strategy, measurement, policy, content, process, technology, culture) can enable or influence the knowledge creation activities in the first dimension perspective, which

include knowledge exchange, knowledge capture, knowledge reuse, and knowledge internalization.

Correspondingly, Davenport (1998) provided ten principles that guide the KM processes in organizations. Earl (2001) also proposed schools of KM that ought to help corporate executives to understand the sorts of KM initiatives that make sense in their context. Likewise, Kruger and Snyman (2005) suggested that KM principles should be predetermined for the successful institutionalization of KM practices in the organization.

Nonaka (1991) first proposed the SECI model in 1991 which was further refined and expanded for a broader audience in 1995 (Nonaka and Takeuchi, 1995). In 2000, Nonaka, Toyama and Konno (2000) further developed the model of knowledge creation to consist of three elements: (i) the SECI process, the process of knowledge creation through conversion between tacit and explicit knowledge; (ii) *ba*, the shared context for knowledge creation; and (iii) knowledge assets - the inputs, outputs, and moderator of the knowledge-creating process. The three elements of knowledge creation interact with each other to form the knowledge spiral that creates knowledge as shown in Figure 1.

The SECI model assumes that knowledge is created in a four-way taxonomy and it is transferred and converted through socialization (from tacit-to-tacit knowledge through shared experiences), externalization (from tacit-to-explicit knowledge with the help of metaphors, models and analogies, for example printed materials, rock paintings), combination (from explicit-to- explicit knowledge through ICTs) and

internalization (from explicit-to-tacit knowledge through learning by doing or translating theory into practice). It also assumes that the knowledge creation process in turn, depends on three different kinds of learning relationships that are set up between the individual (I), group (G) and organization (O) (Figure 1).

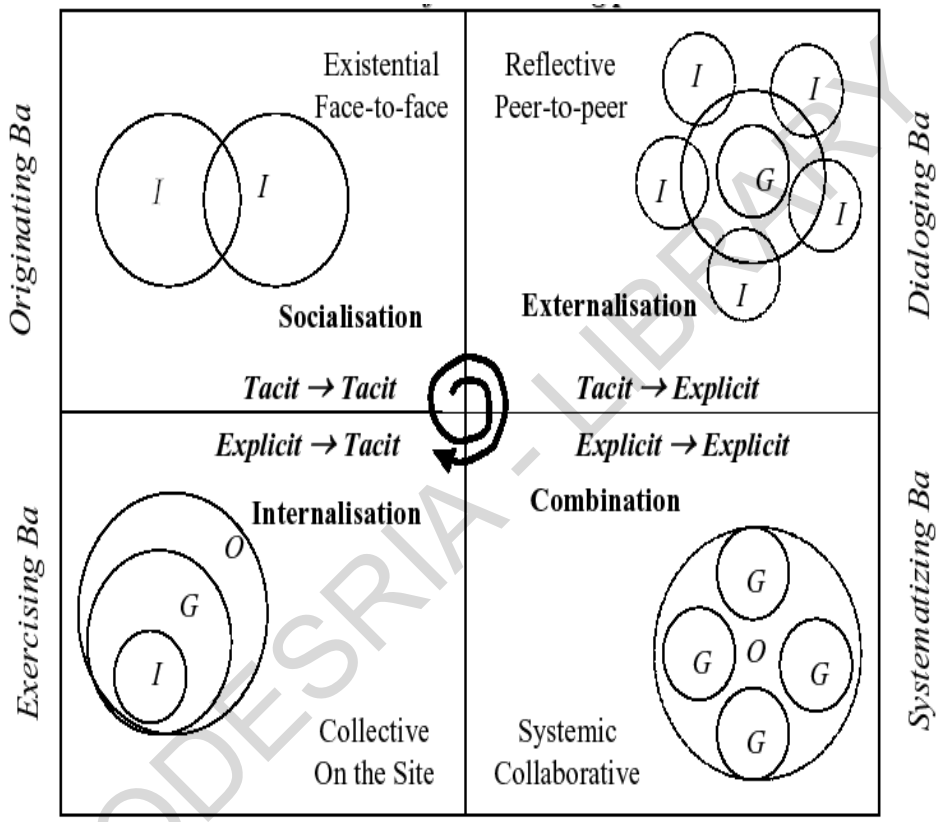

Figure 1: SECI as a self transcending process

(Adapted from Nonaka, Reinmoeller and Senoo, 2001 cited in Lwoga, *et al.*, 2010)

Ba is defined as a shared context in motion, in which knowledge is shared, created and utilized (Nonaka and Toyama, 2003). It is a concept that unifies physical space such as an office space, virtual space such as e-mail, and mental space such as shared ideals, or good social relationships (Ichijo, 2007). *Ba* provides the energy, quality and place to perform the individual conversations and to move along the knowledge

spiral (Nonaka and Konno 1998). Four different notions of *ba* are defined correspondingly with SECI (Nonaka, Toyama and Konno, 2000):

- The Originating *Ba*: defined by individual and face-to-face interactions (individuals feelings, emotions, experiences and mental models are shared). Although ICTs can be used, physical contact is important in this *ba* to facilitate knowledge creation through socialization (Nonaka and Konno, 1998);
- The Dialoguing *Ba*: defined by collective and face-to-face interactions (individuals' mental models and skills are shared, converted into common terms, and articulated as concepts);
- The Systematizing *Ba*: defined by collective and virtual interactions (virtual space facilitates the recombination of existing explicit knowledge to form new explicit knowledge); and
- The Exercising *Ba*: defined by individual and virtual interactions. It is a space where explicit knowledge is converted into tacit knowledge.

Knowledge assets (KA) are the inputs, outputs and moderating factors of the knowledge creating process (Nonaka, Toyama and Konno, 2000). Knowledge assets are key elements that facilitate knowledge creation processes. Those assets include: (i) experiential, which is shared tacit knowledge that is built through shared hands-on experience; (ii) conceptual, consists of explicit knowledge articulated through images, symbols and language; (iii) systemic, consists of systematized and packaged explicit knowledge; and (iv) routine, which consists of tacit knowledge that is reutilized and embedded in the actions and practices of the organization.

In their knowledge creation model, Nonaka, Toyama and Konno (2000) further emphasized that a company has to `map' its stocks of knowledge assets in order to

manage knowledge creation processes effectively. The organization leaders should also provide the knowledge vision, develop and promote sharing of knowledge assets, create and energize *ba*, and enable and promote the continuous spiral of knowledge creation. Boisot's (1987) knowledge category model supports Nonaka's (1991) model as shown in Figure 2 by classifying knowledge based on the ease of transmission and the readiness to share. Boisot (1987) regarded organizational knowledge as either codified or uncodified, and as diffused or undiffused.

The term codified means that knowledge can be captured and transmitted (example, proprietary knowledge), the term un-codified refers to knowledge that cannot readily be transmitted (example, experience). The term diffused denotes knowledge that can be easily shared and undiffused refers to knowledge that is difficult to share.

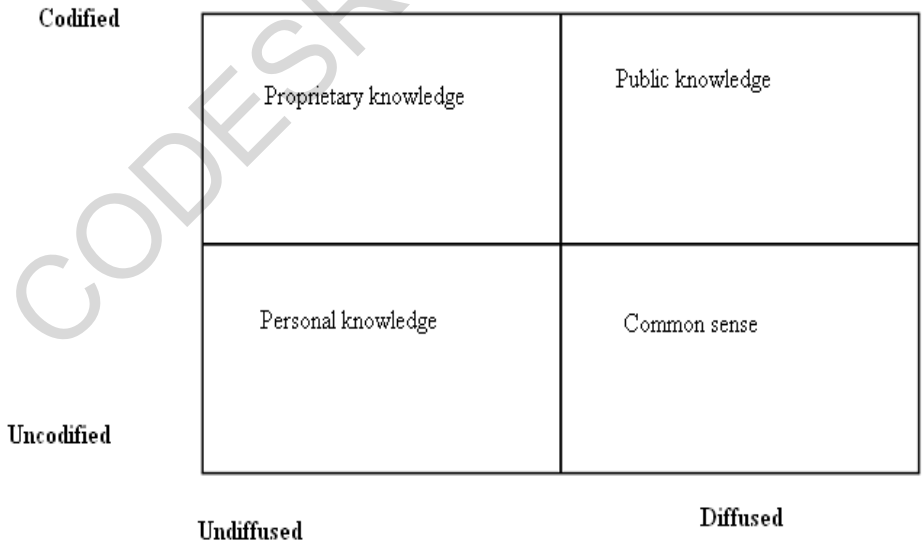

Figure 2: Boisot's knowledge category model

(Adapted from Boisot 1987 as cited in Lwoga 2010).

Nonaka's (1991) categorization of explicit and tacit knowledge has at least some degree of correspondence with Boisot's (1987) reference to codified and uncodified

knowledge. In both models, the horizontal dimension relates to the spread or diffusion of knowledge across the organization (McAdam and McCreedy, 2000). On the other hand, McAdam and McCreedy (2000) emphasized the construction of knowledge within the social and scientific paradigms. The constructed knowledge is then embodied within the organization, both through explicit programmes and social interchange processes. Following the embodiment process, there is a process of dissemination of the espoused knowledge throughout the organization and its environment. Eventually, knowledge is seen as being of economic value with regard to business benefits and employee emancipation in order to have the support and commitment of all stakeholders in the organization.

Similar to McAdam and McCreedy's (2000) KM model, Rowley's (2001) Learning with Knowledge Cycle (LK Cycle) model extended the Demerest's (1997) KM model (cited in Lwoga, 2009). The LK Cycle embraces both the social construction of knowledge and the systems view, and places emphasis on the relationship between knowledge and learning. The LK Cycle includes the following KM processes: (1) knowledge acquisition, creation and construction, which focus on acquiring knowledge from within or outside the organization; (2) knowledge articulation and sharing, which involve the conversion of tacit knowledge to explicit knowledge; (3) knowledge repositories' updating, which involves collection and organization of knowledge in both systems (machines and people's understanding, practices and awareness); (4) knowledge diffusion, access and dissemination, where knowledge may be accessed through searching a system, or by contacting others, or through training courses; (5) knowledge use, where knowledge may be used to develop new

knowledge through integration, creation, innovation and extension of existing knowledge; and lastly, (6) knowledge revision, which takes place as a result of knowledge use and of reflection on the experience of actions and decisions. Such reflection drives individual learning that can form the basis for the creation of new knowledge, which may supplement or substitute the existing knowledge. Further, this stage is crucial for individual development and learning.

Rowley (2001) further emphasized that KM needs appropriate systems to store and disseminate explicit knowledge. It also needs a culture which not only ensures that knowledge is valued as a resource, to be shared, but emphasizes the role of knowledge in supporting individual and organizational learning.

Bouthillier and Shearer's (2002) KM model is also parallel to McAdam and McCreedy (1999) and Rowley (2001) KM models. Bouthillier and Shearer (2002) KM model has three major steps. First, the "gathering" step which includes discovery, acquisition, and creation of knowledge processes. Discovery involves locating internal knowledge within the organization. Acquisition involves bringing knowledge into an organization from the external sources.

Creation of new knowledge may be accomplished in several ways: internal knowledge may be combined with other internal knowledge to create new knowledge, or information may be analyzed to create new knowledge. Secondly, knowledge sharing involves the transfer of knowledge from one (or more) person to another one (or more). Lastly, the model is completed by the knowledge storage, and knowledge use and application steps.

Probst, Raub, and Romhardt's (2000) KM building blocks as shown in Figure 3 is almost similar to Bouthillier and Shearer's (2002), McAdam and McCreedy's (1999) and Rowley's (2001) KM models. Probst, Raub, and Romhardt (2000) core processes of KM include:

- Knowledge identification: analyzes and describes the company's knowledge from both internal and external environment;
- Knowledge acquisition: imports a substantial part of knowledge from outside sources;
- Knowledge development: focuses on generating new skills, new products, better ideas and more efficient processes;
- Knowledge sharing and distribution: gets knowledge to the right place;
- Knowledge utilization: ensures that the present knowledge is applied productively for the benefit of that organization; and
- Knowledge retention: Selects stores and regularly updates knowledge for potential future value.

Probst, Raub, and Romhardt (2000) further added two building blocks, namely, knowledge goals and knowledge assessment. The knowledge goals clarify the strategic direction of KM and the concrete objectives of specific interventions, while knowledge assessment provides a method for measuring normative, strategic and operational knowledge.

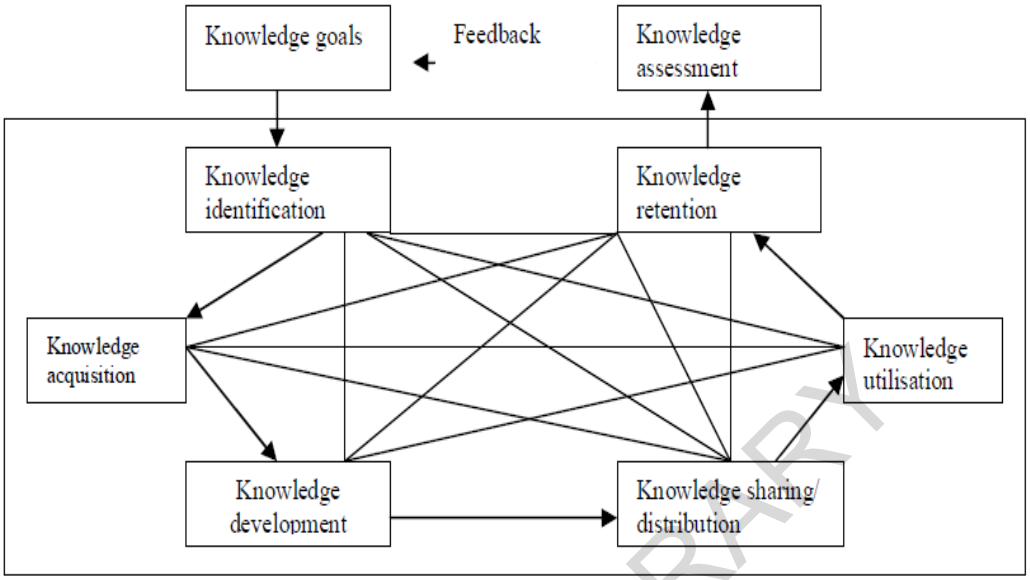

Figure 3: Building blocks of knowledge management
(Adapted from Probst, Raub, and Romhardt, 2000 as cited in Lwoga, 2010).

In contrast, Small and Tattalias's (2000) KM model at Mitre as shown in Figure 5 views KM from a two-dimensional perspective. The first dimension (bottom in Figure 4) consists of activities that are critical to knowledge creation and innovation which are knowledge exchange, knowledge capture, knowledge reuse, and knowledge internalization. The second dimension (top in Figure 4) consists of elements that enable or influence knowledge creation activities. According to Small and Tattalias (2000), these elements include:

Strategy: the alignment of corporate and KM strategies;

Measurement: the measures or metrics captured to determine if KM improvement is occurring or if a benefit is being derived;

Policy: the written policy or guidance that is provided by the organization;

Content: the subset of the corporate knowledge base that is captured electronically;

Process: the processes for achieving organization mission and goals;

Technology: the information technology that facilitates the identification, creation, and diffusion of knowledge within and across enterprises; and

Culture: the environment and context in which KM processes must occur.

Davenport's (1998) ten principles supported the second dimension of Small and Tattalias (2000) and two building blocks (knowledge goals and assessment) of Probst, Raub, and Romhardt (2000). Davenport (1998) asserted that these ten principles can be used to govern or guide KM processes in organizations. When an organization decides what principles (issues) it agrees upon with regard to KM, it can then create detailed approaches and plans based upon these principles.

The principles are as follows:

Knowledge management is expensive. Knowledge is an asset, but its effective management requires investment of other assets;

Effective management of knowledge requires hybrid solutions of people and technology in complementary ways;

Knowledge management is highly political. This principle requires the identification of influential knowledge champions, people who know the organization's politics;

Knowledge management requires knowledge managers;

Knowledge management benefits more from maps than models, more from markets than from hierarchies. Hence, only knowledge with a strategic value should be mapped;

Sharing and using knowledge are often unnatural acts. Thus, people should be judged according to their ability to share and use knowledge;

Knowledge management means improving knowledge work processes. The organization must identify and improve key business processes that are important in knowledge work process for effective KM activities;

Knowledge access is only the beginning. Although access to knowledge is important, it only becomes useful when it is shared and applied to specific situations; *Knowledge management never ends.* The categories of the required knowledge are always changing due to the continuous advancement of technologies, management approaches, regulatory issues, and customer concerns; and *Knowledge management requires a knowledge contract* between the company and the employees.

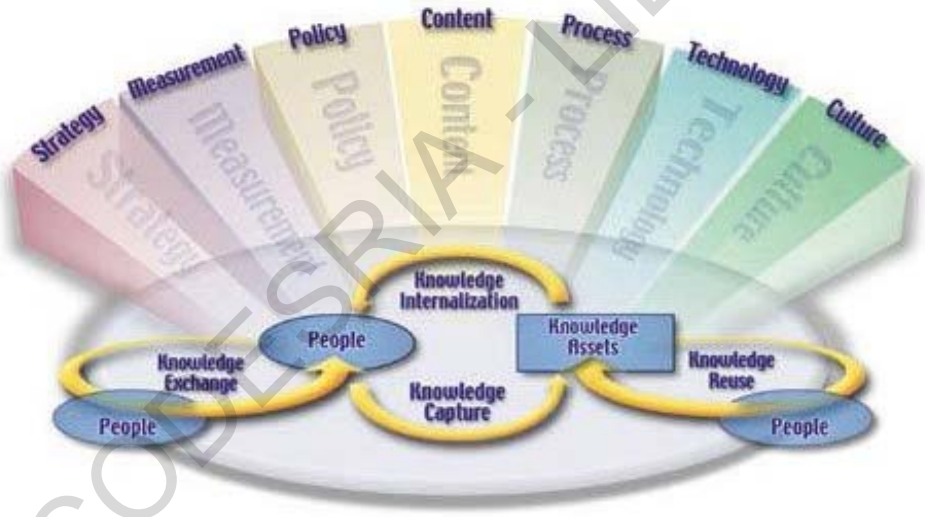

Figure 4: KM model at Mitre

(Adapted from Small and Tattalias, 2000 as cited in Lwoga, 2010)

Earl (2001) also proposed a model that ought to help corporate executives to understand types of KM initiatives or investments that make sense in their context. Earl's (2001) schools of KM thoughts include technocratic, economic and behavioral. Technocratic consist of the first three schools which are largely based on ICTs, and large emphasis is being put on validating, mapping, capturing, codifying,

controlling and updating the specialists' knowledge in knowledge bases. Similarly to Davenport (1998), Nonaka, Toyama and Konno (2000) and Probst, Raub, and Romhardt (2000), Earl (2001) also emphasized the need to map knowledge as a success factor for this school.

The economic school of thought is rather more singular, being the most commercial in orientation, explicitly creating revenue streams from the exploitation of knowledge and intellectual capital. In agreement with Davenport (1998) and Nonaka, Toyama and Konno (2000), Earl (2001) noted that this school can be successful if there is a development of a specialist team or function to aggressively manage knowledge property. Another success factor is the development or acquisition of techniques and procedures to manage intellectual assets as routine processes.

The behavioral school includes the last three schools, where the greater focus is on stimulating the managers and managements to be more proactive in creating, sharing and using knowledge as a resource. However, Earl (2001) cautioned that no school outperforms others since each school represents a particular orientation, a different sort of organizational intervention. Like Davenport (1998) and Small and Tattalias (2000), Earl (2001) also proposed that the potential contribution of ICT is manifold once knowledge strategy drives KM initiatives.

Kruger and Snyman (2005) also agreed with Davenport's (1998), Earl's (2001) and Small and Tattalias's (2000) KM models. Kruger and Snyman (2005) proposed that not only should knowledge be governed by a strategy before detailed KM plans can

be made, but more importantly that sound KM practice should be based on predetermined principles and strategies.

In order to ensure uniformity in the purpose of institutionalizing these principles, Kruger and Snyman (2005) suggest that not only should principles be encapsulated within a policy, but also a strategic management process (strategic requirements for knowledge leading to a knowledge strategy) be used to determine the priority of principles, that is strategy acting as a filter in deciding on the allocation of resources to successfully institutionalize principles.

From the discussion of these KM models, it can be argued that all of these models focus on the business or organizational settings. It is evident that these models emphasize the implementation of KM processes for the effective management of knowledge in organizations. They used different labels to show their KM processes, but they all emphasized the following: knowledge identification, acquisition, development, sharing, preservation and application. Implementation of these KM processes would enable communities to identify, create, share, preserve and use available knowledge to improve their farming activities.

This study therefore adapted some ideas especially the KM processes of identification, acquisition, development, sharing, preservation and application from these models in order to provide theoretical guidance for the application of KM processes and contribution in managing IK in the local community settings in Masasi and Nachingwea districts.

In this context, this study adopted the KM processes as deduced from the reviewed KM models to allow the local communities to manage their knowledge based on pre-determined principles. Thus, the focus of the study was particularly on the following KM processes: knowledge identification, acquisition, development, sharing, preservation and application.

2.7 Knowledge Management Application for Indigenous Agro-biodiversity Knowledge Management

Knowledge Management has been successfully applied to improve business performances in many organizations in developed countries (Ichijo and Nonaka, 2007). Most scholars argue that KM practices are closed systems or formal organizations and are likely to be more successful than in the informal systems or open systems because they have formal structures and rules to which members of organizations adhere (Mosia and Ngulube, 2005; Noeth, 2006). This is why most organizations in these countries offer better customer service, improved products, business processes and new innovative ideas for commercialization (Ikoja-Odongo, 2006).

KM approaches can be used to enable the diffusion of tacit knowledge to cope with the dynamic world in developing countries (Dlamini, 2005; Ikoja-Odongo, 2006; Kaniki and Mphahlele, 2002; Kok, 2005; Ngulube, 2003; Noeth, 2006). KM balances out interest and power differences and encourages knowledge exchange and learning. However, the externalization and diffusion of tacit IK may separate such knowledge from its human agents and from the context, in which it is generated,

transformed and re-generated (Davenport and Prusak, 1998; Ellen and Harris, 2000; Ngulube, 2003; Raseroka, 2008).

Further, IK may change as it undergoes the documentation processes due to the translations, strategies and objectives of those using it (Ellen and Harris, 2000). There is thus a need to strike a balance between the desire to preserve IKS in ex-situ databases and the importance of facilitating the continued performance of IK in its original context (Ngulube, 2003).

Taken in this context, KM should be applied in rural areas for equitable and sustainable development since knowledge is a key resource for socio-economic growth (Hamel, 2005; Kalseth and Cummings, 2001; Mosia and Ngulube, 2005; Noeth, 2006). Rural communities have an extensive base of IK. While organizational knowledge is used as a source for competitive advantage and social advantage. It can be used to integrate and share the diversity of IK in a community that desires to achieve developmental goals (Alavi and Leidner, 2001, Ikoja-Odongo, 2006; and Mosia and Ngulube, 2005). To achieve that, certain initiatives are needed to enable developing countries to manage IK through KM practices like in developed countries. These factors include an educated population to absorb and apply new knowledge supportive policies and an enabling environment (Ikoja-Odongo, 2006).

According to Langill (1999), the rapid environmental, social, economic and political changes occurring in areas inhabited by indigenous people pose a threat in that the IK they possess may be overwhelmed and be lost forever. Younger generations are acquiring different values and lifestyles as a result of exposure to global and national

influences. Traditional communication networks are also breaking down. This means the elders are dying without passing on their knowledge to children. Moreover, younger generations underestimate the utility of indigenous knowledge systems (IKSs) because of the influence of modern technology and education (Ulluwishewa, 1993 cited in Ngulube, 2002).They should record, document to ensure both the scientific and local communities have access to it.

2.8 Indigenous Knowledge in Tanzania

The physical and biological diversity and cultural diversity that embrace more than 120 ethnic groups represents a wide variety of IK systems in Tanzania (Mascarenhas, 2003, Koda, 1999; 2000). IK is an important part of the various fields, including agriculture, health, veterinary, and arts and crafts. However, IK is still underestimated and under-valued due to the disappearance of local cultures, a prevailing colonial mentality, increasing control by government, inadequate incentives, an institutional framework that is heavily tilted against creativity, diversity and IK, and a bureaucratic system that promotes the conventional knowledge from the west (Mascarenhas, 2004). Few sectoral and cross-sectoral policies recognize IK protection. Some of them include:

1990: Health Policy, which recognizes the importance of traditional healers and birth attendants in delivering health services;

1996: Education and training policy. This seeks to strengthen the integration of formal and non-formal relationship, by instituting points to knowledge comparability and intermobility within the two sub-sectors of education;

1996: National Science and Technology Policy, in which IK issues are implied without explicit mention to ensure that they are protected.

1996: Sustainable Industrial development policy. This addresses IK in terms of copyright and patents acts. However, IPR does not adequately recognise and protect IK;

1997: Agriculture and Livestock Policy. IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It recognizes the relationship between IK and agricultural research;

1997: Cultural policy. IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It stresses the need to identify, preserve and disseminate environment friendly traditional knowledge and technologies;

1997: Environment policy. There is a policy statement with reference to IK issues without elaboration, but enough to warrant distinct implementation. It addresses the development of biotechnology by allowing fair and equitable sharing of the results and benefits arising out of utilization by foreign recipients, and of genetic resources originating from Tanzania;

1997: Fisheries policy. IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It recognizes the need to promote acquisition and documentation of traditional fisheries knowledge;

1998: Forest policy. There is a policy statement and strategies on community involvement for sustainable forest management;

1998: Wildlife policy. IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It recognizes the use of IK in the conservation and management of natural resources;

2001: Agricultural Sector Development Strategy (ASDS). This focuses on incorporating IK at the district level through District Agricultural Development Plan (DADP) as part of the District Participatory Plan (DPP);

2003: ICT policy. IK is mentioned as an objective, followed by a policy statement and a strategy for implementation. It emphasizes the use of ICTs to collect and disseminate relevant local knowledge and content in local languages;

2005: National Strategy for Growth and Reduction of Poverty (NSGRP).Acknowledges the use of IK for agricultural development and wildlife management. 2025: Tanzania Development Vision. IK issues are implied but are not explicitly mentioned (Kabudi, 2003; Kaiza-Boshe, 2003; URT, 1990; 1995; 1996a; 1996b; 1996c; 1997a; 1997c; 1997d; 1997e; 1998a; 1998b; 2001a; 2001b; 2003a; 2005b cited in Lwoga, 2009).

Despite the fact that IK is not given adequate treatment in the entire policy frameworks stated above, there are various initiatives which have been undertaken to promote the integration of IK in the developmental programmes in the country. For example, in October 2004, the Tanzanian President endorsed a six-point action plan to raise the profile of IK, mainstreamed IK in country development programs, and secured additional funding from development partners (World Bank 2009). Further, the FAO-LinKS Project in collaboration with the Tanzania government was instrumental in promoting IK through capacity building, research and advocacy activities.

By 2005, the FAO-LinKS Project had achieved the following: 400 trained researchers and extension officers; developed curriculum on IK issues at the Sokoine

University of Agriculture; sixteen research studies on IK; and established a Trust Fund in 2005 to promote the development and implementation of IK policies, strategies and intellectual property rights in Tanzania (FAO, 2007). However, the momentum for formulating a national strategy and action plan for IK is yet to be built. Given that IK does not receive adequate treatment in sectoral and national policies, there is a need to develop a comprehensive policy, strategy and action plan that will specifically deal with IK issues in the country.

2.9 Indigenous Knowledge and Agro-biodiversity Development in Tanzania

The agricultural practices have increasingly proved to be productive, sustainable and ecologically sound, even under extraordinarily difficult conditions due to the utilization of IK in Tanzania (Mugurusi, 2001). Most farmers practice low input agriculture (approximately 80 percent of the agriculture) in the country (Mella, *et al.*, 2007). The traditional sector accounts for about 99 percent of the country's cattle, 85 percent of the poultry (Hill 2003:1), and more than 90 percent of the seeds planted in Tanzania (Mushi, 2008). In reality, the potential of IK in improving agricultural production, conserving environment and ensuring food security at the local level in Tanzania can be gauged by the following: the matengo pits practiced in Ruvuma region, the ufipa mound system, the traditional terracing systems of the Iraqw, and the rotational fallowing systems in Mufindi District (Kauzeni and Madulu, 2003; Mugurusi, 2001; Naess and Missano, 2000 and Mattee, 1998).

However, most traditional farming systems were sustainable only under low-input–low-output regimes. The introduction of mechanization, fertilizers and phyto medicines has turned some of these systems into high-input–high-output systems,

most of which were either not sustainable or did not produce high outputs that were expected (Aluma, 2004). Major causes for this problem are market restrictions, land use rights, inappropriate technology transfer, poor communication infrastructure and poor access to rural finance (Kaburire and Ruvuga, 2006; Lema and Kapange, 2006; Ngendello, Byabachwezi and Schrader, 2003). The modernization of agriculture has also reduced genetic variability of crops and livestock. It is estimated by FAO that 30 percent of animal genetic resources are at high risk of loss due to negligence of IK in favour of conventional scientific findings (Muyungi and Tillya, 2003).

Researchers and producers are now counteracting this trend by re-introducing indigenous species back into the gene pool of domestic crops and livestock (Aluma, 2004). Further, due to ongoing campaigns on environmental conservation, farmers in Tanzania, like their counterparts in other parts of the world are becoming more aware of hazardous effects of industrial agro-chemicals, and are reverting to indigenous inputs (Mgumia, 2001). Many African communities also revert to indigenous plants and crops in the event of severe shortages of major staples (Aluma, 2004). However, indigenous farming has received but a fraction of the research attention of the major crops in developing countries including Tanzania (Aluma, 2004). For example, the crop research policies in Tanzania emphasize research on crops with export potential.

As a result, research institutes and extension agents in Tanzania neglect crops that are vital for food security such as traditional crops (Manda, 2002). Thus, the development of indigenous farming methods in Tanzania rely on the farmers' observation, experimentation, adaptation and propagation of new ideas gained

through experience (Koda, 2000; Mugurusi, 2001). There is thus a need to continuously recognise, identify, validate, preserve and disseminate indigenous skills and practices for improved agricultural activities.

2.10 The Management of Indigenous Agro-biodiversity Knowledge in Tanzania

Despite its potential for agricultural and biodiversity development, IK is not properly managed in Tanzania and thus it is not effectively replicated in other communities (Koda, 1999; Mgumia, 2001; Sempeho, 2004). Instead, IK is threatened by erosion due to lack of proper documentation and exchange of IK information; low level of awareness of the importance of IKS, innovations and practices; and issues of benefit-sharing (Mugurusi, 2001). Most of the traditional structures for packaging and sharing IK in Tanzania have disappeared while attempts to replace them have been futile (Koda, 1999). Even when IK is documented, in most cases, such information is neither made available to farmers in a usable form nor relates to the targeted groups' own surroundings and culture (Mgumia, 2001; Sempeho, 2004). For instance, even where IK is promoted, the content is usually commercialized and hence there is decreased accessibility for the majority who cannot afford it (Koda, 1999).

Due to inadequate documentation efforts, agricultural IK is mostly stored in people's minds and often expressed and shared through individual and collective interactions. The older members of the villages are the major custodians of this type of knowledge (Kauzeni and Madulu, 2003). IK is mainly shared through face-to-face interactions, folklore activities, artefacts, deliberate instructions and direct observation and

practices (Akullo, *et al.*, 2007; Owuor, 2007; Ihucha, 2006; Ikoja-Odongo, 2006; Rao, 2006; Sen and Khashmelmous, 2006).

The existing structures or set norms are also used to safeguard and ensure further development of IK in Tanzania (Kauzeni, 2000). In particular, IK is shared through its three basic categories, which include the “public” knowledge to which access is unrestricted, "discretionary" knowledge which is usually clan based and is hence accessed along clan lines (such as tin smithery/pottery knowledge) and "secretive" knowledge which is usually accessed through inheritance such as medicinal knowledge (Kauzeni, 2000). As a result, IK is not equally distributed in the local communities.

There is thus a need to determine an approach that would enable acquisition, sharing, preservation and use of IK by communities to improve agricultural practices in the country. Furthermore, men and women hold different types of agricultural knowledge, reflecting their roles and responsibilities at household level (Kaiza-boshe, 2003; Koda, 2000; Naess and Missano, 2000). In most developing countries including Tanzania women is the major workforce in agricultural production while men are more involved in and have control over income-generating activities, and therefore are more oriented to conventional agricultural techniques and practices (Kaiza-Boshe, 2003; Koda, 2000; Naess and Missano, 2000).

Women are major custodians of knowledge pertaining to farming and food security and they contribute most of the labour in agricultural activities in Tanzania (Kaiza-Boshe, 2003; Kessy, 2006; Mattee, 1998). However, women's local knowledge is

marginalized due to the inferior position accorded to women in society a factor which results in relatively low productivity, worsening poverty and increasing food insecurity (Kaiza-Boshe, 2003; Koda, 1999). Any intervention aimed at improving the management of IK in Tanzania cannot be effective if the linkages between gender and IK are not taken into consideration.

Very few initiatives have focused attention on the management of IK in Tanzania, which include farmers' groups and donor funded projects. For example, the national farmers' group networks also known in Swahili as Mtandao wa Vikundi vya Wakulima Tanzania (MVIWATA) facilitates the exchange of knowledge among farmers through a bottom-up participatory approach (Kaburire and Ruvuga, 2006). The Uluguru Mountains Agricultural Development Project (UMADEP) in Morogoro region is another initiative in Tanzania which uses participatory approaches to document farmer's knowledge on natural crop protection. This knowledge is shared with other farmers through local and relevant educational print materials and farmer-led training workshops (Mgumia, 2001). There is thus a need to strengthen existing initiatives to ensure that IK is managed for improved agricultural practices in local communities in Tanzania.

2.11 Literature Synthesis and Research Gap

Reviewed literature shows that:

- Ideally, IK and agro-biodiversity should not be lost; rather it should remain permanent and contribute immensely to the livelihoods of communities.

- Maintenance and use of agro-biodiversity should rely on extensive indigenous knowledge systems, which address aspects such as cultivation practices, uses, and genetic resource management of plant species.

However, in practice:

- The transfer of IK from one generation to another is mostly done through oral tradition and demonstrations.
- IK is not equally shared among communities due to power and cultural differences.
- IK is stored mainly in the minds of the elderly who may die and disappear with the knowledge accumulated over a long period of time.
- Much of IK remains undocumented.
- There is existence of a number of KM models, but many of them are applied in business organization settings.
- There is little empirical research that has been done to validate the application of the existing Knowledge Management (KM) models used in business organizations for better management of IK on agro-biodiversity despite their potential in application in local communities.
- KM scholars used different labels to show their KM processes, but they all emphasized six knowledge management processes which are: knowledge identification, acquisition, development, sharing, preservation and application.
- According to Gari (2004), agricultural modernization accelerates environmental degradation and the main victims of it have been indigenous knowledge and agro-biodiversity.

- The consequence of this IK loss is reduced capacity of communities to control their subsistence systems, including their food security and nutrition.
- There is a need to examine issues related to IK creation, development, and transfer and sharing among local communities and enhance understanding and improvement of agro-biodiversity management using indigenous knowledge and KM approaches by local communities in Tanzania.

Therefore, the present study sought to:

Investigate and document existing indigenous knowledge practices and prove how Nonaka and Konnos' 1998 KM model (Socialization, Externalization, Combination and Internalization (SECI) model) can be utilized to manage indigenous knowledge related to agro-biodiversity management in local communities. Combined with Adapted Sustainable Livelihood model, the study also sought to investigate how such knowledge contributes to livelihoods of local communities. According to Borghoff and Pareschi (1997), much of the knowledge possessed by local people is mostly tacit and the SECI model is suitable for such kind of studies and hence its adaptation for this study.

2.12 Theoretical Frameworks used in the Study

A theoretical framework like a theory is a collection of interrelated concepts, but not necessarily well worked-out. The theoretical framework guides research in determining what should be measured, and what statistical relationships it should look for (Vicent and Norma, 2006). This study was guided by the knowledge Management Model, also known as the Knowledge Creation Model proposed by

Nonaka and Konno (1998) (Figure 5) and Adapted Sustainable Livelihood Model developed by CARE (2009) (Figure 6).The dominant model was Knowledge Creation Model, also called SECI model.

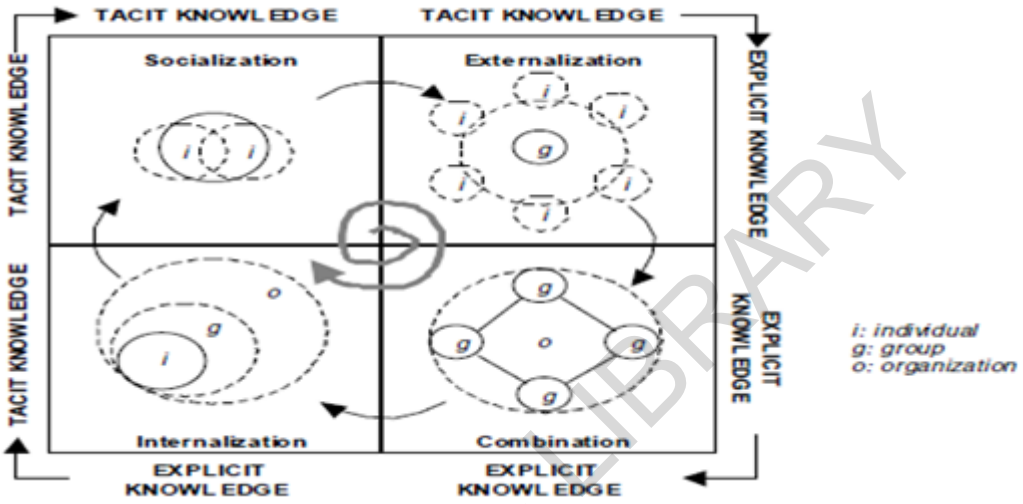

Figure 5: The engine of knowledge creation
(Adapted from Nonaka and Konno, 1998).

Nonaka and Konno's (1998) model emphasizes the creation of knowledge through conversion of tacit to explicit knowledge and vice versa. Tacit knowledge is personal knowledge embedded in individual experiences and is shared and exchanged through direct, eye to-eye contact. It can be communicated in a most direct and effective way (Borghoff and Pareschi, 1997). Tacit knowledge is difficult to formalize and communicate because it is often intimately tied to action and experience. It includes people's know-how, secrets and personal skills. This knowledge can be gathered by socializing, using face-to-face communication or by sharing experiences directly at work through arrangement such as tutor and the apprentice. Explicit knowledge is formal knowledge that can be packaged as information and is found in organizational documents such as reports, articles,

manuals, patents, pictures, images, video, sound, and software (Borghoff and Pareschi, 1997).

Explicit knowledge can be put into words, written down, modeled and is easily transferred. Modes of knowledge conversion include socialization (from tacit to tacit knowledge), externalization (from tacit to explicit knowledge), combination (from explicit to explicit knowledge) and internalization (from explicit to tacit knowledge).

However, there are some weaknesses pointed by researchers in KM regarding this model. For instance, Gourlay (2006), Kaplan (2008), Li and Gao (2003) and Snowden (2007) listed some of the weaknesses of this model as follows:

i. The model considers the knowledge creation process in the Japanese context and that it cannot be applied in a different setting (Li and Gao, 2003 and Snowden, 2007).
ii. Tacit and explicit knowledge are dimensions of knowledge that cannot be transformed from one form to the other (Snowden, 2007).
iii. The tacit dimension of knowledge in the knowledge creation model is different from that in Polanyi original context. It actually includes considerable implicitness (indirectness) which is peculiar in Japanese context. The separation of implicitness from real tacitness indicates a need for careful consideration about the potential of tacit knowledge in different contexts (Li and Gao, 2003).
iv. There is no evidence to prove that the knowledge creation process is not different from information creation and thus knowledge conversion has been conflated with knowledge transfer in the matrix. Further the Combination and

Internalization sub-processes from the SECI model are not described clearly (Gurlay, 2006).

v. There is lack of knowledge content development (Kaplan, 2008).

However, despite these weaknesses, the theory claimed to be useful in understanding and testing the application of KM through knowledge creation processes in various non-Japanese organizations (Rice and Rice, 2005 and Kaplan, 2008). Further, other schools of thought have argued that this theory can be adapted by the rural communities of developing countries such as South Africa (Ngulube, 2003) and can be applied to manage the IK of local communities in developing countries such as Nigeria (Ha, Okgbo and Igboaka, 2008) and Tanzania (Lwoga, 2009). Because much of the knowledge possessed by local people is mostly tacit, this knowledge creation model was seen suitable for this study.

The Adapted Sustainable Livelihoods Framework (ASLF) developed by CARE International will be used in this study. The sustainable livelihoods approach (SLA) is a way to improve understanding of the livelihoods of poor people. It draws on the main factors that affect poor people's livelihoods and the typical relationships between these factors. It can be used in planning new development activities and in assessing the contribution that existing activities have made to sustaining livelihoods (CARE, 2009).

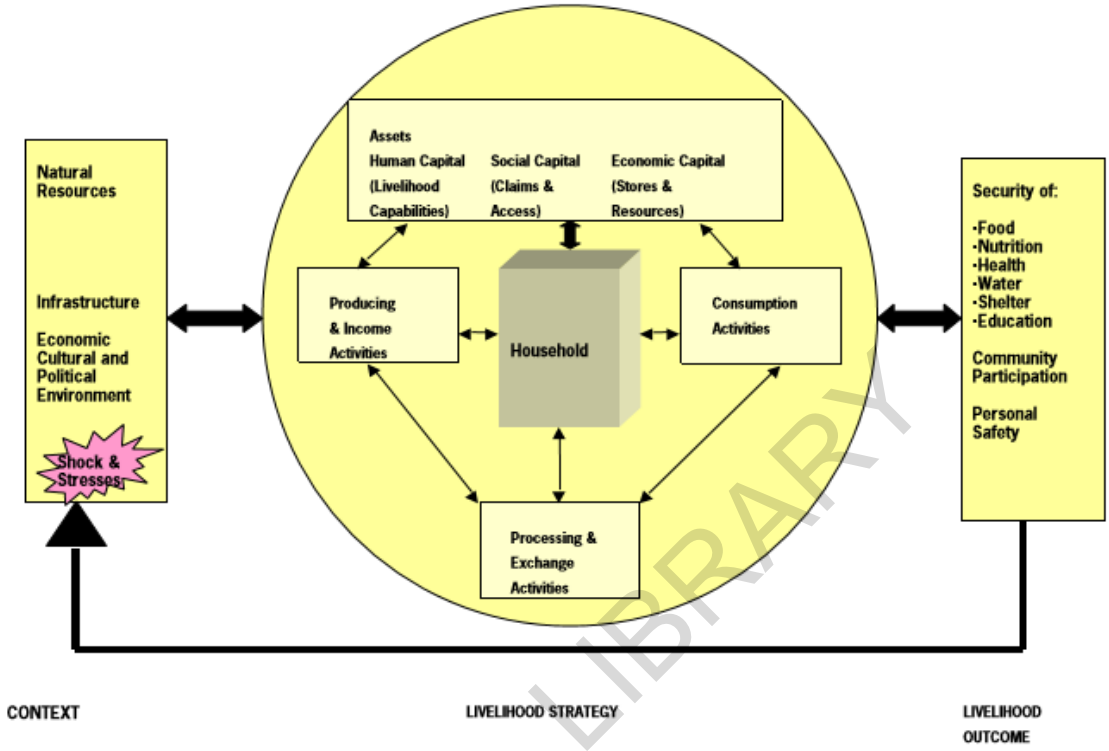

Figure 6: Adapted Sustainable Livelihood Framework
(Adapted from CARE, 2009).

According to the ASLF the *impact group* is presented at the centre of the schematic, meaning that it is the main focus for studies trying to understand the livelihoods of communities under study. Women and men as impact groups access *resources, services and opportunities* (R/S/O) through a set of individual and /or collective livelihoods strategies. The strategies could be productive/exchange activities such as selling labour, goods or gathering wild natural resources, farming one's own land, participation in networks, alliances, coalitions of self identified interest groups of men and women in communities and markets, interaction with local authorities in collaboration with others and holding them to account, coping strategies to gain continued access to resources in lean times or when resources are depleted or scarce (CARE, 2009).

In applying strategies to access R/S/O, women and men as impact groups encounter barriers that prevent them from accessing these R/S/O. The barriers could be *agency related* (such as lack of capacity, skills or confidence), *structural* (such as social, political, economic institutions and systems), *relational* (such as unequal gender relations) or *environmental related* (such as increasing scarcity in natural resources) at multiple levels, and results in inequity in access to R/S/O. Availability of , access to, and use of these resources is controlled by or mediated through *policies, institutions, processes* (PIP), both formal and informal at multiple levels. These PIPs are indicated as lock in the schematic and they influence the ability of impact groups to gain access to R/S/O (CARE, 2009).

The impact groups along with others in their communities and beyond employ individual and collective livelihood strategies to use (or influence the use of) R/S/O. As most of the impact groups seek their livelihoods in harsh environments, it is always important to understand the environmental impacts of their livelihood strategies. The use of these livelihood strategies enables them to fulfil their basic rights to food, water, health, shelter, education, participation, personal safety) and freedoms (from want, from fear, of thought and speech and to participate in decision making, for decent work, from discrimination, from injustice and violations of the rule of law, to develop and realise one's human potential). *Assets* are also considered important in this framework as they help to build resilience, reduce vulnerability to buffer the impact groups and their families from *shocks* (such as unpredictable natural disasters), *stresses* ((like land grabbing by political elites) and *negative trends* (like increasing volatility of markets, or rising price of food) (CARE, 2009).

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This section presents the methodology, study area, research design, and sampling design, methods for data collection and analysis as well as ethical issues.

3.1 Study Areas

The study was conducted in Lindi (Nachingwea district) and Mtwara (Masasi district). These districts are located in the southern part of Tanzania, 600 km from Dar es Salaam. The main ethnic groups are Mwera, Ngindo, Yao, Makonde and Makua. Their main occupation is agriculture and major crops grown in the districts include cassava, sorghum, legumes, maize, cashew, sesame, paddy, fruits and Irish potatoes.

3.1.1 Nachingwea district

Nachingwea is one of the six districts in Lindi region. The district borders with Ruangwa district in the North-East; Masasi district to the South-east, Tunduru district to the South-West and Liwale district to the North-West. Administratively, the district has five (5) divisions, which in turn are sub divided into 26 wards and a total of 104 villages. According to the 2012-population census, the district has a population of 178,464 people of which 86,382 are males and 92,082 are females (NBS, 2013). The main ethnic groups are Makua, Yao and Makonde. Their main occupation is agriculture and major crops grown in the district include cassava, sorghum, legumes, maize, cashew, sesame, paddy, fruits and Irish potatoes.

3.1.2 Masasi district

Masasi is one of the six districts in Mtwara region and borders Nachingwea and Ruangwa district to the North, Lindi and Newala districts to the East and Ruvuma River to the South and Nanyumbu district to the West. According to the 2012-population census, Masasi's total population is 247,993. Of these 118,976 are males and 129,017 are females. Masasi district administratively has 5 divisions, 22 wards and 156 villages (NBS, 2013). The main ethnic groups are Makonde and Makua. Major economic activities include agriculture and livestock keeping. Major crops grown are cassava, groundnuts, cashew nuts, sorghum, sesame, maize, pigeon peas and vegetable. Livestock kept include cattle, goats, sheep, pigs and poultry. Fishing and beekeeping also contributes to household income. Most of Masasi residents depend on cashew nuts production which is their major cash crop and cassava is a major staple food.

The selection of these districts as study areas were influenced by the following factors: The two districts experience threats to agro-biodiversity richness because of environmental degradation resulting from deforestation, bush fires and bad farming practices. The two districts lie in the low altitudes with most parts having low fertility soils which are not best for farming activities (URT, 2009). The districts are remotely located from major towns where explicit knowledge and access to modern practices for agro-biodiversity management could be obtained. Evidence from FAO (2006) indicate that soil fertility in these areas are suitable for some forms of farming but soil fertility is generally low and there is very little use of modern inputs for farming such as inorganic fertilizers, modern varieties and mechanization.

Nevertheless, the communities in these areas are engaged in staple food production throughout the farming seasons than in the wage employment schemes. Kolawole (2004) suggests that the active involvement of people in farming activities than in wage employment indicates that indigenous knowledge systems practices may have found common use amongst the local people. Thus, it was hypothesized that most knowledge used to produce crops and manage biodiversity there is mainly done through indigenous practices. Two criteria were used to select study villages: (i) Proximity to the Chiwale general land which has considerable biodiversity (ii) agriculture being the main livelihood activity for most people in the study villages and is currently climatically stressed.

Another factor of concern for choice of these areas was climate change effects and how local communities adapt to such changes. Tanzania being one of developing countries has not been spared of climate change effects. Currently the climate of Tanzania is highly variable and unpredictable. Climate assessments indicate that the country is prone to extreme weather conditions, including droughts and floods (Shemsanga, 2010). Climate variability has direct adverse impacts on agricultural production in Tanzania because nearly 80% of agricultural production in the country is rainfall dependent (Thornton, 2011). In recent years the country has experienced crop failure due to low rainfall and emerging animal, crop and human diseases in many parts. Adaptation helps farmers achieve their food, income and livelihood security in the face of changing climatic conditions, extreme weather conditions such as droughts and floods (IISD, 2007 and De Wit and Stankiewicz, 2006). It is believed that small scale farmers can reduce the potential damage by making local tactical

responses to these changes (Maddison, 2006; Mano *et al*., 2003). Although small scale farmers in developing countries have low capacity to adapt to climate change effects, they have, however, survived and coped in various ways over time (Mano and Nhemachena, 2006). A better understanding of how they are doing it is essential for designing incentives to enhance adaptation. Supporting the coping strategies of local farmers through appropriate public policy, investment and collective actions can help increase the adoption of well-crafted adaptation measures (IISD, 2007). For poor countries like Tanzania this will help to reduce the negative consequences of predicted changes in the coming years, with great benefits to vulnerable rural communities at large (URT, 2007).

Therefore, it was important to study how local communities in these two districts cope up with these challenges in order to earn their living.

3.2 Research Design

Research design is a logical and systematic plan prepared for directing the collection, measurement and analysis of data in objective and economical procedures (Krishnaswami, 2002). This study employed a mixed method research design employing cross-sectional and a case study research designs. Cross-sectional design involves collecting data at one point in time, utilizing a combination of activities, including extensive literature review, consultations with experts and local communities to provide socio-economic oriented findings (Bryman, 2008). **Case studies** (small communities in villages) were drawn to enable description of features (indigenous agro-biodiversity knowledge and management practices) in detail (Bryman, 2008).

Mixed method involves using methods of inquiry which focus on collecting, analyzing and mixing both quantitative and qualitative data in a single study or a series of studies (Creswell and Plano-Clark, 2007). Thus, both qualitative and quantitative approaches were used in some of questions, data collection and analysis procedures, and/or inferences. This approach uses multiple approaches in answering research questions and does not restrict or constrain researchers' choices.

A mixed methods approach was used to collect data and to simultaneously address both exploratory and confirmatory questions. Quantitative data were embedded in the qualitative design to enrich the description of the sampled participants (Morse, 1991), and to systematically measure factors considered important for this study such as measurements of the contribution of IK to livelihoods among communities. This approach deployed triangulation to seek convergence across qualitative and quantitative approaches (Tashakkori and Teddlie, 2006). It was used because it is recommended in IK studies as an effective method for collecting different types of data which can be used to confirm the validity and consistency of IK of a certain locality (Kiptot, 2007). Lastly, the study used mixed methods in order to offset the weaknesses of both qualitative and quantitative methods and to draw on the strengths of both (Bryman, 2006).

3.3 Study Population

The population for this study included two categories of respondents: (1) Local communities - farmers, and village leaders; (2) IK intermediaries - extension officers/forest officers in the two districts.

3.4 Sampling Procedure

Sampling procedure is the process of selecting a sub-set of people or social phenomena to be studied, from the larger universe to which they belong, in one of several ways so as to be either non-representative or representative (Kothari, 2004). A four-stage sampling technique was used to draw the sample for this study. Multi-stage sampling was adopted because the population is scattered over a wide geographical area and a survey made within a limited time and financial resources.. The study sample was drawn by choosing the study regions, districts and villages purposively. The two districts selected were Masasi and Nachingwea because of time and financial constraints; agro-biodiversity richness; accessibility by roads; the 'rurality' of the districts and the already stated reasons under section 3.2 above. The final sample covered only 8 villages, 4 villages from each district (Table 1) to reflect the management of agro-biodiversity using IK.

Households: respondents who were interviewed were selected using systematic sampling. Their names were picked from the village government register of households using systematic random sampling. Systematic random sampling was used because there were complete list of respondents in the village registers in the study villages and it was preferred in order to get evenly distributed (spread) sample from the sampling frame which was developed for each village from the village government registers.

The final total sample consisted of 230 heads of household (husband and wife) for all the 8 villages (achievement of 96% response rate for heads of households).

Purposive sampling was used to select other categories of respondents including participants for Focus Group Discussions (FGD). Between 8 and 12 people participated in one FGD discussions in each village. This sample size (230) represents an average of 30 respondents selected from each village. According to Bailey (1994), a minimum sample size of 30 is normally sufficient for studies in which statistical data analysis is to be done in social sciences (regardless of the population size). Similarly, according to Boyd *et al.,* (1981), it is recommended that a sample size of 5 percent of the total population should be used to form a sample for the study. Further, a 5 percent of total population should not be less than 30 ($X \geq 30$). Studies from other researchers have also suggested the same sample size to be used such as that by Stutely, (2003) and Saunders *et al.,* (2007) who states that a sample size of 30 or more will usually result in a sampling distribution that is very close to the normal distribution, and the larger the absolute size of a sample, the closer its distribution will be to the normal distribution. From these recommendations the sample size selected in the study area was 30 respondents in each village for interviews. This sample size was also predetermined depending on the homogeneity of the population and the available time and financial resources. Based on the population found in the villages under study, the numbers of respondents were distributed as shown in Table 1 below.

Table 1: Number of respondents for the villages studied

Village	Number of households in the village	Sample size at minimum of 5% by Boyd *et al.*, (1981)	Sampling interval	District	
				Nachingwea	Masasi
Mwenge	519	26	17	30	0
Ikungu	597	30	20	30	0
Kivukoni	1082	54	36	0	29
Mkwapa	550	28	18	0	26
Muungano	535	27	18	0	30
Naipingo	852	43	14	28	0
Namatula (B)	546	27	18	27	0
Nambaya	475	24	16	0	30
Total	**5156**	**259**		**115**	**115**

Source: field survey, 2012

3.5 Data Collection Methods

This study used a combination of methods to collect both primary and secondary data.

3.5.1 Semi-structured and Structured interviews

Interviews are used to collect data in face-to-face settings, using oral question-and-answer format which either employs the same questions in a systematic and structured way for all respondents, or allows respondents to talk about issues in less directed but discursive manner (Payne and Payne, 2004). Interviews enable participants to discuss their interpretations of the world in which they live, and to express how they regard situations from their own point of view (Cohen, Manion and Morrison, 2007).

Semi-structured interviews are based on written lists of questions or topics that need to be covered in a particular order although some questions may arise during the semi-structured interviews (International Institute for Rural Reconstruction (IIRR),

1996). Structured interviews are based on a set of predetermined questions and of highly standardized techniques of recording (Kothari, 2004). The socio-economic overview of households, dependence on indigenous knowledge in agro-biodiversity management and perception on usefulness of indigenous knowledge were expected to be captured using semi-structured interviews.

3.5.1.1 Procedure of semi-structured interview administration

After the household had been selected to take part in the survey, either the *husband* or *wife* of the respective household (*for a married couple*) was responsible for answering the questionnaire. In the event both (husband and wife) were present during interviews, the couples were asked to decide who should answer the questions. For single headed households or at the time of the visit if only one of the couple was present, the questionnaire was administered to either single household heads or the available partner (for the latter case). Where both wife and husband were not present, the household was skipped and visited the second time during the same day or the next day. The traditional paper and pencil *interviewer-administered* mode of questionnaire administration was used in this study. This method of questionnaire administration (as opposed to *self-administered* mode) was preferred because this is the most feasible and practical method and enables the researcher to clarify questions and offset difficulties for respondents who cannot read or write. The questionnaires were administered by field assistants and the researcher. The researchers introduced themselves and explained the purpose of the survey, and how the findings would be used. Respondents were also informed that participation is voluntary and that the information they provide would be used exclusively for

academic purposes and that their names would not be needed or revealed. In fact: (1) respondents were not asked to *provide their names* during the interview, and (2) the sampling frames (containing the up-dated list of households arranged in alphabetical order) were always kept by the village leaders and the research team had no access to the names of the respondents after sampling procedure.

3.6 Key Informant Interviews

Key informant interviews are qualitative in-depth interviews with selected individuals who are considered to have first hand information on investigated issues in a community. In this study, the researcher conducted key informant interviews with village leaders in selected villages. Village leaders (village executive officers, chairpersons and hamlet leaders) were interviewed in the surveyed villages. The choice of these groups as key informants was based on the assumption that such people *know their areas extensively*. They are also conversant with various *socio-cultural aspects* (which may influence use of indigenous knowledge in the management of agro-biodiversity).

3.6.1 Focus group discussions

Focus group discussions are the *exploratory* research tools 'structured group process' conducted for the purpose of exploring peoples' thoughts and feelings and obtaining information about a particular topic or issue in a permissive, non-threatening environment (Dewey, 2000; Ogunbameru, 2003; Chang and Zepeda, 2005; and Davies, *et al.,* 2008). According to Chang and Zepeda (2005), the focus group is typically comprised of 7-10 people who are purposively selected because they have

certain characteristics in common that relate to the topic or issue under discussion. Davies *et al.,* (2008) posit that the group size is usually between 6-12 people, but it can be as small as 4 people. According to Ogunbameru (2003), the group size is in the range of 7-10 people but at times can range from 4-12 people, while Dewey (2000) maintains that the group size is between 6-10 people. According to Slaughter, *et al.,* (1999), FGDs have advantage over in-depth interviews in that information such as needs, beliefs, attitudes; values of individuals or population sub-groups, and insights into new or complex public issues can be best sought using FGDs than in-depth interviews.

In this study, one FGD was conducted in each of the selected villages to augment the data gathered through questionnaire and interviews and in order to take advantage of the synergistic effects of focused discussions, and discuss possible questions arising from the study. Based on recommended size proposed by authors above, 8-12 persons were included in the FGDs in the villages studied.

3.6.2 Organization of FGDs

In this study, focus group discussions were conducted with the local communities. A set of focus groups were formed through the help of village leaders and groups were formed based on gender and age. The focus group discussions were comprised between eight to twelve people depending on their availability. One focus group was conducted in each village. The selected participants for FGDs were gathered in either a primary school classroom or village office whenever they had large space. The researcher asked questions and participants responded to the questions freely and

randomly. One field assistant took notes. The questions were formulated in an unstructured manner in order to explore the research topics in depth.

3.6.3 Interviews of knowledge intermediaries

A self administered questionnaire was distributed to extension and forest officers at district headquarters. These officers provided the information on the existing indigenous knowledge, agricultural and forests diversity in their districts including general information on the management aspects of agro-biodiversity and existing means of integrating exogenous and indigenous knowledge on management of agro-biodiversity within their districts.

3.7 Data Analysis

3.7.1 Quantitative and qualitative data analysis techniques

Data analysis aims at discovering the patterns among data that point to theoretical understandings of a social life (Babbie, 2004). The Statistical Package for Social Sciences (SPSS) software Version 16.0 was used to generate frequencies and percentages and statistics. Quantitative data from semi-structured and structured interviews was analysed quantitatively. Qualitative data analysis involves preparing and organizing the data for analysis, then reducing the data into themes through coding and condensing the codes, and finally presenting the data in figures, tables or discussions. This was accomplished through content analysis of verbal discussions held with different respondents during FGDs and open ended questions in the semi-structured and structured interviews. Furthermore, the excel computer software was used to generate the bar charts for categorical variables.

3.7.2 Households' preference towards indigenous agro-biodiversity management approaches

It was imperative to analyze the respondents' preference towards use of indigenous knowledge when managing agro-biodiversity, and whether the preference was statistically significant. This was achieved through the use of *Chi-square* Analysis Technique. Binary logistic regression was conducted to determine the perceived usefulness of indigenous knowledge when managing agro-biodiversity. The Binary Logistic regression model equation is given by:

$$Logt(Y) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... + \beta_n X_n$$

Where: logit = $\ln\left(\frac{p}{1-p}\right)$ and p is the probability of the study event = Dependent variable (perceived usefulness of indigenous knowledge);

X_s = independent variables (social-economic factors),

α is the *Y* intercept, β_s are regression coefficients.

3.7.3 Measurements of improved livelihoods

In this study indigenous agro-biodiversity knowledge management approaches on livelihoods were measured by examining adaptive strategies (all adjustments in behavior or economic structure) used by communities to cope with vulnerabilities or shocks they encounter in their living with natural resources surrounding them (Salick and Byg, 2007). Some of the vulnerabilities/shocks include: climate changes, occurrence of droughts, high rainfall or low rainfall, decline in soil fertility, food shortage and pest invasion. Moreover, the quantities of both cultivated and wild products gathered were recorded and valued to ascertain their contribution in terms of food security and income earnings.

3.8 Data quality Control

Data quality control was achieved through validity and reliability means. Reliability and validity are important criteria for establishing and assessing the quality of research (Bryman, 2004). Reliability is a consistency of results produced by a measuring instrument when the entity being measured has not changed. It is achieved when repeated observations yield similar results over the entity being measured (Leedy and Ormrod, 2001). Validity is the extent to which the instrument measures what the instrument is supposed to measure, or the extent to which a variable represents what it is supposed to represent. In this study, reliability and validity were achieved by pre-testing the instruments, triangulation and rigor. Questions were simple and objective so as to increase reliability (Dunn *et al.,* 2004). Fieldwork assistants were trained to ensure that they were conversant with the study objectives and that they were confident that they would be able to use the research instruments accurately and in the same way. The gist here was to attain standardization of data collection.

Pre-testing gives the researcher an opportunity to identify questionnaire or interview items that may be misunderstood by respondents (Sekaran, 2003). The purpose of pre-testing is to increase reliability, validity and practicability of the instrument (Cohen, Manion and Morrison, 2000). Pretesting involves a use of a smaller sample of respondents with similar characteristics (Sekaran, 2003, Babbie and Mouton, 2001).

In this study, Pre-testing of interview instruments was done through pilot testing (giving the instruments to 2 experts with experience in survey research, mainly

superior colleagues in the office and supervisors to go through the instruments and advise accordingly) and field testing of instruments at Mkwapa village, in Masasi district prior to actual data collection by the researcher and research assistants. 10 smallholder farmers and two knowledge intermediaries were interviewed, and twelve farmers participated in the focus group discussions. All the participants were conveniently sampled. The findings from the pre-test were used to refine the instruments.

Triangulation enables the collection of multiple data using different strategies, approaches, and methods in such a way that the resulting mixture or combination is likely to result in complementary strengths and non-overlapping weaknesses (Gray, 2004 and Neuman, 2006). Triangulation allows researchers to be more confident of their results. This study triangulated the instruments in order to compliment the strengths and weaknesses in each method and to compare, validate, confirm and corroborate quantitative results with qualitative findings (Creswell, 2003). The study also triangulated data collection methods to ensure the validity and reliability of the findings. By triangulation, accuracy of data was sought in several ways: triangulation of data collection methods (qualitative and quantitative), triangulation of investigators and triangulation of data sources (farmers, extension staff, forest officers, secondary data sources).

In terms of rigour, the researcher ensured that all the research procedures and requirements were followed from data collection, analysis to data interpretation. Bias was also minimized in this study by following Cohen, Manion and Morrison's (2000) suggestions that the questions must be carefully formulated to ensure the meaning is

crystal clear and thorough training of 5 research assistants to familiarise them with possible problems; and interviewer characteristics. All the research quensions were coded using a computer program to ensure every piece of information collected was included in the analysis and interpretation.

3.9 Ethical Issues

The researcher adhered to the University's research ethics policy and code of conduct throughout the study. Further, all sources used in the study are acknowledged. The collected data is aggregated to reflect categories of responses, rather than individual responses in order to ensure confidentiality and privacy of respondents.

Research clearance was sought from the Vice Chancellor of UDSM before embarking on fieldwork. The *Vice-Chancellor's Office* issued two letters to forward to the Regional Administrative Secretary (RAS) of Lindi and Mtwara who in turn issued me with letters to forward to District Administrative Secretary (DAS) in Masasi and Nachingwea districts, allowing collect data for this study. The letters explicitly stipulated the objectives of the study and how the results would be used. Each DAS in turn provided me with the authorization letter, with the copy of the same given to every Village Executive Officer (VEO) in the respective districts. The authorization letter from DAS asked the VEOs to take note of my presence in their area and that they should render any assistance which I may require. Therefore, whenever we wanted to go to a certain study village, we first reported to the Village Office. Village government leaders appointed two persons to take the research team to the sampled households in the villages.

CHAPTER FOUR

PRESENTATION OF KEY FINDINGS

4.0 Introduction

This chapter reports the outcome of the data analysis from transformed raw data collected during field work, into meaningful facts. It reports the social-economic characteristics of the respondents and results based on the research objectives. The presented results for each objective are discussed in turn in chapter five. The study results are presented as verbal descriptions and symbolic representations which include tables and graphs.

The sequence of data presentation is as follows:

Section 4.2.1explains the social-economic characteristics of the study population;

Section 4.3 explains identification of existing indigenous knowledge related to agro-biodiversity management among local communities;

Section 4.4 explains how local communities' access and share indigenous knowledge related to agro-biodiversity;

Section 4.5 examines the barriers constraining access to and use of indigenous knowledge when managing agro-biodiversity at local levels;

Section 4.6 explains the contribution of indigenous agro-biodiversity knowledge management to counter vulnerabilities and shocks;

Section 4.7 explains overall perception on contribution of indigenous agro-biodiversity knowledge management on meeting community's livelihoods; and

Section 4.8 explains rrespondents opinions on how best to preserve IK.

4.1 Social-economic Characteristics of Respondents

Relevant social-economic characteristics of the respondents in this study include age, sex, education, occupation, land size and experience with farming. Respondents' characteristics were important in order to provide a snapshot on the background of the respondents and their suitability for this inquiry. However, these statistics are not necessarily reflective of the communities in the study area, since the study did not cover the whole country.

Table 2: Ethnic group distribution in the two districts N=230

Ethnic group	District			
	Nachingwea		Masasi	
	Frequency	Percent	Frequency	Percent
Kialo	0	0.0	1	0.9
Likanga	0	0.0	1	0.9
Makonde	9	7.8	41	35.7
Makua	40	34.8	66	56.5
Matambuje	0	.0	1	0.9
Pogolo	1	0.9	0	0.0
Mwera	38	33.0	0	0.0
Ndonde	2	1.7	0	0.0
Ngindu	1	0.9	0	0.0
Ngoni	0	0.0	1	0.9
Nyasa	2	1.7	0	0.0
Yao	22	19.1	5	4.3

Source: Field survey, 2012; multiple responses were used

Two hundred and thirty (230) respondents participated in this study - and were drawn from the two selected districts.

As indicated in Table 2 above the Makua constituted 40 (34.8%), of the ethnic groups found in the two selected districts. The Mwera 38 (33.0%), Yao 22 (19.1%) and Makonde 9 (7.8%) are four major ethnic groups in Nachingwea district while Makua 66 (56.5%) and Makonde 41 (35.7%) are the two major ethnic groups in Masasi district. Other ethnic groups and their distribution are as indicated in Table 2.

Table 3: Sex of respondents N=230

Sex	Frequency	Percent
Female	96	41.7
Male	134	58.3

Source: Field survey 2012

Table 3 shows that 134 (58.3%) of the respondents who participated in this study are male and 96 (41.7%) are female.

Table 4: Distribution of respondents by age group N=230

Category	Frequency	Percentage
36-45 age group	64	28.2
27-35 age group	43	18.9
18-26 age group	14	2.2
Total	122	63

Source: Field survey 2012

Table 4 above shows that 64 (28.2%) of the respondents were in the 36 to 45 age group 43 (18.9%) in the 27 to 35, age group and 14 (6.2%) in the 18 to 26 age group. The mean age of the respondents is 46.04 years. Therefore, 47% of the respondents are middle aged.

Table 5: Distribution of respondents by level of education N=230

Category	Frequency	Percentage
Primary education	193	83.9
Secondary education	6	2.6
No schooling	17	7.4
Informal education	9	3.9
Post secondary education	5	2.2
Total		

Source: Field survey 2012

According to Table 5, a majority of the respondents 193 (83.9%) had primary school education, 6 (2.6%) had secondary education, 17 (7.4%) had no formal schooling

(illiterate), 9 (3.9%) had informal schooling and 5 (2.2%) had post secondary education. All the interviewed respondents were engaged in farming activities and collection of wild products for their survival as shown in Table 6 below.

Table 6: Respondents by occupation N=230

Category	Frequency	Percent
Farming	230	100
Wild product collection	230	100

Table 7: Highest education level by sex of respondent N=230

Category	Female		Male	
	Frequency	Percent	Frequency	Percent
Informal schooling	4	44.4	5	55.6
Primary education	78	40.4	115	59.6
Secondary education	2	33.3	4	66.7
Illiterate	3	52.9	8	47.1
Post secondary	9	60.0	2	40.0

Source: Field survey, 2012

Level of education was cross tabulated with sex of respondents. The study results as indicated in Table 7 above shows that 3 (53%) of the female respondents have no formal education. 9 (60%) of females have post secondary education compared to 2 (40%) of their male counterparts. By contrast, 115 (59.6%) of males have primary education compared to 78 (40.4%) of their female counterparts while 4 (66.7 %) of the males have secondary education compared to 2 (33.3%) their female counterparts. In terms of literacy levels that are the ability to read and write in Kiswahili language is high in the two districts surveyed. The study findings revealed that 193 (84%) of the respondents have primary education.

As indicated in Table 8 above, the proportion of females engaged in collecting wild products are fewer compared to their male counterparts except for firewood collection where 59 (93.7%) of female collect firewood compared to 67 (92.6%).

Most heads of households interviewed in Nachingwea and Masasi were males (except in Nachingwea where female heads of households dominated). This implies that males are the main collectors and traders of wild products in the study areas. However, when it comes to high value products such as charcoal and bamboo, 16 (25.4%) and 17 (27.0%) of females are also engaged in charcoal and bamboo activities respectively just like their male counterparts 20 (27.4%) and 28 (38.4%) respectively.

Table 8: Wild products collection using indigenous knowledge by sex in Masasi and Nachingwea districts N=230

Product collected	Sex			
	Female		Male	
	Frequency	Percent	Frequency	Percent
Firewood	59	93.7	67	92.6
Poles	13	20.6	24	32.9
Plant medicine	0	0.0	7	9.6
Honey	1	1.6	7	9.6
Mushroom	4	6.3	16	22.2
Fruits	15	23.8	30	41.1
Vegetables	8	12.7	22	30.1
Wild animals	3	4.8	10	13.7
Charcoal	16	25.4	20	27.4
Bamboo	17	27.0	28	38.4

Source: Field survey, 2012

4.1.1 Occupation of respondents

All the respondents in this study are engaged in crop farming and gathering of wild products.

4.1.1.1 Crop and tree farming

Table 9: Major crops grown using indigenous knowledge by respondents in selected districts N=230

Category	Frequency	Percent
Maize	227	98.7
Rice	17	7.4
Pigeon peas	204	88.7
Sesame	35	15.2
Cashew nut	127	55.2
Cassava	146	63.5
Groundnuts	39	17.0

Source: Field survey, 2012

All the 230 respondents interviewed are involved in crop farming and gathering of wild products. Table 9 above shows that 227 (98.7%) of the respondents grow mostly maize, 204 (88.7%) grow pigeon peas, 146 (63.5%) grow cassava, 127 (55.2%) grow cashew nut, 39 (17%) grow groundnuts, 35 (15.2%) grow sesame and 17 (7.4%) grow paddy.

Table 10: Size of farm and farming experience of respondents N=230

Category	N	Minimum	Maximum	Mean
Size of the farm (acres)	229	1.00	55.00	7.7576
Experience in crop production (years)	227	1.00	60.00	23.5419

Source: Field survey, 2012

The average farm size cultivated is 7.76 acres. Most respondents had an average of 23.54 years of farming experience (Table 10).

Table 11: Tools used for cultivating and managing wild surroundings N=230

Category	Frequency	Percent
Hand hoe	227	99.6
Axe	198	92.5
Machete	170	98.8

Source: Field survey, 2012

As shown in Table 11 above major tools used to manage farms and wild surroundings are mainly hand hoes 227 (99.6%), axes 198 (92.5%) and machetes 170 (98.8%).This indicates that farmers rely on non mechanized farming which predominantly uses local knowledge to earn a living.

4.2 Various types of Indigenous Knowledge Related to Agro-biodiversity Management Among Local Communities

The first objective of the study was to identify existing indigenous knowledge related to agro-biodiversity management among local communities. Data to address this objective were collected using semi-structured interviews, focus group discussions and key informant interviews. This objective was based on the assumption that the communities have an extensive base in IK which needs to be identified for KM practices and sustainable agro-biodiversity activities to be effective. This section presents the results in relation to the identification of agro-biodiversity IK types and use of IK for agro-biodiversity management activities. The following indicators were used to identify types of indigenous agro-biodiversity knowledge, and the extent to which indigenous knowledge is applied to manage farming systems and biodiversity in surveyed communities.

4.2.1 Indigenous knowledge on selected farming practices

4.2.1.1 Indigenous knowledge on soil characteristics

Local communities possess a range of knowledge on soil types in their farms.

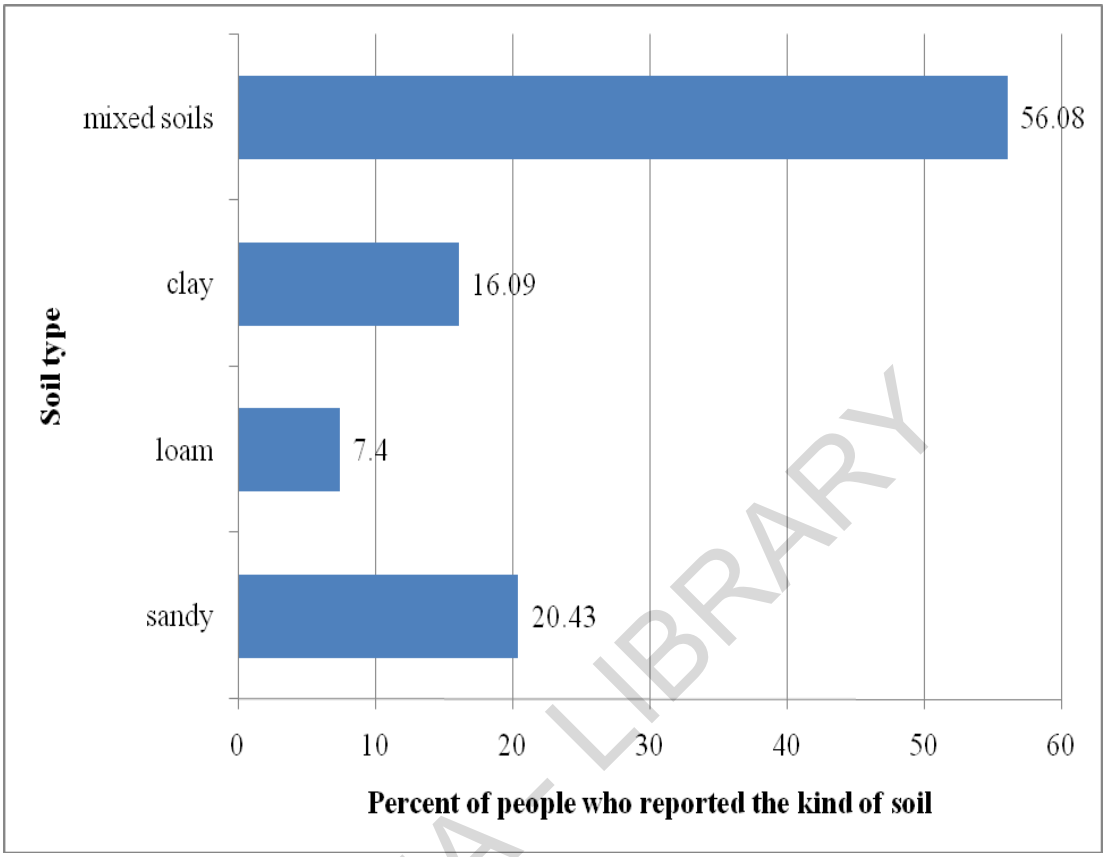

Figure 7: Indigenous knowledge on soil characteristics

Source: Field survey, 2012

In this study and as shown in Figure 6, 129 (56.08%) of the farmers indicated that their farms are rich in sandy, clay and loam soils. 47 (20.43%) of the respondents indicated that their farms are rich in sandy soils, 37 (16.09%) rich in clay soils and 17 (7.4%) said their farms were rich in loam soils.

During Focus Group Discussions, it was revealed that local communities possess a wide range of indigenous knowledge on soil fertility (especially good and bad soil characteristics).

Table 12: Indigenous knowledge on good soils and technical equivalents

Local indicators	Technical equivalents
Black color	High organic matter content
Cracks during dry season	High clay content
Good crop performance	Adequate supply of growth factors
Presence/ vigorous growth of certain plants	Large supply of plant nutrients
Presence of plants in a dry environment	High water holding capacity (WHC)
Low frequency of watering	High infiltration rate and WHC
Abundance of earth worms	High biological activity, high organic matter content and neutral pH.

Source: Field survey, 2012

Table 12 above and Table 13 below show local knowledge indicators of good and bad soils. They also show their technical equivalents.

Table 13: Indigenous knowledge on indicators of bad soil and technical equivalents

Local indicators	Technical equivalents
Yellow and red color	Low soil fertility / low organic matter content
Compacted soils	Presence of cementing materials (Al, Fe2O3 heavy clays) and low biological activity
Stunted growth	Physical, chemical and biological limitation
Appearance of certain bad species of plants	Low fertility
Salt visible on surface	High pH, high osmotic pressure
Presence of rocks and stones	Shallow soils

Source: Field survey, 2012

4.2.1.2 Indigenous knowledge on cropping systems

Respondents were asked to state types of crop systems they practice.

According to Table 14 a majority of the respondents 224 (97.4%) indicated that they practice intercropping and 62 (27.0%) said they practice monocropping.

Intercropping is practiced widely by local communities in Masasi and Nachingwea. In both districts, the dominant intercropped crops are mainly maize + pigeon peas and maize + cassava + pigeon peas as shown in Table 15 below.

Table 14: Indigenous knowledge on cropping systems practiced in the study area N=230

Category	Frequency	Percent
Intercropping	224	97.4
Monocropping	62	27.0

Source: Field survey, 2012

Table 15: Kinds of crops intercropped using indigenous knowledge N=230

Crops intercropped	Frequency	Percent
Maize + pigeon peas	49	21.3
Maize + cassava + pigeon peas	39	17.0
Maize + pigeon peas + groundnuts	5	2.2
Maize + pigeon peas + cashew nuts	4	1.7
Maize + pigeon peas + Sesame	3	1.3
Maize + pigeon peas +,cashew nuts + cowpeas	3	1.3

Source: Field survey, 2012; multiple responses were possible.

As indicated in Table 14 above the mono-cropping system was ranked second in terms of application in farming system by local communities. Respondents were asked to give reasons why they preferred intercropping. In response to this question, 54 (23.5%) indicated that they prefer intercropping due to land shortages, 54 (23.5%) said intercropping, is easy to manage 39 (17.0) attributed it to inadequate labor, 22 (9.6%) said lack of knowledge on other farming methods, 22 (9.6%), said intercropping maximizes production through diversification because when one crop fails other crops may perform better and 16 (7.0%) said in order to conserve soil fertility. Other reasons mentioned for practicing inter-cropping include: inherited culture 21(9.1%), lack of farming tools and lack of income 2 (0.8%) (Figure 7).

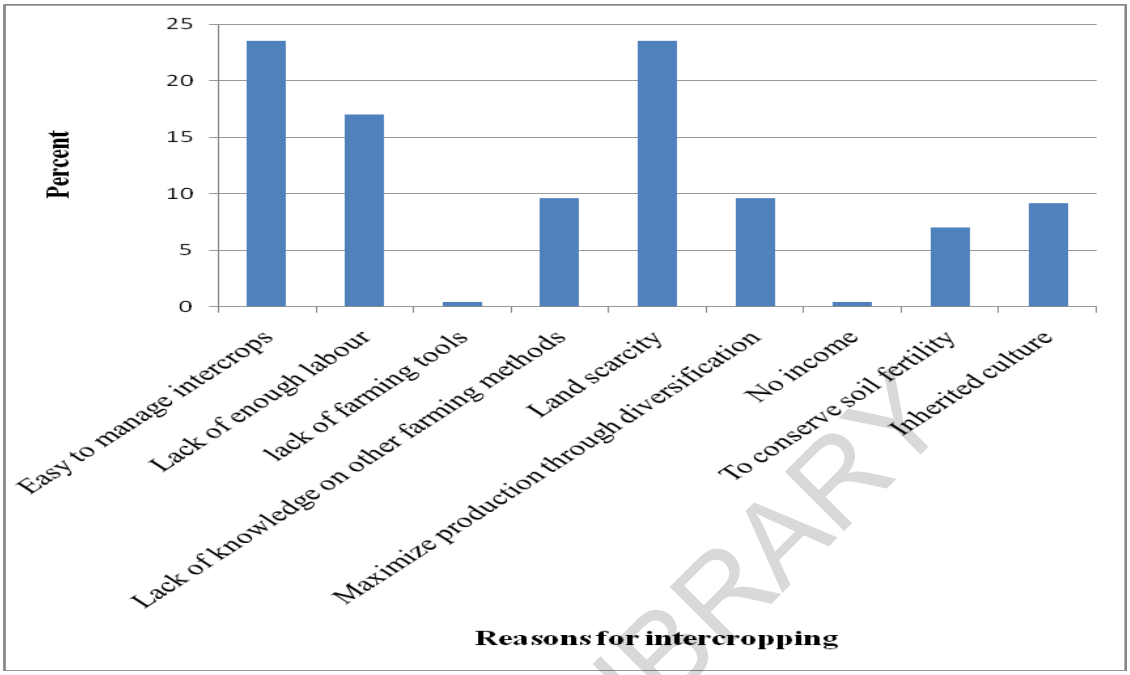

Figure 8: Reasons for intercropping

Source: Field survey, 2012

Respondents were asked to give reasons as to why they prefer mono-cropping. Responses are shown in Table 16 below.

Table 16: Reasons for monocropping N=230

Category	Frequency	Percent
Ability to handle monocropping	1	0.4
Depend on soil type	1	0.4
Does not practice monocropping	156	67.8
Easy weeding	1	0.4
Enough land	6	2.6
Increased harvest due to reduced competition	24	10.4
Is a cultural inheritance	2	0.9
It is hard and takes time to do intercropping	1	0.4
Lack of income	2	0.9
Lack of knowledge	1	0.4
Nature of crops grown	16	7.0
To avoid shade for other crops	18	7.8
To increase soil fertility	1	0.4

Source: Field survey, 2012

Table 16 above shows that 24 (10.4%) cited increased harvest due to reduced competition among plants as a major reason, 18 (7.8%) said to avoid shade for other crops and 16 (7.0%), said nature of crops grown is a major decisive factor.

Respondents were asked to mention crops which are monocropped. Responses are shown in Table 17 below.

Table 17: Kinds of crops grown under monocropping system N=230

Category	Frequency	Percent
Cashew nut	27	11.7
Maize	11	4.8
Pigeon peas	14	6.1
Cassava	7	3.0
Sesame	7	3.0
Paddy	14	6.1
Groundnut	10	4.3
Cow peas	2	0.9
Millet/sorghum	7	3.0
Tomato	2	0.9

Source: Field survey, 2012

4.2.1.3 Indigenous knowledge on land suitability for farming

Respondents were asked to state the criteria they use to select land before cultivation.

Table 18: Criteria used to select a piece of land suitable for planting crops N=230

Criteria	Frequency	Percent
Plots suitability for specific crops	134	58.3
Fertile lands	126	54.8
Type of soil	109	47.4
Water holding capacity	29	12.6
Weather conditions (rain season)	33	14.3

Source: Field survey, 2012

Findings revealed that over half 134 (58.3%) of the respondents use plot suitability for specific crops, 126 (54.8%) look at fertile land and 109 (47.4%) use the type of soil to decide which crops to grow. Only 29 (12.6%) use water holding capacity and 33 (14.3%) look at occurrence of rains as criteria to determine when crops should be planted (Table 18).

4.2.1.4 Indigenous knowledge on preservation of planting materials

Centuries of practical experience have given local farmers a unique decision-making ability and knowledge about conservation and storage of seeds. Methods for preserving seeds in the communities were grouped in the following categories:

- Exogenous techniques: conventional facilities which include use of non-traditional storage facilities such as polythene bags, drums, plastic containers and tins for preserving seeds; conventional inputs include use of synthetic chemicals such as pesticides to prevent, destroy, repel or mitigate pests in the planting materials;
- Indigenous techniques: traditional facilities which include use of facilities that are locally made for preserving seeds such as clay pots, roof tops and granaries located outside or within farmers houses; cultural inputs and practices: these include use of locally available inputs (such as kitchen ash, anthill soil), and cultural practices (such as some crops were left in the soil, and selected cobs are hung over a tree or over a wood cooking stove to ensure smoke penetrates maize cob.

Local communities were asked to mention methods they prefer to store seeds for the next growing season.

Table 19: Methods preferred for storing seeds N=226

Method	Frequency	Percent
Indigenous	132	58.4
Exogenous	94	41.6
Total	226	100.0

Source: Field survey, 2012

Findings as shown in Table 19, revealed that 132 (58.4%) prefer to use indigenous techniques. Only 94 (41.6%) prefer exogenous techniques (Table 16). During Focus Group Discussions and Key Informant Interviews, it was revealed that many households in the study area do not have cash to access improved seeds varieties. Moreover, a few vendors in the villages bring agro-inputs occasionally. Some of the agro-inputs supplied are pesticides and packaging materials (polythene bags).

When asked to mention methods they use to store maize, pigeon peas and cassava seeds, the farmers mentioned a wide variety of methods used as shown in Table 20 below.

Table 20: Methods used to store maize and pigeon peas after harvesting N=230

Crop	Methods of storage (%)								
	Hung on racks outside the house	**Hung over smoke in the kitchen**	**Store in a granary outside the house**	**In polythene bags**	**Store in plolythene bags and mix with insecticide**	**On the rooftops**	**Left to dry in field**	**Mixed with ash in polythene bags**	**Pat in day pot**
Maize	6.1	8.3	19.1	36.1	11.3	0.4	0.4	1.3	3
Pigeon peas	0	3	0	40.4	7.4	0	0	2.2	2.2

-

While conventional inputs are important for preserving seeds in the surveyed regions, findings of this study further revealed that farmers have extensive knowledge on cultural practices and traditional facilities which are used for preserving seeds.

The methods used to preserve each crop vary. For example 112 (48.7%) of the respondents indicated that they store maize seeds in polythene bags, 19 (8.3%) said they store seeds in granary outside the house. Other methods include drying crops on roof tops, storing seeds in clay pots, plastic containers and hanging them on wooden racks outside the house (Table 20). 115 (50%) said they store pigeon peas in polythene bags , drums, plastic containers, clay pots or simply hang seeds over smoke (Table 20, Plate 1 and 2).

Plate 1: Maize storage on racks outside the house after harvesting

Plate 2: Maize hung over smoke as a method of storage after harvesting

Respondents were asked to mention methods they use to store cassava cuttings. Responses are shown in Table 21 below.

Table 21: Methods used to store cassava cuttings

Method	Frequency	Percent
In wet polythene bags	37	16.1
Left in soil in farm	57	24.8
Do not store	136	59.1
Total	230	100.0

Source: Field survey, 2012

Table 21 shows that 57 (24.1%) of the farmers leave some of the cassava plants in the field for planting during the subsequent planting season. 37 (16.1%) said they store cassava cuttings in polythene bags which they water occasionally until they are ready for planting (Table 21). The storage method for storing cassava is unique because of the nature of the plant.

4.2.1.5 Indigenous knowledge on methods of crop planting

Respondents were asked to indicate Indigenous Knowledge on methods of crop planting. **R**esults are indicated in Table 22 below.

Table 22: Planting/sowing patterns for three major crops in the study area N=230

Crop	Planting/sowing pattern					
	Use of ridges		Rows without proper spacing		Random	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Maize	43	18.7	142	61.7	45	19.5
Pigeon peas	29	12.6	115	50.0	32	13.9
Cassava	17	7.4	80	34.7	26	11.3

Source: Field survey, 2012

Interviews with maize, pigeon peas and cassava growers revealed three major crop planting/sowing methods. For example in this study 43 (18.7%) said they plant maize using ridges, and 29 (12.6%) they plant pigeon peas on ridges. However, 142 (61.7 %) plant maize on rows but with no proper spacing and 115 (50%) also plant pigeon peas on rows with no proper spacing. However, 45 (19.5) plant maize randomly and 32 (13.9) plant pigeon peas randomly. Similarly, 17 (7.4%),use ridges to plant cassava and 80 (34.7%) plant cassava in rows without proper spacing while 26 (11.3%) plant cassava randomly. The use of rows on flat land without proper spacing, random method and use of ridges are the methods used to plant crops but overall, most farmers prefer rows followed by random planting/sowing and use of ridges.

4.2.1.6 Indigenous knowledge on crop preservation after harvesting

Farmers were asked to state methods they use to preserve crops after harvesting as shown in Figure 8 below.

Figure 9: Crop preservation after harvesting

Source: Field survey, 2012

Respondents mentioned a wide range of both conventional and indigenous crop preservation methods. For example, 160 (69.6) of the respondents mentioned polythene bags, 97 (42.2%) mentioned hanging over the kitchen hearth, 87 (37.8%) mentioned granary outside the house, 81 (35.2%) said granary inside the house, 55 (23.9%) said they hang crops on trees, 54 (23.5%) said they use plastic containers, 49 (21.3%) use synthetic pesticides and 11 (4.8%) said they add ash to seeds. Only 1 (0.4% farmer said they mix crops with mud 1 (0.4%).

4.2.1.7 Indigenous knowledge on plant pests, diseases, predators and their control

Respondents were asked to indicate methods they use to diagnose and control plant diseases and pests. Responses are shown in Table 23 below.

The findings revealed that farmers have a broad base of knowledge on the diagnosis of plant diseases. Many farmers identified plant diseases/pest using symptoms rather than the name of the diseases/pests. As shown in Table 23 for each crop the symptoms varied. For maize 110 (48.8%), pigeon peas 79 (34.3%), cassava 55 (23.9%) and cashew 71 (30.8%) farmers used symptoms to identify crop diseases. For example, when cross checked with key informants (extension staffs), it was revealed that the powdery substance mentioned for cashew disease is powdery mildew (a fungal disease that attacks cashew trees). Similarly, the powdery substance identified for pigeon peas is powdery mildew. What this implies is that farmers use indigenous knowledge and experience to identify crop diseases/pests.

Table 23: Indigenous knowledge on crop diseases and pest symptoms N=230

Crop	Symptom	Frequency	Percent
Maize			
	Bored stems/leaves	28	12.2
	Withering	50	21.7
	Yellowing	13	6.3
	Maize streaks	4	2.0
	Fungal attack	9	4.0
	Empty cobs, bored leaves, brown leaves	6	2.6
	Do not know the symptoms	120	52.2
Pigeon peas			
	Withering	35	15.7
	Powdery substance	5	2.1
	Stunting	3	1.3
	Yellowing	2	0.9
	Dry leaves, empty pods, flower fall	34	14.3
	Do not know the symptoms	151	65.7
Cassava			
	Root rot	23	10.0
	Bored roots	11	4.8
	Cassava mosaic	5	2.2
	Powdery substance	6	2.6
	Withering	8	3.5
	Wilting	1	0.4
	Brown stem and leaves	1	0.4
	Do not know the symptoms	175	76.1
Cashew nut			
	Powdery substance	39	17.0
	Withering	20	8.7
	Bored leaves	7	3.0
	Yellowing	4	1.7
	Rotting	1	0.4
	Do not know the symptoms	154	67.0

Source: Field survey, 2012

In terms of diseases/pests control, and as shown in Table 24 below findings revealed that farmers use chemical inputs to control plant diseases/pests. In this study, 84 (36.6%) of the respondents said they use synthetic pesticides and 146 (63.4%) did not indicate any method. Wild animals invading farms are controlled mainly using cultural methods as listed in Table 24 below. Many farmers do not use any measures to control plant diseases/pest probably due to lack of access to knowledge and inputs for diseases/pest control.

Table 24: Control of diseases, pests and wild animals N=230

Element	Control method	Frequency	Percent
Diseases/pests			
	Use of synthetic pesticides	84	36.6
	No control measure	146	63.4
Wild animals (predators)			
	Use of traps	19	8.3
	Use of poisons	30	10.9
	Use of poisons and traps	27	13.1
	Use of scarecrow sculptures	8	11.3
	Hunting	9	3.9
	Early crop planting	2	0.9
	Hunting, scaring, patrols and fire	23	10.7
	No control measure	112	48.7

Source: Field survey, 2012

4.2.1.8 Indigenous knowledge on agro-biodiversity management around community surroundings

Respondents were asked to state the methods they use to protect their surroundings.

Table 25: IK used to protect agro-biodiversity surrounding local communities N=230

Method	Frequency	Percent
Uses fire to control pests	40	17.4
Uses fallow to allow plant regeneration	22	9.6
Makes buffer zones in the general land	20	8.7
Observes village bylaws for use of wild surroundings	10	4.3
Makes patrols to protect wild surroundings	25	10.9

Source: Field survey, 2012

Findings as shown in Table 25 above revealed that 40 (17.4%) use fire and 25 (10.9%) said they patrol the surrounding areas. Other methods they use include fallow to allow plant regeneration, buffer zones to demarcate areas allowed for public use and protected areas and observation of village bylaws in land usage.

4.3 How Local Communities Access and Share Indigenous Knowledge on Agro-Biodiversity

The second objective of this study was to determine how local communities' access and share indigenous knowledge related to agro-biodiversity. This section presents study findings obtained in relation to KM processes. These KM processes include: knowledge acquisition (access), sharing, preservation and application of indigenous knowledge for agro-biodiversity management.

4.3.1 Access to indigenous agrobiodiversity knowledge

4.3.1.1 Sources of indigenous agro-biodiversity knowledge

The respondents were asked to mention sources of indigenous knowledge (IK) they use for management of agro-biodiversity, frequency of accessing that knowledge and type of IK obtained from the sources of knowledge. This was a multiple response question. Responses are shown in Table 26 below.

Table 26: Sources of indigenous agro-biodiversity knowledge

Source	Frequency	Percent
Personal experience	205	89.1
Parents/ guardian/family	202	87.8
Neighbors/Friends/relatives	131	57.0
Women meetings	5	2.2
Wild product gathering	2	0.9
Demonstration and observation	10	4.3
Magazines	1	0.4
Newsletters	1	0.4
Posters	0	0.0
Church/mosque	9	3.9
Social group gatherings	55	23.9
Village leaders	30	13.0
Farmers' groups	19	8.3
Village meetings	31	13.5
Newspapers	2	0.9
Books	2	0.9
Conference/workshops/seminars	4	1.7
Agricultural shows	2	0.9

Source: Field survey, 2012; multiple responses were possible

Primary sources of agricultural IK are predominantly tacit and local and personal experience. In this study and as shown in Table 26, 205 (89.1%) of the respondents indicated that personal experience, 202 (87.8%) parents, guardians and family are their key sources of information,131 (57.0%) mentioned neighbors, friends and relatives, 55 (23.9.5%) mentioned social group gatherings, 31 (13.5%) said village meetings, 30 (13.0%) said village leaders and 19 (8.3%) said farmers groups.

4.4 Frequency of Accessing Indigenous agro Biodiversity Knowledge

For each of IK source, the respondents were asked to indicate how often they access IK from tacit and explicit sources of knowledge. The responses depict again the predominance of the parents/guardian/family, neighbor/friends, social groups and village meetings as primary sources of IK they most frequently consulted as shown in Table 27.

The findings revealed that 69.6% said parent/guardian/family, 40.0% said neighbors/ friends, 30.4% said social gatherings, and 10.4% said village meetings. Farmers rarely use printed materials, and rarely attend conferences, seminars or workshops.

Table 27: Frequency of access to Tacit and Explicit indigenous knowledge on agro-biodiversity

Category	Frequency of access (%)				
	Very often	Often	Sometimes	Rarely	Very Rarely
Parent/guardian/family (N=222)	69.6	19.1	1.3	0.9	5.9
Neighbors/Friends (N=186)	40.0	26.1	2.6	2.7	12.4
Social group gatherings (N=162)	30.4	20.0	3.9	3.7	19.1
Religious leader (N=95)	7.0	8.3	3.5	3.2	51.6
Women meetings (N=78)	7.0	3.9	3.5	2.6	55.1
Farmers' groups (N=87)	8.7	4.8	2.6	4.6	52.9
Herding livestock (N=70)	4.8	2.6	1.7	1.4	68.6
Village meetings (N=117)	10.4	5.2	4.3	3.4	57.3
Agricultural shows (N=66)	2.2	1.3	0.9	4.5	80.3
Newspapers (N=59)	1.3	0.4	0.9	3.4	86.4
Magazines (N=55)	1.3	0.4	0.9	3.6	89.1
Books (N=56)	2.2	0.4	0.9	3.6	85.7
Newsletters (N=45)	0.4	0.4	0.4	0.0	93.3
Conference/workshop/seminars (N=44)	0.4	0.4	0.0	0.0	95.5
Posters (N=45)	0.4	0.4	0.4	2.0	91.8

Source: Field survey, 2012; multiple responses were used

4.4.1 Types of indigenous agro-biodiversity knowledge obtained from different sources

Respondents were asked to indicate types of agro-biodiversity knowledge they frequently seek from tacit and explicit sources of knowledge. Responses are shown in Table 28 below.

Table 28: Indigenous agro-biodiversity knowledge sources N=230

Kind of IK	Indigenous agro-biodiversity knowledge source											
	Parents		Experience		Ancestors		Friends		Parents/friends/relatives		Mass media/farmer groups/Input shops/meetings	
	F	%	F	%	F	%	F	%	F	%	F	%
New crop varieties	31	24.80	29	23.20	29	24.80	14	11.20	8	6.40	14	11.20
Crop planting	33	23.91	57	41.30	3	2.20	30	21.74	6	4.35	9	6.52
crop harvesting, processing, storage	37	27.82	55	41.35	2	1.50	17	12.78	15	11.28	7	5.26
Crop diseases/pests	29	19.73	44	29.93	2	1.36	7	4.76	43	29.25	22	14.95
Utilization of Non Timber Forest Products	38	28.79	49	37.12	2	1.52	16	12.12	16	12.12	11	8.33
Soil fertility improvement	34	24.28	48	34.29	2	1.43	20	14.29	24	17.14	12	8.60

As shown in Table 28 above, findings revealed that a majority of the respondents 111 (90.4%), acquire knowledge on new crop varieties, 129 (93.5%) said methods of crop planting, 126 (94.73%) said harvesting, processing, storage, 121 (91.67%) said utilization of non timber forest products, 125 (85.03% said crop diseases and pests and 128 (91.43%) mentioned soil fertility improvement from mainly tacit sources of knowledge.

It is apparent from the findings that communities lack reliable sources of exogenous knowledge. There is therefore a need to integrate IK into exogenous knowledge to strengthen the local knowledge system.

Further analysis was done to find out how respondents acquire knowledge on wild food plants, specifically, preservation of edible wild plants, processing of edible wild plants, use of edible wild plants and knowledge on seasons where these are available.

Table 29: Means of acquisition of indigenous knowledge on edible wild food

plants among the surveyed communities N=230

Kind of IK	Means of acquisition							
	Accompany relatives during harvesting seasons		Training by elders		Direct observation		Initiation rites during adolescent	
	F	%	F	%	F	%	F	%
Preservation of edible wild plants	91	50.30	29	16.10	30	16.70	31	17.10
Processing of edible wild plants	89	49.40	29	16.10	30	16.70	32	17.80
Uses of edible wild plants	96	49.40	23	12.80	30	16.70	31	17.20
Seasons of availability of edible wild plants	146	67.30	48	22.10	20	9.30	3	1.40

Source: Field survey, 2012; Key: F = Frequency

Findings as shown in Table 29 above show that 91 (50.3%) said they acquire knowledge on preservation of edible wild plants, 96 (49.40% use of edible wild plants, 89 (49.4% processing of edible wild plants and 146 (67.3%) seasons of availability of edible wild plants when they accompany relatives during harvesting seasons.

Indigenous knowledge trained by elders were: preservation of edible wild plants 29 (16.10%), processing of edible wild plants 29 (16.10%), use of edible wild plants 23 (12.80%), and seasons of availability of edible wild plants 48 (22.10%). Indigenous knowledge gained through direct observation were: preservation of edible wild plants 30 (16.70%), processing of edible wild plants 30 (16.70%), use of edible wild plants 30 (16.70%), and seasons of availability of edible wild plants 20 (9.30%). Indigenous knowledge gained through initiation rites were: preservation of edible wild plants 31 (17.10%), processing of edible wild plants 32 (17.80%), use of edible wild plants 31 (17.20%), and seasons of availability of edible wild plants 20 (3.40%).

4.4.2 The integration of agro-biodiversity exogenous and indigenous knowledge

The respondents were asked to indicate if they are satisfied with the agricultural IK that exists in their communities, their willingness to share IK for agricultural development purpose, and if rural knowledge providers identified their agricultural IK. The respondents were also asked to indicate to what extent the knowledge providers involve them in the identification of IK when developing and disseminating agro-biodiversity technologies and methods used to identify knowledge.

Table 30: Identification and integration of exogenous knowledge and indigenous agro-biodiversity knowledge: data from local communities

Inquiry (N=228)	**F**	**%**	**Example of integration (N=21)**	**F**	**%**
Inquired on IK	33	14.50	Participatory sowing/planting	11	53.38
Methods of inquiry (N=26)			Design of intercropping	4	19.05
Interviews during field and household surveys	21	80.77	Looking soil quality in the farm	2	9.52
Interviews during meetings	5	19.23	Advise on pest control and planting	1	4.76
Integration with exogenous knowledge (N=228)			Participatory design of savings/credit associations (vicoba)	1	4.76
Information providers integrate IK	24	10.50	Operation of cassava processing machine	1	4.76
Meet farming requirements (N=230)			Training on proper weeding and spraying	1	4.76
IK met farming requirements	151	65.70			
Willing to share IK with development partners (N=230)	185	80.40			

Source: Field survey, 2012

Findings as shown in Table 30, revealed that 33 (14.50%) of the respondents indicated they were involved in the identification of IK when developing and disseminating agro-biodiversity technologies. The same respondents were asked to

provide details on the methods of inquiry on their agro-biodiversity indigenous knowledge. Twenty one (80.77%) respondents stated that information providers inquire about IK information during field and household surveys, 5 (19.23%) said during meetings.

Based on these findings it would appear that only a few farmers are involved in participatory research activities in the surveyed communities and knowledge is mainly created within the social paradigm more than in the scientific paradigm in the surveyed communities. The study sought to establish whether the knowledge intermediaries managed indigenous agro biodiversity in the communities. The respondents were asked to indicate methods used for acquiring, preserving, and disseminating indigenous agro biodiversity knowledge in the communities. Results are presented in Table 31 below.

All the respondents 4 (100%) were aware that farmers possessed indigenous agro biodiversity knowledge. When asked to specify if they had collected indigenous agro biodiversity knowledge in the local communities, most of the respondents 3 (75%) had collected IK in the local communities, while 1 (25%) had not. An inquiry about the methods used to capture indigenous agro biodiversity knowledge in the communities showed that most of the respondents used personal visits 3 (75%), farmer groups 2 (50%) and demonstration plots 2 (50%).

The knowledge intermediaries who reported accessing IK in the local communities were asked to indicate the purpose of collecting IK in the communities. All of them 4 (100%) identified extension services as their major purpose for collecting IK. Other purposes

were interest in managing IK 2 (50%), research activities 4 (100%), marketing agricultural inputs 3 (75%), and to raise the profile of IK 3 (75%).

Table 31: Management of indigenous agro-biodiversity knowledge: data from indigenous knowledge intermediaries (extension staff and forest officers) N=4

Awareness on possession of IK	Frequency	Percent
Aware	4	100
Collection of IK from local communities	3	75
Method used to capture IK		
Personal visits	3	75
Farmer groups	2	50
Demonstration plots	2	50
Purpose for collecting IK		
Extension services	4	100
Interest in managing IK	2	50
Research activities	4	100
Marketing agricultural inputs	3	75
Raising the profile of IK	3	75
Preservation of IK		
Written notes	4	100
Newsletters	1	25
Leaflets	1	25
Books	1	25
Methods of dissemination		
Personal visits	4	100
Training	4	100
Village notice boards	4	100

Source: Field survey, 2012

Four (100%) respondents used written notes to preserve IK, followed by newsletters 1 (25%), leaflets 1 (25%), and books 1 (25%). When asked to indicate strategies for disseminating indigenous agro biodiversity knowledge in the communities, the majority of the respondents used personal visits 4 (100%), training 4 (100%) and village notice boards.

4.4.3 The need to integrate agricultural exogenous and indigenous knowledge in the local community

The respondents were asked if the existing agricultural IK in the local community is sufficient to meet their farming requirements. In response to this question, 151

(65.7%) of the respondents reported that IK is sufficient for solving farming problems (Table 30), 57 (24.8%) were not satisfied with existing IK in their communities, and 22 (9.6%) respondents did not have any opinion. Farmers who indicated that IK is not sufficient to solve their farming activities gave the following reasons which are arranged in descending order of importance:

- Low agricultural production: The respondents reported that they experienced low agricultural production due to the use of IK. Thus, farmers suggested a need to have access to external knowledge in order to improve their knowledge base and agricultural productivity;
- Unreliable weather especially rainfall. They stated that local landraces do not perform well when rains come late and or diminish earlier in the season;
- Lack of extension services to train farmers on how to integrate exogenous knowledge and technologies with indigenous knowledge and technologies.

Hence their IK remained ineffective in solving some problems such as animal and plant diseases, soil fertility decline, marketing information, and sources of credits.

When asked to state their opinions on usefulness of IK in the management of agro-biodiversity, 212 (95.0%) said Indigenous knowledge is useful and only 11 (5.0%) said it is not useful (Table 32 below).

Table 32 Usefulness of indigenous knowledge in management of agro-biodiversity

Perception	Frequency	Percent
Very useful	73	32.7
Useful	89	39.9
Somehow useful	50	22.4
Not useful	11	4.9
Total	223	100.0

Source: Field survey, 2012

4.4.2 Sharing and distribution of agro-biodiversity indigenous knowledge

The respondents were asked to provide details on major methods for sharing IK in their communities, including folklore, farmers' groups and initiation rites. The following methods were mentioned:

4.4.2.1 Folklore practices

Respondents were asked to describe types of folklore performed in their communities, occasions on which the folklore were performed and the purpose of performing those aspects of folklore.

Table 33: Types of folklore practiced in the study area N=230

Folklore	Frequency	Percent
Drama	52	22.6
Songs	85	37.0
Plays	51	22.2
Poetry	12	5.2
Puppet shows	4	1.7
Story telling	57	24.8
Festivals	56	24.3
Debates	50	21.7
Dances	84	36.5

Source: Field survey, 2012; multiple responses were possible

According to Table 33, 85 (37.0%) of the respondents said songs are major forms of folklore practiced across the districts, followed by 84 (36.5%) who mentioned dance, 57 (24.8%) who said storytelling, 56 (24.3%) mentioned festivals, 52 (22.6%) said drama, 51 (22.2%) said plays and 50 (21.7%) said debates. Less frequently practiced folklores were poetry and puppet shows.

4.4.2.1.2 The occasion of folklore activities

Table 34: Time for folklore activities N=230

Time	Frequency	Percent
December	1	.4
During dry seasons (June-July)	78	33.9
During farming season	3	1.3
During festivals	1	.4
During wedding ceremonies	1	.4
None	146	63.5
Total	230	100.0

Source: Field survey, 2012

When asked to state the time of the year when most folklore activities are performed, 78 (33.9%) of the respondents indicated that folklore activities take place during dry seasons (June-July). Further probing with village leaders, revealed that such practices go as far as October before the onset of rains and the period between June and October is the harvest season. During this time families encourage invited guests to attend folklore celebrations. Folklore activities are also performed during farming seasons and at wedding ceremonies.

4.4.2.1.3 Purposes of folklore

Table 35: Key messages portrayed in folklores

Key message	Frequency	Percent
Cultural norms	40	17.4
Educate people	1	0.4
Entertainment	6	2.6
Farming related messages	29	12.6
For motivation	1	0.4
HIV/AIDS	1	0.4
How to behave during adulthood	14	6.1
Increase income	5	2.2
Marriage related messages	2	0.9
None	128	55.7
Telling the past	3	1.3
Total	230	100.0

Source: Field survey, 2012

Findings of this study as shown in Table 35, show that 40 (17.4%) of the respondents indicated that key messages depicted in folklore are cultural norms, 29 (12.6%) said farming related messages and 14 (6.1%) said how to behave during adulthood. Others mentioned education, entertainment, motivation, HIV/AIDS, income and historic issues.

4.4.2.2 Farmer's groups

The study sought to establish whether farmer groups share IK in the communities. The respondents were asked to indicate if they belonged to any farmer groups, the type of farmer groups they belonged to, how often they hold farmer group meetings and where they hold such meetings. Results are shown in Table 36 below.

Table 36: Number of people in farmer groups and objectives of farmer groups

Item	F	%	Item	F	%
Group membership (N=230)			**Objective of groups (N=51)**		
Member of farmer group	59	25.70	Savings and credit	25	49.10
Kind of group (N=230)			Improved crop farming	12	23.53
Formal	47	20.40	Improved livestock keeping	6	11.76
Informal	12	5.22	Others: marketing and empowerment	8	15.70
Meeting place (N=54)					
Chairperson's house	25	46.30			
Village office	21	38.90			
Other places	8	14.81			

Source: Field survey, 2012

The study findings as shown in Table 36 show that only 59 (25.70%) of the respondents belong to association in their communities and 171 (74.3%) do not belong to any association. Respondents were also asked to indicate if their associations are formal or informal. In response to this question, 47 (20.40%) indicated that they belong to formal associations and 12 (5.22%) said they belong to informal associations.

Associations are created for a variety of reasons. For example and as shown in Table 36, 25 (49.10%) of the respondents said they joined associations in order to improve their savings and access to credit, 12 (23.53%) said to improve crop farming, 6 (11.76%) to improve livestock keeping and 8 (15.70%) mentioned variety of reasons including improved access to markets and for women empowerment. Members of these associations meet often once a week in the village government building.

4.4.2.3 Initiation rites

The respondents were asked to indicate indigenous agro-biodiversity knowledge children acquire during initiation rites.

Table 37: Initiation rites during adolescent age N=115

Initiation rite	Frequency	Percent
Crop production	41	35.7
Animal husbandry	1	0.9
Crop production/animal husbandry	10	8.7
Both crop production and animal husbandry	63	54.8
Total	115	100.0

Source: Field survey, 2012

Table 37 shows that 63 (54.8%) of the respondents indicated that children acquire over half of both crop and animal husbandry IK during their adolescence. Forty (35.7%) said children acquire crop production agro-biodiversity related IK during initiation rites, and 10 (8.7%) said they acquire both crop production/animal husbandry agro-biodiversity IK.

4.4.3 The preservation of indigenous agro-biodiversity knowledge

Respondents were asked if they preserve indigenous agro-biodiversity knowledge and if they do, how do they preserve indigenous agro-biodiversity knowledge. In response to this question, only 58 (25.7%) of the respondents indicated that they do and the majority 149 (65.9%) said they do not.

Table 38: Methods used to preserve indigenous agro-biodiversity knowledge N=230

Method of preservation	Frequency	Percent
Writing	9	10.2
Carving	1	1.1
Folklore	9	10.3
Painting	0	0.0
Do not know	149	65.9

Source: Field survey, 2012

Table 38 show that 9 (10.2%) of the respondents indicated that they preserve indigenous agro-biodiversity knowledge in written form and 9 (10.3%) said they preserve indigenous agro-biodiversity knowledge through folklore. Only 1 (1.1%) said to preserve it on carvings including locally made traps to control plant pests, utensils, toys, ornaments, and drawings on clay pots, hand mills and pestles.

Table 39: Indigenous agro-biodiversity knowledge record keepers

Category	Frequency	Percent
Does not know	161	70.0
Individuals memory	55	23.9
VEO	14	6.1
Total	230	100.0

Source: Field survey, 2012

When asked who keeps records of indigenous agro-biodiversity knowledge keepers 55 (23.9%) of the respondents said individuals, and 14 (6.1%) said village executive officers (VEO) and a majority 161 (70%) said they do not know (Table 39).

4.4.4 Problems constraining indigenous agro-biodiversity knowledge management activities in surveyed areas

The third study objective sought to determine barriers constraining access to and use of indigenous knowledge among local communities**.** The respondents were asked to indicate challenges constraining acquisition, sharing and preservation of indigenous agro-biodiversity knowledge in the local communities. Responses are shown in Table 40 below.

4.4.4.1 Factors constraining acquisition of indigenous agro-biodiversity knowledge

According to Table 40, 172 (76.8%), of the respondents mentioned weak knowledge sharing as factor constraining acquisition of indigenous agro-biodiversity knowledge, 134 (59.8%) mentioned lack of information materials, 134 (59.8%) said lack of a nearby library and 113 (50.4%) said none recognition of IK in surveyed communities.

Table 40 further shows that 87 (38.8%), of the respondents were of the opinion that lack of trust is a major problem deterring proper acquisition of IK related agro-biodiversity, 75 (33.6%) said social status and 67 (29.9%) mentioned lack of appropriate IPR to govern IK.

Interviews of key informants in the villages showed that, 4 (25.0%), of the respondents mentioned poor knowledge sharing as factor constraining acquisition of indigenous agro-biodiversity knowledge, 3 (18.8%) mentioned lack of farmer's trust, 3 (18.8%) said lack of training to manage IK, 2 (12.5%) mentioned social status in local communities and 2 (12.5%) said lack of appropriate IPR.

Table 40: Problems encountered during management of indigenous agro-biodiversity: data from local communities N=230

	Indigenous agro-biodiversity knowledge management					
	Acquisition		Sharing		Preservation	
Category	Frequency	Percent	Frequency	Percent	Frequency	Percent
Weak knowledge sharing culture	172	76.8	153	68.3	91	40.6
Lack of trust	87	38.8	66	29.6	55	24.7
Social status	75	33.6	67	30.2	66	27.5
None recognition of IK	113	50.4	90	40.4	83	37.2
Lack of information materials (records) on IK	134	59.8	117	52.5	95	42.6
Lack of nearby library	134	59.8	81	36.3	77	34.5
Lack of appropriate IPR to govern IK	67	29.9	50	22.4	55	24.7

Source: Field survey, 2012

Table 41: Problems encountered during management of indigenous agro-biodiversity: data from key informants N=16

Category	Indigenous agro-biodiversity knowledge management

	Acquisition		Sharing		Preservation	
	Frequency	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Poor knowledge sharing culture	4	25.0	3	18.8	2	12.5
Lack of farmer's trust	3	18.8	5	31.3	4	25.0
Social status in local communities	2	12.5	1	6.3	2	12.5
Lack of appropriate IPR to govern IK	2	12.5	2	12.5	3	18.8
Lack of specific IK policy	2	12.5	1	6.3	1	6.3
Lack of training to manage IK	3	18.8	4	25.0	4	25.0

Source: Field survey, 2012

Table 41 further shows that 2 (12.5%), of the respondents were of the opinion that lack of specific policy is a major problem deterring proper acquisition of IK related agro-biodiversity.

4.4.4.2 Factors constraining the sharing of indigenous agro-biodiversity knowledge

According to the findings of this study, and as shown in Table 40, 153 (68.3%) of the respondents attributed factors constraining the sharing of indigenous agro-biodiversity knowledge to a weak knowledge sharing culture, 117 (52.5%) said lack of information materials on IK, 81 (36.3%) said lack of a nearby library and IK and 90 (40.4%) said lack of recognition of IK by government, 67 (30.2%) said social status , while 66 (29.6%) said lack of trust, and 50 (22.4%) attributed it to lack of appropriate IPR to govern IK.

Interviews with key informants also identified problems in sharing of indigenous agro-biodiversity knowledge. According to the findings of this study, and as shown in Table 41, 5 (31.3%) of the respondents attributed factors constraining the sharing of indigenous agro-biodiversity knowledge to lack of farmer's trust, 4 (25.0%) said lack of training to manage IK, 3 (18.8%) said poor knowledge sharing culture, 2 (12.5%) said lack of appropriate IPR, 1 (6.3%) said social status in local communities, while 1 (6.3%) said lack of specific IK policy.

4.4.4.3 Factors constraining preservation of indigenous agro-biodiversity knowledge

Table 40 shows that 91 (40.6%), of the respondents were of the opinion that lack of a knowledge sharing culture undermines preservation of agro-biodiversity knowledge, 95 (42.6%), attributed this to lack of information materials on IK, 83 (37.2%) mentioned none recognition of IK as a factor while 77 (34.5%) attributed it to lack of libraries in the study areas. Similarly, 61 (27.5%) attributed it to social status, 55 (24.7%) attributed it to lack of trust and other 55 (24.7%) mentioned lack of IPR governing IK.

Further interviews with key informants as indicated in Table 41 shows that 4 (25.0%), of the respondents were of the opinion that lack of farmer's trust undermines preservation of agro-biodiversity knowledge, 4 (25.0%), attributed this to lack of training to manage IK, 3 (18.8%) attributed it to lack of IPR to govern IK, 2 (12.5%) mentioned poor knowledge sharing culture as a factor while 2 (12.5%) attributed it to social status in the study areas. Moreover, 1 (6.3%) attributed it to lack of specific IK policy.

4.5 Contribution of Indigenous Agro-biodiversity Knowledge Management Practices to Livelihoods of Local Communities and Opinions on Preservation of IK

The fourth objective of the study was to assess the extent to which use of indigenous knowledge on agro-biodiversity management contributes to livelihoods of local communities.

4.5.1 Contribution of Indigenous knowledge to livelihoods

When asked to why they practice crop and tree cultivation in the same field, and as shown in Table 42 below, 226 (98.3%) said they do so in order to ensure food availability at house hold level followed by 212 (92.2%) who said to generate income 101 (44.3%) said in order to improve soil fertility through soil conditioning, 60 (26.1%) said this methods provides manure for the fields. Others also indicated that the trees are a source of fuel energy, and veterinary medicine and human medicines. They also said for ornaments and because trees also demarcate boundaries between fields. The trees are mostly fruit trees such as mango and guava which serve as sources of food and income.

Table 42: Purposes of crop and tree farming N=230

Crop/tree benefit	Frequency	Percent
Food	226	98.3
Fuel	13	5.7
Income	212	92.2
Veterinary medicine	2	0.9
Human medicine	3	1.3
Ornaments	5	2.2
Soil conditioner in farms	101	44.3
Manure in farms	60	26.1

Source: Field survey, 2012

Respondents were asked to state the linkages between the crops they grow and trees (cultivated and uncultivated tree species left in farms). As shown in Table 43 below, 123 (58.6%) of the respondents said trees serve as wind breakers for crops, 34 (16.1%) said trees supply natural manure for crops, 33 (15.6%) said trees support crops and 18 (8.5%) indicated that crop residuals act as mulch for the trees).

In terms of income, the crops and NTFPs contributed annually the following amounts (Tshs.) as shown in Figure 9.

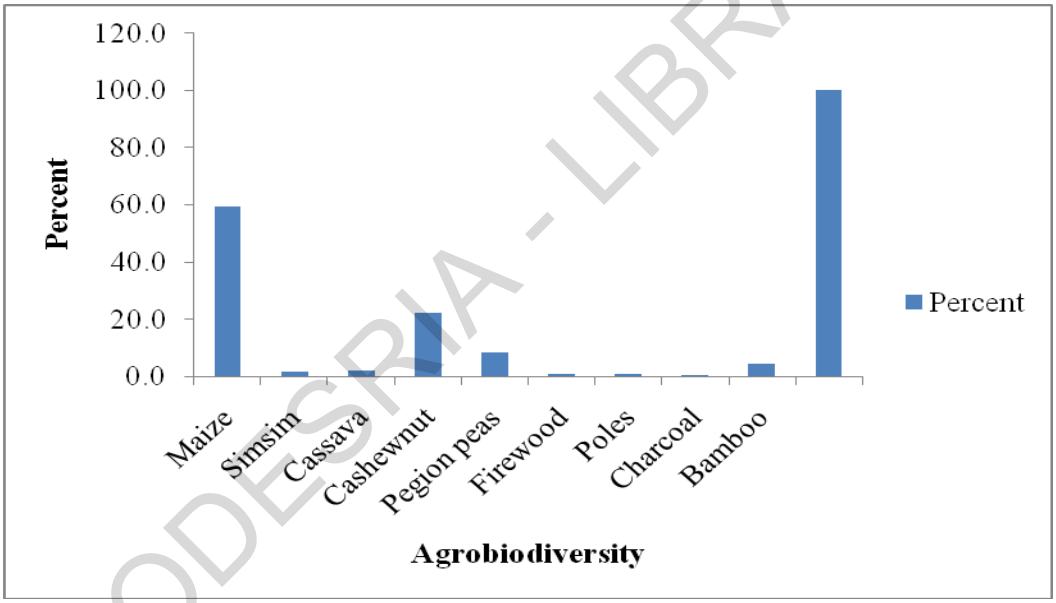

Figure 10: Income contribution from main crops and NTFPs in the study areas
Source: Field survey, 2012

As shown in Figure 9, maize contributed annually Tshs. 929,233.00 (64%), cashew nut Tshs. 345,337.00 (24%), pigeon peas Tshs. 129,752.00 (9%), cassava Tshs. 31,297.00 (2.1%), simsim Tshs. 26,069.00 (1.8%), firewood Tshs. 14,644.00 (0.9%), poles Tshs. 10,487.00 (0.7%), charcoal Tshs. 5,413.00 (0.3%) and bamboo Tshs. 70,200.00 (4.5%) to household income.

Table 43: Linkage between crops and trees in local community farms N=230

Linkage	Frequency	Percent
Crop residual are mulch for trees	18	8.5
Trees act as wind breakers for crops	123	58.6
Tree leaves are manure for crops	34	16.1
Trees as support for crops	33	15.6

Source: Field survey, 2012

4.5.2 Indigenous knowledge's contribution to biodiversity surrounding areas

Communities in the two districts surveyed use indigenous knowledge to extract a variety of non timber forest products (NTFPs) throughout the year for their daily subsistence and income generation. These products are collected from the general land forests, farmlands and woodlands. Non timber forest products NTFPs extracted by respondents in Nachingwea and Masasi districts are shown in Figure 10 below.

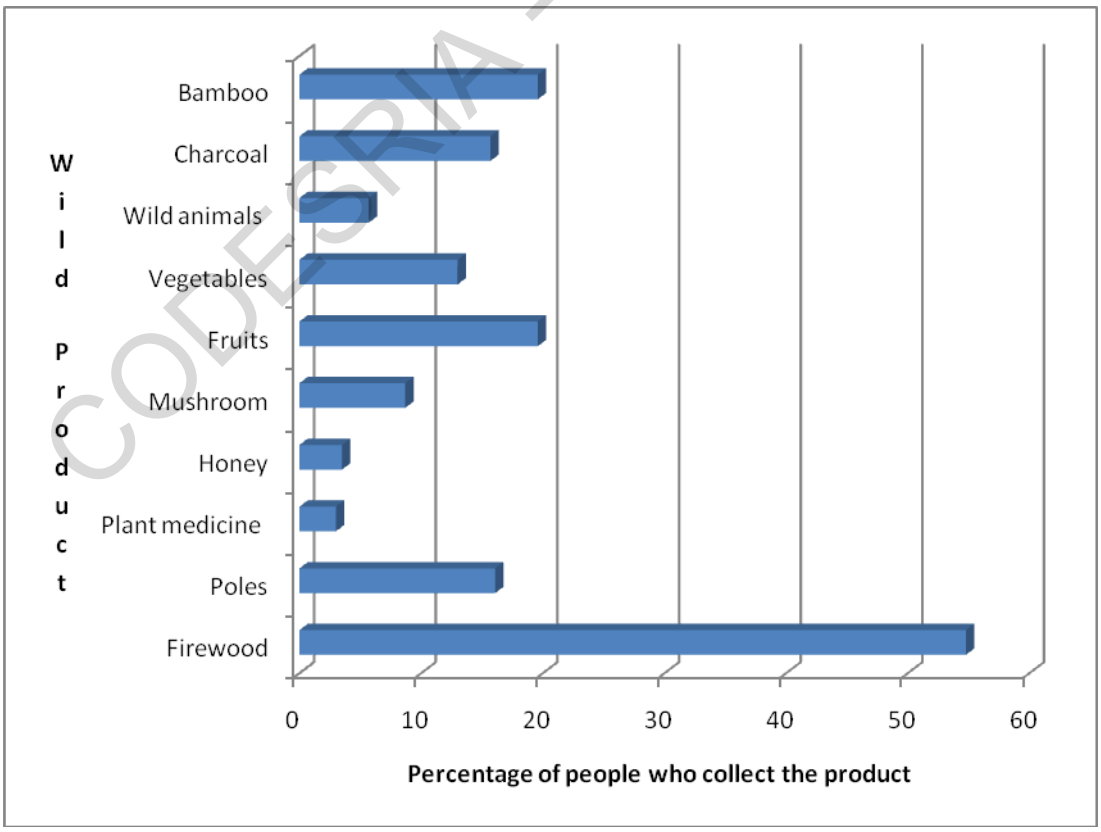

Figure 11: Percentage distribution of major wild products collected from surrounding land and forest

Source: Field survey, 2012

Table 44: Tree species in Masasi and Nachingwea used for firewood

Local name	Botanical name
Mpindimbi	*Vitex doniana*
Mseva	
Msimbiti	
Mpande	*Millettia stuhlmannia*
Mchejesya	*Crosspteryx febrifuga*
Mnepa	*Pseudolachnostlylist spp*
Mkarati	*Burkea africana*
Mpingo	*Dalbergia melanoxylon*
Mkakaruka	
Mkololа	
Mtomoni	*Diplorhynchus mossambicensis*
Mnyadi	
Msolo	*Pseudolachnostylis maprouneifolia*
Mtanga	*Albizia verscolor*
Mchenga,Mtondo	*Julbernardia globiflora*
Myombo	*Brachystagia bussei*
Mbambakofi	*Afzelia quanzensis*

Source: Field survey, 2012

Table 45: Tree species in Masasi and Nachingwea used for poles

Local name	Botanical name
Msolo	*Pseudolachnostylis maprouneifolia*
Mnyadi	
Msimbiti	
Mseva	
Mkokonasimba	
Mpingo	*Dalbergia melanoxylon*
Mpande	*Millettia stuhlmannia*
Mtalala	
Mgungu	*Acacia polycantha*
Mwanzi	*Oxytenanthera abyssinica*
Mnepa	
Mchejesya/mkakaruka/mkololа	
Mtumbati	*Pterocarpus angolensis*
Mbambakofi	*Afzelia quanzesis*

Source: Field survey, 2012

Table 46: Some tree species in Masasi and Nachingwea districts used as

medicinal plants

Local name	Botanical name	Deaseses cured	Part of plant used	Price per dose (TAS)
Mshelisheli	*Artocarpus altilis*	Stomarch	Roots	3,000
Msolo	*Pseudolachnostylis maprouneifolia*	Maddness	Roots	20,000
Msolo	*Pseudolachnostylis maprouneifolia*	Hernia	Roots	5,000
Mtalala		Head ache	Roots/leaves	10,000
Katatu/Sintatu		Witchcraft related deseases	roots	3,000
Nuvi		Hernia	Roots	5,000
Mtunda jiwe		Virus	Roots	5,000
Mchenga	*Julbernardia globiflora*	Stomarch	Roots	5,000
Mtomoni	*Diplorhynchus mossambicensis*	Hernia	Roots	5,000
Mnyawanyawa		Eye diseases	Roots	7,500
Mdaa	*Crosscephalum mannii*	Eye diseases (mtoto wa jicho)	roots	7,500
Msalanjasi		Heart diseases	Roots/ leaves	5,000

Source: Field survey, 2012

Table 47: Some animal species hunted in Masasi and Nachingwea districts

Local name	Scientific name	English name
Ngolombwe	*Cephalophus natalensis*	Duinker
Nyati	*Syncerus caffer*	Buffalo
Kanga		Guinea fowl
Sungura	*Lepus canensis*	African hare
Kwale		
Mbunju		
Ndandala/Mbawala	*Tragelaphus scriptus*	Bush buck
Ngedele/nyani	*Papis cynocephalus*	Yellow baboon
Nungunungu	*Hystrix cristata*	Porcupine
Panya		Rodents
Nguluwepori	*Potamochoerus africanus*	Wild pig
Tembo	*Loxodanta africana*	Elephant

Source: Field survey, 2012

In addition 8 (5.9%) of the respondents they also extract honey 20 (14.8%) said they also extract mushrooms from the surrounding forests.

4.5.3 Quantities of selected key NTFPs collected in Masasi and Nachingwea

The annual quantity of firewood collected per household is about 96 headloads. Therefore, for respondents this means 126 collect 12,096 headloads of firewood annually from the surrounding areas. The average quantity of bamboo hervested per household per year is about 288. Therefore, for 45 respondents, the total comes to about 12,960 bamboo headloads annually. It is estimated that households use about 10 poles per household per year. For 37 respondents, this would mean about 370 building poles are extracted from the surrounding areas per year. Average estimate of charcoal harvested per household per week is 23 bags which is equivalent to 1,104 sacks of charcoal per year (39,744 bags for 36 households).

According to the study findings, each household can collect an average of 1 kg of wild fruits per day during the season, and 90kgs per year per household. This means 4050 kgs of wild fruits are collected every year. In monetary terms, these products add a sizeable income to the total household income. The quantities are listed in Table 46 below.

Table 48: Quantities of selected key NTFPs collected from surrounding areas in Masasi and Nachingwea districts

NTFPs	Number of Respondents (n=230)	Average Household collection per year	Total Quantity
Firewood (Head loads of 15 kgs)	126	96	12,096
Bamboo (head load of 15 pieces)	45	288	12,960
Poles (pieces)	37	10	370
Fruits (kg)	45	90	4,050
Charcoal (bags of 20 kgs)	36	1 ,104	39,744

Source: Field survey, 2012

The actual amount of earnings from sales of firewood, bamboo, poles and charcoal was found to be Tshs. 100,748.00.

4.6 Contribution of Indigenous Agro-biodiversity Knowledge Management to Counter Vulnerabilities and Shocks

One Focus Group Discussion was held in each village to find out how local communities coped up with vulnerabilities and shocks from climate change.

A majority of participants in the FGDs indicated that they plant cover crops such as sweet potato,, early maturing crops like sesame, they use fruit stands, plant crops on ridges, use mixed and row intercropping, and use of forest products to cope up with vulnerabilities and shocks caused by climate change in the area. Others said they use long term fallow, use of short term fallow, agroforestry, and use of legume crops. Respondents in one village (Mkwapa) indicated use of mineral fertilizer and one use of tree leaves.

4.7 Overall Perception on Contribution of Indigenous Agro-biodiversity Knowledge Management on Meeting Community's Livelihoods

4.7.1 Chi-square test of independence

It was imperative to analyze the respondents' preferences towards use of indigenous knowledge when managing agro-biodiversity, and whether the preference was statistically significant. This was done using chi-square test of independence.

In order to test this following hypothesis was put forward:

Hypothesis 1: was concerned with the influence of households' characteristics on preference towards use of indigenous knowledge.

Test statistic: *Chi-square (χ^2)*

H_o : There is no difference in the respondent's preferences

H_1 : The preferences are at variance

Results of the analysis are presented in Table 49 below.

Table 49: Perceived preferences towards indigenous knowledge in farming requirements N=230

Sex	Frequency	Percent	Chi-square p-value
Female	64	42.4	0.547
Male	87	57.6	
Highest education level			
Informal schooling	4	2.6	0.049**
Primary education	123	81.5	
Secondary education	6	4.0	
No any schooling (Illiterates)	14	9.3	
Post secondary schooling	4	2.6	
Age (years)			
18-26	10	6.8	0.886
27-35	28	18.9	
36-45	45	30.4	
Over 45	65	43.9	

** Statistically significant at p = 0.05. Source: field survey, 2012; Source: Field survey, 2012

Looking at the values of probability for the three predictors (sex, education and age), sex and age had relatively large 'p' values (0.547 and 0.886 respectively) than that for education (p = 0.049) (Table 49).

4.7.2 Logistic Regression Model

In addition, binary logistic regression model was conducted to determine perceptions on the usefulness of indigenous knowledge and management of agro-biodiversity and its contribution to local community's livelihoods. Results of the analysis are presented in Tables 50, 51 and 52 below.

4.7.2.1 Binary Logistic regression model:

$$Logit(Y) = \ln\left(\frac{p}{1-p}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_n X_n + \varepsilon_i$$

Where: p = probability of the event,

α = Y intercept,

β_i = regression coefficients,

X_s = a set of predictors.

Hypothesis 2: wanted to find out if household' characteristics influence perceptions regarding the importance of IK and its contribution to livelihoods.

Test statistic: *Binary Logistic regression*

H_o : $\beta_1 = \beta 1 = \quad ... = \beta_n = 0$

H_1 : At least one of $\beta_s \neq 0$

Variables used in the Logistic Regression

Table 50: Variables used in the Logistic Regression

Variable	Description
Y	Perceptions on usefulness of indigenous knowledge in managing agro-biodiversity and its contributions to local community's livelihoods (0 = Not useful, 1 = useful)
X_1	Sex of the head of the household (1 = male, 0 = female)
X_2	Age of the household head (years)
X_3	Literacy level (0 = no formal education, 1 = formal education)
X_4	Farm size (acres)
X5	Farming experience
X6	Parents as source of learning farming (0 = no, 1 = yes)
X7	Family as source of learning farming (0 = no, 1 = yes)
X8	Neighbors/friends as source of learning farming (0 = no, 1 = yes)
X9	Personal experience as source of learning farming (0 = no, 1 = yes)
X10	Extension staff as source of learning farming (0 = no, 1 = yes)

Source: Field survey, 2012

4.7.2.2 Logistic Regression Results

Table 51: Importance of IK in management of agro-biodiversity and contribution to livelihoods

Predictors	B	S.E.	Wald x^2 value	df	Sig.	Exp(B)	95.0% C.I for EXP (B)	
							Lower	Upper
Gender of the household head	0.494	0.565	0.765	1	0.382	0.610	0.202	1.846
Age of the household head (years)	0.025	0.023	1.189	1	0.275	0.975	0.932	1.020
Literacy level	0.997	0.723	1.901	1	0.168	2.711	0.657	11.189
Farm size (acres)	0.017	0.038	0.198	1	0.656	1.017	0.944	1.096
Farming experience	0.022	0.026	0.723	1	0.395	1.022	0.972	1.074
Parents	0.175	0.581	0.090	1	0.764	0.840	0.269	2.621
Family	0.291	1.124	0.067	1	0.796	0.748	0.083	6.767
Neighbours/friends	18.856	10156.415	0.000	1	0.999	154581779.238	0.000	.
Personal experience	0.005	0.620	0.000	1	0.994	1.005	0.298	3.384
Extension staff	18.841	40192.970	0.000	1	1.000	152313342.19	0.000	.
Constant	2.448	1.171	4.371	1	0.037	11.569		

Source: Field survey, 2012

Table 52: Test statistics for Binary Logistic Regression

Tests	χ^2	df	P-value
Model evaluation (overall):			
Likelihood ratio test (Omnibus Tests of Model Coefficients)	6.812	10	0.743
Goodness-of-fit test:			
H-L test	18.848	8	0.016
Percentage Accuracy in Classification (PAC): Null model = 92.0; Model with descriptors = 92.0			
Cox & Snell R^2 = 0.030			
Negelkerke R^2 = 0.070			
Valid Sample size = 230			

Source: Field survey, 2012

Thus, the model equation is given as:

Logit (Y) = $2.448-0.494X_1-0.025X_2+0.997X_3+0.017X_4+0.022X_5-0.175X_6-0.291X_7+18.856X_8+0.005X_9+18.841X_{10}$

The model did not fit very well (was not worthwhile) as indicated by Hosmer and Lemeshow Test being below 0.05 (p=0.016) and the Omnibus test of model co-

efficient of 0.743 (far above 0.05). For the best goodness of fit model the two tests should bear the 'p' values greater than 0.05 and less or equal to 0.05 respectively (Table 52) (Tabachnik and Fidell, 2001).

4.8 Respondents Opinions on how Best to Preserve IK

Managing and preserving IK helps to reduce poverty, enhance equity, reduce environmental degradation and leads to sustainable development and increased local participation in the development process. In this study, local communities were asked to give opinions on how they would like to preserve indigenous knowledge for improved livelihoods.

Table 53: Opinions on ways that can best be used to preserve IK on agro-biodiversity management

Category	Frequency	Percent
Avail modern farming inputs	56	24.3
Convince communities to share experience and knowledge	1	.4
Documentation in various forms	38	16.5
Frequent visits by extension staff	44	19.1
IK should be integrated with EK	32	13.9
No opinion	47	20.4
Promote usage of IK and indigenous products among youth	7	3.0
Teach communities modern IK record keeping	4	1.7
IK should be integrated in the school curriculum	1	.4
Total	230	100.0

Source: Field survey, 2012

A majority, 56 (24.3%) of the respondents said they need access to modern farming inputs and their integration with local farming techniques. 44 (19.1%) suggested that they need frequent visits from extension staff to teach farmers on how to integrate farmers knowledge and external knowledge (EK), 38 (16.5%) suggested that IK

should be documented in various forms such as songs, text, dance films and other storage devices. 32 (13.9%) suggested that IK should be integrated with EK. 7 (3%) suggested that usage of IK and other indigenous products should be promoted among youth so they can value it and 4 (1.7) indicated that local communities should be taught modern methods of IK record keeping.

CHAPTER FIVE

DISCUSSIONS OF FINDINGS

5.0 Introduction

The research findings were interpreted in line with knowledge management (KM) models, theoretical framework reviewed literature and research objectives. The chapter also discusses social-economic characteristics of respondents engaged in various KM activities related to agro-biodiversity.

5.1 Social-economic Characteristics of Respondents

5.1.1 Gender

Respondents' characteristics are important in determining how they facilitate or hinder the respondents' ability to manage IK in relation to farming activities, agro-biodiversity management and effective KM. Both men and women have different knowledge about agro-biodiversity activities, organization of knowledge, and preserving and knowledge transfer (Niamir- Fuller, 1994). Gender is thus an important factor and influences KM processes in local communities. The characteristics of the respondents in this study are similar to those in other studies on agricultural KM in rural Tanzania in particular, and developing countries in general. For example, a study conducted in Samoa revealed that 77% of the respondents involved in IK for sustainable agriculture are male and 23% are female (Tikai and Kama, 2004). The gendered nature of the social, culture, economic and policy systems may have limited more women farmers from participating in this study.

Studies show that gender determines who does what in terms of collection of wild products (Kajembe, *et al.,* 2000). Indigenous knowledge is unevenly distributed because it is closely tied to an activity and accessibility is determined by participation in related activities. Traditional healers, traditional birth attendants,

farmers, livestock keepers and honey collectors for instance, access relevant local knowledge and acquire skills through active involvement in related activities, experimentation, adaptation and propagation of new ideas gained through experience (Koda, 2003).

In Njombe district for example, males dominate in collecting, processing, transportation and marketing of wild products (Mhapa, 2011). Similarly, in Nguru South Mountain in Morogoro region it is the men who collect bush meat, honey, udaha (black pepper), charcoal, poles and ropes (Robinson and Kajembe, 2009). In Meatu district, Tanzania women are responsible for collecting, processing and for selling forest vegetables and fruits (NTFPs of low quality) while men sell high value products like honey and medicinal plants because they can travel far in search of these products (Kagya, 2002). In Mwanza district collection of firewood and wild foods (fruits and vegetables) is done by women (Katani, 1999). Hence women are more knowledgeable about tree species suitable for fuel wood, vegetables and fruits. Men are responsible for collecting fodder for livestock and are therefore knowledgeable about fodder plants for different animals.

This trend has also been observed in Zimbabwe, where it was reported that significant gender difference exists in terms of resource demands (Campbel, *et al*., 1991). Similalrly, Fernandez (1994), Koda (2003), Rubin (2010) and Lyimo-Macha, Sife and Malekani (2010), reported that both women's and men's generation, adaptation and use of knowledge and technology are shaped by economic, social, cultural, political and geographical contexts in which they live, but each sex experiences this in different ways. According to these studies in farming

communities, women and men have general knowledge on farming systems, but women are more conversant with issues related to food crops and vegetables and the food basket in general since they are the ones who collect vegetables, process, prepare, preserve and cook for their families usually assisted by their daughters.

Invariably, men also are more knowledgeable about hunting and related activities, including housing construction and cash earning activities but in a few ethnic groups this role also is assigned to women. In Gumla, Hazaribagh and Simdega districts in Jharkhand, India women are the main collectors, processors and marketers of wild products except for timber (Gharai and Chakrabarti, 2009).

In this study, the proportion of females engaged in collection of wild products was fewer compared to their male counterparts. Most heads of households interviewed in Nachingwea and Masasi were males (except in Nachingwea where female heads of households dominated). This implies that males were the main collectors and traders of wild products in the study areas. However, when it comes to high value products such as charcoal and bamboo, almost a similar proportion of females were also engaged in these activities just like their male counterparts. This is contrary to what other studies above have reported.

5.1.2 Age

Age is one of factor that may influence management of IK in local communities (Fairhead and Leach 1994; Sillitoe, Dixon and Barr 2005). The mean age of the respondents in this study was 46.04 years and 47.1% of the respondents were

between 27 and 45 years, hence were middle aged. The researcher interviewed heads of households. Other studies have come up with similar findings. In Tanzania for instance, more than 54% of Tanzanians are aged between 15 and 64 years, and a majority are expected to reach 52.45 years, statistically (CIA, 2009). In terms of age, findings of this study are similar to the profile of IK holders in most developing countries including Africa. A study conducted by Tikai and Kama (2004), revealed that 63% of farmers utilizing IK in farming activities were aged 30 to 50 years and was well experienced and knowledgeable in the local Samoan methods of farming. Mugisha-Kamatenesi, *et al*., (2008) reported that 53% of active farmers in Uganda are aged between 31 and 50 years old.

This study included relatively middle aged or elderly men and women who are actively involved in farming activities. However, this does not mean that only the elderly posses IK (Dube and Musi, 2002; Fairhead and Leach, 1994; Onyango, 2002; Sillitoe, Dixon and Barr, 2005). Results also show that those aged between 27 to 45 years (47.1%) were actively engaged in agro-biodiversity management usage of IK. Similarly age plays a vital role on determining usage of local knowledge on wild products. For example, Mhapa (2011) observed that, about 55% of wild product (also called non-timber forest products-NTFPs) collectors and traders in Njombe district are aged between 30-50 years. Kilonzo (2009) found that collection of wild vegetables, honey and poles in Nyanganje forest reserve decreased as one moves from age 18-30 years, through to age 30-60 years and beyond.

These results imply that middle aged men and women have a lot of accumulated experience and knowledge on sources of wild vegetable, honey and pole species and can distinguish between poisonous and non-poisonous species wild vegetables. This also implies that young energetic men and women travel far in search of these products unlike the eldery. In this study, all respondents at household level and those who participated in Focus Group Discussions indicated that they extract wild products. This means both young and adults have some forms of indigenous knowledge on wild products for improving their livelihoods. In the study areas, there are active initiation rites performed mainly after crop harvesting season where young men and women are taught various roles and activities including farming and wild product related activities. This is why both elderly and the middle aged generation were found to have indigenous knowledge in the use of such products.

5.1.3 Literacy and education level of the respondents

Literacy levels in terms of the ability to read and write in Kiswahili language is high in the two districts surveyed. The study findings revealed that 193 (84%) of the respondents have primary education. Literacy levels of the respondents in this study are similar to those of other studies. For Example, Lwoga (2009) found that 152 (84%) of respondents in various districts had formal schooling. Similarly, Castella, *et al.*, (2006) reported that household heads in Vietnam Uplands had at least secondary school education.

Similarly, a study conducted by Mugisha-Kamatenesi, *et al*., (2008) in Uganda indicated that over 80% of the farmers interviewed, had some formal education (that is, primary and secondary school education). In Tanzania, Mwakaje, Mwakipesile

and Nyakisinda (2009) found that 99% of rural farmers in Rungwe district in Mbeya region had formal education. The findings of this study indicate that most farmers can use a wide range of oral and written sources of knowledge to manage IK in local communities.

The study findings further revealed that more male heads of households have primary and secondary education compared to their female counterparts. This is not surprising due to cultural and historical factors which create gender imbalances in education in the country (Mbilinyi, *et al.*, 1991). Generally, there is a big difference in terms of literacy between men and women in Tanzania, where males constitute 77.5% of the literate population and females constitute 62.2%, statistically (URT, 2002). The findings of this study corroborate those by Lyimo-Macha, Sife and Malekani (2010) and Rubin (2010), who found that three quarters (75%) of the female respondents in Lindi and Mtwara had no formal education.

A similar proportion of females have attended adult education classes, only one female had secondary education. In contrast, more than half (56.9%) of males had primary school education. This is also supported by Tanzania 2007 Household Budget Survey and the 2006 URT report which shows that only 68% of the males in Tanzania have primary school level education and less so for women. What this suggests is that there are very few highly educated people in rural areas and in Tanzania in general. Banmeke and Olowu (2005) also reported that almost 48% of the women farmers in Nigerial have no formal education and only 28% have primary

school education. Olatokun and Ayanbode (2008) also found that 73% percentage of rural women in Nigeria can neither read nor write.

Education level of rural Africans influences their reliance on wild product trading or production. Kamanga, *et al.,* (2009) found that households in Africa with higher education levels generally have more reliable sources of income o and wider asset bases. In a survey that focusing on African wild product users and producers, Arnold, *et al.,* (1994) found that half of the respondents involved in grass, cane, and bamboo enterprises had no education, while the rest had only primary education and those owning forest products trade enterprises were slightly better educated. In contrast, very few woodworking proprietors had no education and more than a third had qualifications beyond primary school level. Paulo (2007), observed that in Kilwa District an increase in education level decreases significantly in the extraction of wild vegetables, wild mushrooms, medicinal plants and poles.

Kilonzo (2009), noted that increase in education level especially secondary education, decreases significantly in the extraction of bush meat,wild fruits, wild vegetables, honey, poles, wild mushrooms, firewood and medicinal plants. The findings of this study indicate that local communities have a low level of education and more women farmers are disadvantaged in terms of access to formal education. Moreover, most respondents in this study are not employed in the formal sector but are engaged in farming and collection of wild products.

5.1.4 Occupation of respondents

The findings of this study are in line with Olatokun and Ayanbode (2008) who reported that a majority of the respondents in their study (72%) were subsistence farmers who owned between 0.164 to 2.025 hectares (or 4.052 to 5.009 acres) of land in Nigeria. Chapman, *et al.,* (2003) also reported that in Ghana a majority (85%) of peasants cultivate less than four hectares of land for their household needs.

According to the findings of this study, all the respondents were involved in crop farming and wild product collection. None of the interviewed respondent was employed in the formal sector. Kolawole (2004) suggests that the active involvement of people in farming activities than in wage employment indicates that indigenous knowledge systems practices may have found common use amongst the local people. In this study it is clear that small-scale farmers in the study area possess an extensive base of IK on crop farming and wild product collection.

5.2 Various Types of Indigenous Knowledge Related to Agro-biodiversity Management Among Local Communities

5.2.1 Indigenous knowledge on soil characteristics

Interviews with respondents revealed that local communities possess a wide range of indigenous knowledge on soil fertility (good and bad soil characteristics). Local communities indicated some of the following soil characteristics as indicators of good soil fertility: black soil color, good crop performance, presence/ vigorous growth of certain plants, presence of plants in a dry environment and abundance of earth worms in the soil. They also mentioned some characteristics indicating poor or bad soils such as presence of yellow and red soil colors, compacted soils, stunted

plant growth, appearance of certain bad species of plants, and presence of sands, rocks and stones.

Other studies also found similar characteristics used by small-holder farmers to characterize bad and good soil types. For example, a study by Dejene, *et al.*, (1997), found that the most commonly cited indicator of soil fertility decline is a decrease in crop yields. Other indicators reported in their study were crop leaves becoming yellow, crops becoming stunted, occurrence of weeds, termite mounds and disappearance of grass and palatable species. In this study, local communities cited occurrence of plant species known in local vernacular as *Nambanawe (Bidens pilosa), Chikungulu (Striga weed) and Mbuta (Cyperus rotundus)* which signify decline in soil fertility.

5.2.2 Indigenous knowledge on cropping systems

Findings revealed that intercropping is widely practiced in Masasi and Nachingwea. In both districts, the dominant intercropped crops are mainly maize + pigeon peas and maize + cassava + pigeon peas. The mono-cropping system is the second most applied method in the farming system in these communities. Intercropping is determined by land shortages, easy to manage intercrops, inadequate labour, and inadequate knowledge on other farming methods, and in order to maximize production through diversification and in order to conserve soil fertility. Other reasons for inter-cropping include: inherited culture, lack of farming tools and lack of income.

In this study, none of the respondents mentioned the usefulness of intercropping as a method for crop pest control. This is contrary to what Songa, *et al,*. (2007), found who reported that intercropping systems that contain the non-host bean are more efficient in reducing pest densities of Lepidopteran stem borers in maize than in millet or sorghum.

The communities that practice mono-cropping gave a wide range of reasons for use of mono-cropping and cited increased harvest due to reduced competition between plants and in order to avoid shade for other crops and nature of crops grown. Similar findings have been reported by Lwoga (2009) who found that mono-cropping is used elsewhere in Tanzania.

Intercropping is an effective means of spreading risk especially where rainfall is unreliable for example coastal regions. The findings of this study further confirm the reasons for multiple intercropping. A study done by Lwoga (2009) and Dejene, *et al,*. (1997) found that apart from soil fertility restoration, local communities also use this method to protect themselves against crop failure, early maturing crops, weed control, and to prevent plant diseases. With regard to monocropping, Lwoga (2009) found that 7.7% of the respondents practiced monocropping to increase yields,7.1% to ensure good exposure of crops to sunlight, 7.1% to simplify field operations, 5.4% to rotate crops, 3.6% to increase soil fertility, 1.8% to prevent plant pests and 1.8% to mature early..

Findings of this study revealed that a major driving force behind farmer's knowledge and intercropping practices are: land scarcity, easy management of intercropped plants, inadequate labour to cultivate large areas, crop diversification to avert risk, low level of knowledge on other farming methods, culture and soil fertility conservation.

In terms of soil fertility restoration, findings of this study revealed that intercropping is a dominant traditional method used and none of the farmers practice mulching, use of animal manure and other modern farming practices to maintain soil fertility. In terms of soil fertility restoration, the findings support Dejene *et al.,* (1997) who found that intercropping is dominantly used to enhance soil fertility in Kondoa District. However, other studies in Tanzania have revealed more than one traditional practice people use to restore soil fertility. For example a study by Lwoga (2009) found that 57.9% of the respondents use manure to improve their soil quality, 44.5% to rotate crops, 35.4% to use crop residues, and organic materials (31.7%).

The least used methods are planting nitrogen fixing crops 8.5% and leaving land fallow 2.4%. Other techniques are deep tillage, mulching and cultivating at the bottom of the valley. During Focus Group Discussions it was revealed that local communities in the study area rarely keep livestock. Thus animal manure is scarce for soil fertility restoration. Moreover, most farmers use a hand hoe to dig the soil, in other words, many farmers practice minimum tillage that does not guarantee soil fertility maintenance.

5.2.3 Indigenous knowledge on land suitability for farming

The findings from this study found that the type of soil and soil fertility are important criterion used by farmers to assess the quality of a piece of land for farming. Other major criteria used include: water retention capacity, suitability of a plot for a specific crop, and growth of certain plants. For example, farmers reported that certain types of grass such as nambanawe *(Bidens pilosa), chikungulu* (witch weed) and *mbuta (nut grass)* are present this is a good indication that the soil is suitable for pigeon peas and groundnuts but not for maize, millet or sorghum.

Based on these findings it is clear farmers have a wealth of knowledge on the assessment of the quality of soil fertility**.** Apart from low crop yields and poor growth of crops and weeds, farmers assess changes in soil fertility by using crop characteristics (that is, changes in crop color, layers of rotten grass, and appearance of certain plant species), soil characteristics such as the presence of compact soil, and common sense and prior experience to evaluate soil fertility. These findings corroborate what other studies have found elsewhere for example Bailey (2003) in Jamaica, Price (2007) in the Philippines and Akullo, *et al*., (2007) in Uganda.

5.2.4 Indigenous knowledge on preservation of planting materials

The findings revealed that many of the households in the study area do not have cash to access modern planting materials. Moreover, in all the surveyed villages there is not a single agro-input shop where farmers can purchase modern farm inputs. A few vendors bring agro-inputs but only occasionally. Some of the agro-inputs supplied are pesticides and packaging materials (polythene bags). Thus, most farmers rely on planting materials stored and preserved from previous harvests.

The findings from the interviews revealed that both traditional and conventional approaches are used to store seeds even though applicability of indigenous methods outnumbered exogenous methods. Through Focus Group Discussions and Key Informant Interviews it was revealed that conventional techniques are the least popular methods used by farmers for preserving seeds due to scarcity of synthetic materials. Farmers who prefer synthetic materials for seed storage stated that not all indigenous preservation methods are effective for seed preservations. Those who prefer indigenous do because traditional seeds are more resistant to diseases, available, affordable and safe unlike chemical pesticides.

In a study conducted by Lwoga (2009) in five districts in Tanzania it was also revealed that despite the discrepancies of indigenous and exogenous seed storage methods, generally farmers prefer both indigenous and exogenous methods to preserve seeds. Other studies found similar trends in the use of seeds stored locally and those mixed with insecticides. For example, Modi (2004) reported that some native subsistence farmers in South Africa store maize (*Zea mays* L.) cobs over a fireplace and subject the seeds to smoke and heat. He also reported that taro *(Colocasia esculenta L.* Schott.) propagules are maintained in dry pits for one month, in layers separated by straw, and no contact with water. These methods have been used together with others to maintain landraces for centuries by farmers. When the maize seeds were tested it was revealed that the seeds stored over fire and smoke showed higher germination and vigour than non-smoked seeds.

The findings on storage of maize and pigeon peas seeds for the next season agree with what other studies have found that local knowledge and technology can effectively be applied across different locales by communities (Briggs, 2005; Briggs and Sharpe, 2004). For example, the study did not find usage of common local materials used in other communities to preserve seeds such as chili pepper and neem. However, it is argued that a local innovation is developed to fit a particular biophysical and socio-economic setting and usually cannot be transferred "as is" to other settings **(**Waters-Bayer and van Veldhuizen, 2005**).** Other authors have argued that IK should not be up-scaled because it becomes outside the context and ineffective when separated from its environment (Klees, 2008). Nevertheless, the documentation and sharing of local innovations can provide ideas and inspiration for others to try out and adapt new ideas to their own settings (Waters-Bayer *et al.*, 2006; Waters-Bayer and van Veldhuizen, 2005**).** Since IK is site-specific, it is therefore seldom scaled up without adaptation, but can be used to stimulate experimentation and innovation in communities.

5.2.5 Indigenous knowledge on methods of crop planting

During interviews with pigeon peas and cassava growers, three major planting/sowing methods of crops were identified by respondents including e use of rows on flat land without proper spacing, random method and ridges. Overall, most farmers prefer rows followed by random method and ridges. It was also revealed that farmers possess IK not only with other crop husbandry techniques but also knowledge on soil fertility assessment, assessment of arable land, cropping systems, preservation of seeds and crops, plant diseases and pests control as indicated earlier.

They also have knowledge on planting methods. For example, during Focus Group Discussions, respondents said they use ridges because ridges preserve moisture for a long time compared to flat land. Moreover, those who use rows said they also intercropping. This is one way of spreading risk in case of unreliable weather especially rainfall. When planted randomly, crop ground cover is increased and hence reduces moisture loss from the soil. Other studies such as that by Eyong (2007), reported that local people in Central Africa have an enormous wealth of IK that covers land clearing, tilling, selecting seed varieties, planting, harvesting and storage. Related observations have been made by various studies in Bangladesh (Miah, *et al.*, 2005), Laos (Saito, *et al.*, 2006), Tanzania (Hill, 2003; Kamwenda, 2002; Minja, 2001; Dejene, 1997) and Uganda (Hart and Mouton, 2005).

5.2.6 Indigenous knowledge on crop preservation after harvesting

Farmers were asked to state methods they use to preserve crops after harvest. The findings revealed that farmers use traditional methods rather than conventional inputs and facilities. During Focus Group Discussions respondents indicated that they use clay pots and granaries located outside or inside farmers' houses and kitchen hearths to preserve shelled maize and pigeon peas. Cultural practices such as mixing crops with ash, hanging crops on tree tops were also used to store unshelled maize and pigeon peas pods. The smoke and heat from fire on kitchen hearth repels weevils that attack maize and pigeon peas grains. Similarly, ash mixed in grains excludes air and suffocates grain weevils. A majority of them also use polythene bags compared to other conventional methods.

Other studies also show that there is increasing interest in the use of indigenous practices and inputs for crop preservation in African countries. For example, Gana (2003) found that small-scale farmers in the three villages in Nigeria use indigenous materials to protect food crops because they are effective, safe and cheap. Therefore there is a need to promote sharing and use of local crop preservation practice because they are safe and affordable.

Agea, *et al.*, (2008) study in Uganda found that a majority of households in Mukungwe sub-county store food in granaries (80%), and locally made sacks, on kitchen shelves, in pots and baskets (42%). Nigeria is said to have high use of granaries (Ogundele, 2006). In the study area, use of granaries and hanging cobs of maize on tree tops is common because there are very few cases of theft.

5.2.7 Indigenous knowledge on plant pests, diseases, predators and their control

The study findings show that farmers have a broad base of knowledge regarding diagnosis of plant diseases. Many farmers identified plant diseases/pest attacks to crops using symptoms rather than by the name of the diseases/pests. For each crop the symptoms varied. For instance, when cross checked through key informants (extension staffs), it was revealed that the powdery substance mentioned for cashew disease is powdery mildew (a fungal disease that attacks cashew trees). Similarly, the powdery substance identified for pigeon peas is powdery mildew. What this implies is that farmers use indigenous knowledge that has existed among them to identify crop diseases/pests.

Other studies show that IK is used to identify herbs and local medicines used to control crop diseases/pests. For instance, Lwoga (2009), reported that IK was location specific, where various plant parts (bark, roots, leaves) are used alone, or in combination with other ingredients such as cattle urine, kitchen ash and other inputs to control crop diseases/pests in Karagwe, Moshi, Mpwapwa and Songea rural districts in Tanzania. Mugisha-Kamatenesi, *et al.*, (2008) reported similar findings in their study of IK on field insect pests in Uganda. Findings of this study differ with previous studies because none of the respondents reported the use of indigenous materials to control crop diseases/pests. There is a need therefore to introduce proven indigenous control methods from other parts of the country to the study area for experimentation and stimulation of innovations in the use and application of IK.

5.2.8 Indigenous knowledge on agro-biodiversity management around community surroundings

The respondents use different methods to protect agro-biodiversity resources surrounding them. Findings indicate that the use of fire, making patrols, use of fallow to allow plant regeneration, making buffer zones in the general land to demarcate areas allowed for public use and protected area, and observation of village by laws in the use of the land was predominantly used by the communities.

Other scholars found that IK is used to protect wild surroundings. For example, Hens (2006), found that in the Ashanti region of South – Western Ghana, trees which are regarded as housing spirits are cannot be cut without rituals. This custom protects trees such as odum (*Chlorophora excelsa*), African mahogany (*Khaya ivorensis*) and

tall palm trees such as betene (*Elaeis Guineensis*) and osese (*Funtumia sp*.), o shea butter (*Butyrospermum parkii*) and Dawadawa (*Parkia clappertoniana*) trees, in the Northern Savannah zone of Ghana are protected under traditional protection systems (Boaten, 1998). It is argued that traditional farming practices are champions in sustainable land and water management. In Ghana, Hens (2006) found that traditional farming practices involve land rotation and shifting cultivation to allow land to remain fallow for more than 10 years to restore its natural fertility. A study by Dejene, *et al.* (1997) in Kondoa district in Tanzania found that fire is widely used as a land management tool. Findings revealed that almost every respondent uses fire to reduce incidences of livestock diseases such as Trypanosomiasis and in order to allow regeneration of grass and pasture for livestock.

5.3 How Local Communities Access and Share Indigenous Knowledge on Agro-biodiversity

5.3.1 Access to agricultural indigenous knowledge

The respondents mentioned several sources of indigenous knowledge (IK) used for management of agro-biodiversity. Primary sources of agricultural IK are predominantly tacit and local, which included personal experience, parents/guardian/family, neighbours, friends/relatives, social group gatherings, village meetings, and village leaders and farmers groups. Findings revealed that farmers make little use of formal sources of knowledge such as books, posters, newspapers, seminars and agricultural shows. In terms of frequency of access, the responses again showed the predominance of the parents/guardian/family, neighbour/friends, social groups and village meetings as primary sources of IK they most frequently consulted.

In terms of the type of indigenous knowledge they seek, the majority of respondents stated that they seek knowledge on new crop varieties, methods of crop planting, harvesting, processing, storage, utilization of non timber forest products and soil fertility improvement. It is apparent from the findings that the communities lack reliable sources of exogenous knowledge. There is therefore a need to integrate IK into exogenous knowledge to strengthen the local knowledge system. The major means of acquiring knowledge related to use of wild plants is accompanying relatives during harvesting seasons, initiation rites and through training by elders and direct observations.

In this study findings revealed that a majority of farmers in the surveyed areas do not utilize formal sources of knowledge such as books, posters, newspapers, seminars and agricultural. These findings are contrary to what several KM processes that deal with knowledge acquisition suggest. The KM models posit that the acquisition of knowledge involves the importation of substantial amounts of knowledge from internal and external sources of the organization (Bouthillier and Shearer, 2002; Earl, 2001; Probst, Raub, and Romhardt, 2000). However, findings of this study show that farmers rely heavily on local (internal) sources of knowledge to acquire IK, rather than external and formal sources of knowledge.

Farmers rarely use formal sources of knowledge (public and private extension services) and printed materials to acquire IK; instead they prefer local sources of knowledge. These findings are supported by studies conducted in other developing countries, such as Uzbekistan (Wall, 2006) where local sources are major sources of

agricultural IK unlike formal sources of knowledge. Similar observation were made in Ethiopia (Dixon 2002), Nigeria (Nathaniel-Imeh, 2004; Olatokun and Ayanbode, 2008), Tanzania (Nathaniels and Mwijage, 2000; Lwoga, *et al*,. 2010), and Uganda (Akullo, *et al*.,2007). These findings are also supported by various authors who contend that face-to-face communication is a major mechanism for acquiring knowledge by organizations and local communities (Earl, 2001; Meyer and Boon, 2003).

In terms of knowledge on use of wild plants, the findings from this study support observations made by Gari (2003), who found that the Gogo people in central Tanzania hold local knowledge of uses of over 40 wild food plants some of which grow only during food shortages (during dry seasons) and how to process and preserve these wild foods. Such knowledge is passed from one generation to another and to children when they accompany parents/ relatives during harvesting time. Similar findings were also reported by Somnasang, *et al.*, (1998) in north-east Thailand.

5.3.2 The integration of agro-biodiversity exogenous and indigenous knowledge

The study found little identification and integration of indigenous knowledge with exogenous knowledge in the farming communities by knowledge providers. The fact that few farmers were involved in participatory research activities in the surveyed areas indicates that knowledge is mainly created within the social paradigm rather than the scientific paradigm. Further analysis of individual interviews showed that farmers use their own knowledge or combine their knowledge with other indigenous

or exogenous knowledge to create new knowledge, better ideas and new effective agricultural processes. The research findings confirm what the KM model by Nonaka and Konno (1998) who state that internal knowledge may be combined with other internal or external knowledge to create new knowledge. These findings are also similar to the socialization sub-process (that is, transferring tacit to tacit knowledge) of the knowledge creation model of Nonaka and Konno (1998).

Furthermore, these findings show that farmers create new knowledge through socialization processes such as face-to-face interactions, group interactions (that is, social gatherings and farmer groups meetings and village meetings), and cultural roles such as initiation rites during adolescence and direct observation (section **4.4.1.3**). The socialization process enables local communities to combine their knowledge with that of others to solve problems and to adapt knowledge to their own environment.

Apart from the socialization process, the findings show that other sub-processes in Nonaka and Konno's (1998) knowledge creation model were partially fulfilled in this study, which include externalization, combination and internalization. These findings are similar to earlier findings by Ha, Okigbo, and Igboaka (2008) who found that Nonaka's (1994) model was partially fulfilled in that farmers are able to create knowledge through socialization and combination processes, while externalization and internalization processes were not quite successful at Anambra State in Nigeria.

In the externalization process, the findings of this study show that farmers externalize tacit knowledge into explicit knowledge although the practice is very low. The findings of this study show that only a few farmers convert indigenous tacit knowledge into explicit forms, which include written formats, folklore and carvings as explained in section **4.4.3.** As for the combination process, the study findings show that farmers do not create new knowledge through the use of multiple bodies of explicit indigenous and exogenous knowledge as indicated in section **4.4.1.1**. The study found that farmers captured and integrated new explicit knowledge by collecting externalized knowledge from other farmers and indigenous knowledge intermediaries. The printed materials include books, newspapers, newsletters, leaflets and posters. However, print media were used at a low rate in the local communities to create explicit knowledge, because of a lack of reading culture, knowledge culture, bookshops and rural libraries. In the internalization process, the findings of this study show that created explicit knowledge is shared with farmers through learning by doing, extension services, farmers' groups and folklore (section **4.4.2.1-4.4.2.3)**. However, farmers mainly acquire exogenous knowledge from formal and explicit sources of knowledge.

The study findings show that farmers only create knowledge within a scientific paradigm when they are involved in research and when with extension officers in the agricultural technology development. However, the findings indicate that few farmers are involved in participatory research activities and generation of knowledge (Section **4.4.1.4)**. Thus, these findings indicate that knowledge is mainly created in the social paradigm more than in the scientific paradigm in the surveyed communities.

5.3.3 Sharing and distribution of agro-biodiversity indigenous knowledge

This study found out that folklore, farmer groups and initiation rites are major means through which communities share IK on agro-biodiversity. The frequently used folklore is songs, dance, storytelling, festivals, drama, plays, debates, poetry and puppet shows. In this study, it was revealed that folklore is less utilized probably because the young generation is ignorant about such practices and because advancements in ICTs such as radio and television broadcasts have replaced traditional dances and storytelling.

Folklore is dominant during the period between July and October before the onset of rains. These periods mark the harvest season in Nachingwea and Masasi. During this time families can support guests invited to participate in folklore practices. Folklore also plays a major role during farming seasons and wedding ceremonies and socio-cultural events.

Other studies found similar trends in folklore activities. For instance, Eyong, Mufuaya and Foy (2004) noted that the mass media posed a great threat to folklore because now more families spend a lot of time watching pop music and soap operas instead of storytelling or singing folklore songs, which are powerful vehicles for transmitting IK. Due to lack of electricity in the study areas, the influence of mass media was not found in the area. A similar study conducted in five districts in Tanzania (Karagwe, Kasulu, Moshi rural, Mpwapwa and Songea rural) by Lwoga (2009), also noted that formal education has contributed to the diminishing of folklore, since students spend time reading after school, and thus little time is devoted to storytelling or songs. A similar observation was made by Chisenga

(2002). However, if strengthened and recognized, folklore can play a major role in the management and sharing of IK, and its integration in other knowledge systems.

Although folklore activities are not widely practiced in the study area previous researches in other developing countries have shown that folklore plays a key role in the sharing and preservation of indigenous knowledge and culture. A study conducted by Olatokun and Ayanbode (2008) in Nigeria revealed that traditional festivals were celebrated frequently in rural areas and were key players in preserving and promoting and transfer of folklore and songs, dance and cooking. A survey of agricultural knowledge and information systems of the Udaipur and Trichy villages of India revealed that puppet shows were a popular medium, but only in the Udaipur village (Conroy, *et al*., 2004). Chapman, *et al.*, (2003) found that the use of drama by local actors with corresponding thematic discussions improved the sharing of agricultural knowledge and information among farmers who listen to agricultural extension radio programmes in Ghana.

These findings are supported by Meyer and Boon (2003) who found that indigenous communication mechanisms (such as storytelling, dancing, and drama) applicable to the local context, enabled development agents to integrate indigenous and exogenous knowledge in rural communities at Phokoane in South Africa. These findings indicate that folklore alone or in combination with other media such as radio can improve the sharing of agro-biodiversity IK and introduce the relevant exogenous knowledge in local communities.

In terms of occasion of folklore activities, similar findings have been reported in other communities in Tanzania. For example, a study done by Lwoga (2009) indicates that various forms of folklore were practiced during social-cultural events in the communities surveyed. Songs 42 (53.2%), dance 39 (49.4%), and reciting proverbs 18 (22.8%) were the major types of folklore activities practiced during socio-cultural events including wedding ceremonies, initiation rites ceremonies, funerals, entertainment, circumcision, new born babies ceremonies and during harvesting , political events, evenings, farming season, and the tourist season.

These findings concur with those of Mudege's (2005) study onf knowledge production and dissemination in Zimbabwe which revealed that songs and drama are performed for entertainment and to instill agricultural education although the messages conveyed are also highly political in content. These findings indicate that folklore plays key role in the sharing and distribution of agricultural knowledge in the surveyed areas.

The study revealed that songs, dances, storytelling and cultural festivals are major channels for practicing and preserving folklore which carry different messages. Story telling is mostly used to discipline, educate and to passing culture from one generation to the next generation. Generally, farmers do not share or distribute agro-biodiversity knowledge among them. The folklore practices that were mainly used to share farming related matters were songs, dances and drama performed during harvest season.

With regard to the use of farmer groups as a channel for sharing information, however, there are very few such groups in the study area and very few farmers belong to farmers groups. Farmer groups are important for agricultural research and extension; they are also an entry point for communities of practices or knowledge communities as emphasized by various KM models (Earl, 2001; McAdam and McCreedy, 2000). Communities of practices are driven by shared curiosity about what other members know and what the group might eventually accomplish if they continue to explore their common interests and skills (Wenger, 1998).

Farmer groups help communities to enlarge their abilities, to compress the time required to accomplish their tasks and to take advantage of the accumulated knowledge of previous generations. When farmers group together they are able to share what is held among themselves, they become critical to what they share and are able to evaluate who has reliable knowledge on farming matters and who does not have reliable knowledge. In that way the groups create intimate relations that sustain their knowledge base.

The findings of this study support those of Dejene, *et al,*. (1997) who found that there are very few farmers in Haubi and surrounding areas in Dodoma that know and are affiliated to local associations. Similarly, Lwoga (2009) found that very few farmers are members of local associations. This can be attributed to negative experiences with government-initiated associations because they believe t such associations can be used as rubber stamps to promote unpopular farming practices and because farmers who were involved in farmers' groups did not see the benefits

resulting from such groups. It is also true that, low level of awareness on the importance of farmers' groups, age and negative perceptions of farmers' groups are also important factors. The findings suggest that there is a need to encourage farmers to join farmers' groups to cultivate a community of practices and facilitate effective knowledge sharing in local communities.

In terms of initiation rites, the study found that initiation rites are used minimally to share agro-biodiversity IK, because the main purpose of initiation rites is to prepare young women and men for adulthood and to instill responsible sexual and reproductive behavior. However, if formally recognized and promoted initiation ceremonies could be effective vehicles for sharing agro-biodiversity knowledge within these communities.

The findings further show that traditional cultures are location specific and are either enabled or disabled by lack of knowledge sharing activities within communities. Thus, a culture that influences knowledge sharing activities should be identified and promoted to foster knowledge sharing. For instance, the existing structures and networks such as farmer groups, folklore, storytelling, apprenticeships and initiation rites should be promoted, and strengthened for effective knowledge sharing and should be used to encourage innovation and continuous learning in these communities.

Moreover, village leaders, knowledge intermediaries, private and government institutions should encourage farmer's groups to enhance and strengthen communities of practices (CoPs) which already exist for effective knowledge

creation and sharing. Existing structures and networks such as farmer groups, folklore and initiation rites should encourage and motivate active participation of individual farmers and groups and should encourage them to establish links with other communities to enable learning, sharing and creation of new agro-biodiversity knowledge. They should create time and space for communities to share and create new knowledge; and identify IK holders and motivate them to share knowledge through farmer's forums, and other social networks. Story telling should be used more often to share and distribute knowledge during individual and collective interactions such as CoPs.

5.3.4 The preservation of indigenous agro-biodiversity knowledge

This study shows that IK is largely transferred through oral tradition and demonstrations and is preserved in human minds and thus it is disappearing at a high rate. Similar to previous studies (Akiiki, 2006; Campilan, 2002; Mosia and Ngulube, 2005; Wall, 2006), IK is limited by knowledge loss due to the lack of prescribed structures and rules in the surveyed study areas to facilitate the preservation of knowledge as is the case in formal organizations. This study shows that IK is largely transferred through oral tradition and demonstrations and is preserved in human minds, hence has potential to disappear.

Similarly, a study by Agea, *et al*., (2008) found that lack of records on IK is a major limiting factor to effective use of IK in enhancing food security in Uganda. Other major barriers are poor knowledge sharing culture, lack of trust, and social status. It is important to preserve IK before it disappears since it is mainly stored in human minds which may be subjected to either ultimately death or memory lapses. Based on

the study findings, problems related to knowledge loss are personal, social and external environment.

Personal barriers include poor recognition of IK; poor knowledge sharing culture; lack of trust; and personal characteristics (that is, age, gender, status) these factors tend to prevent local communities from sharing knowledge. Social barriers are related to the poor recognition of IK; a poor knowledge sharing culture; disappearance of traditional seeds and plant species; inability to identify IK custodians; disappearance of IK holders; dominant use of contemporary technologies; traditional structures, customs and taboos that inhibit the sharing of IK; high illiteracy levels of early IK custodians; and disappearance of traditions such as folklore. Problems related to the external environment include none integration of IK government policies and plans; lack of appropriate IPR; exclusion of IK in the formal education system; and inadequate professionals, such as extension agents to manage IK.

Another problem stems from the fact that knowledge intermediaries (both in public and private sectors, such as researchers and NGO) who have conducted research on agro-biodiversity IK never disseminated their findings to local communities, and do not fully acknowledge IK. Therefore, all these factors must be taken into consideration at different levels (personal, social, external) in order to prevent IK loss in surveyed study areas. Tacit knowledge can be preserved through oral demonstrations such as folklore, initiation rites, apprenticeships, farmer's groups, communities of practices and seminars. Explicit knowledge formats can be in print

and electronic formats which can be accessed from rural knowledge centers or libraries. Carvings and artifacts can also be used to preserve explicit knowledge.

Public and private partnerships are needed to facilitate the establishment of rural knowledge centers, conduct capacity building on KM issues, and nurture a knowledge culture to enable communities to preserve their knowledge. Knowledge maps can be used to show where knowledge experts are located in a certain locality. Noeth (2004) proposed that knowledge maps in the form of brochures and booklets can be used to help the communities keep in touch with individuals who possess specific types of knowledge. More important, the communities should make sure that knowledge maps and knowledge repositories (either print or electronic) are updated. Outdated maps limit local people from locating knowledge bearers or to access and share knowledge.

5.4 Problems Constraining Indigenous Agro-biodiversity Knowledge Management Activities in Surveyed Areas

5.4.1 Factors constraining acquisition, sharing and preservation of indigenous agro-biodiversity knowledge

Findings revealed that there are a number of factors that hinder the management of indigenous agro-biodiversity knowledge including:

- Poor knowledge sharing culture: inadequate cooperation from knowledgeable farmers limits access to knowledge. For example many of the respondents indicated that they do not share their knowledge, and village leaders do not encourage them to do so;

- Absence of knowledge resource centers (library/documentation centre): since all the surveyed villages are located far from district or regional public libraries;
- Lack of information materials on IK (IK records): Most IK is preserved in people's minds and through folklore and is never documented. There are no journalists or village extension officers to present farmers' issues to the outside world. Therefore most farmers' knowledge is location specific;
- Non recognition of IK: The findings show that farmers consider IK knowledge systems as outdated and linked to witchcraft and therefore neglected by most farmers. Most youth are not receptive to IK due to modernization and formal education system which does not recognized IK. The government also does not recognize IK, since it lacks plans and structures to prioritize, preserve and disseminate IK to communities. There is not a single government project or program that promotes or integrates IK with exogenous knowledge in the surveyed areas;
- Lack of trust: Some of the farmers do not trust the advice given by fellow farmers because they believe such advice is only given with a bad motive and because some of the indigenous techniques have not managed to solve farming problems, such as plant disease control;
- Social economic factors: Differences in age, sex, social, and economic status prevent farmers from acquiring IK from fellow farmers or village leaders. Most of the elderly men and women are not willing to learn from the older generation, while progressive farmers ignore IK, and do not want to learn or share their knowledge with poor farmers. Most poor farmers rely on IK

because they cannot afford to purchase external inputs. As such what IK they know is limited to their own families or friends.

- Lack of intellectual property rights protection: Most IK holders are of the opinion other farmers would benefit once their IK is made public. Others felt that their IK knowledge would benefit pharmaceutical companies and they would have no control. Moreover, some of the IK holders demand payments for services especially knowledge on herbal medicines.
- Illiteracy prevents some farmers from accessing print IK materials;
- Unavailability of extension officers and extension materials prevents communities from accessing IK;
- Lack of information materials in vernacular language: Some farmers fail to acquire IK from fellow farmers and exogenous sources of knowledge because they cannot communicate in vernacular languages. In fact, interviews with some elderly people were conducted with the assistance of a translator because they were not familiar with the Kiswahili or English language. Vernacular languages are disappearing at a fast rate due to formal educational systems which exclude vernacular languages from the curriculum. The coming together of professionals from different ethnic backgrounds and intermarriages has also contributed to the disappearance of vernacular languages.

Similar observations have been made in other studies including, Ecuador (Bode 2006), Swaziland (Dube and Musi, 2002), Uganda (Agea, *et al*., 2008) and Tanzania (Lwoga, 2009) whose findings indicate that farmers do not adequately recognize or explore their knowledge and innovative capacities to improve agricultural

production. Some of the farmers are resistant to change and adopt IK in their agricultural activities, based on personal experiences and thus it is difficult for them to acquire IK from other sources. Resistance to change is a human nature, which leads individuals to resist change (Croteau and Dfouni, 2008). At this level factors constraining management of IK related agro-biodiversity are personal, social-cultural and external environment.

Personal barriers include poor recognition of IK; lack of trust; selfishness of farmers to share knowledge; differences in age, gender, social, and economic status; illiteracy; some indigenous techniques are not effective in solving farmers' problems; IK linked to witchcraft; and due to low income from agrobiodiversity activities. All these factors limit farmers from personally acquiring knowledge from various explicit and tacit sources of knowledge within their communities. These findings are in line with Rowley's (2001) KM model which shows that individuals are willing to share knowledge if they are convinced that they must share knowledge.

Social-cultural barriers relate to none recognition of IK; poor knowledge sharing culture, and the disappearance of culture that influence knowledge acquisition in the communities. Most traditional cultures have been eroded due to modernization, ICTs, population pressure and education. The settlement of professionals from different ethnic backgrounds and intermarriages also contribute to the disappearance of traditional cultures in the surveyed areas. The disappearance of vernacular languages also limits acquisition, sharing and preservation of agricultural IK in these communities. It is therefore important to find ways to prevent the disappearance of

local languages since the continuous use and impact of IK on farming systems depend on these languages. Another barrier is the inability to locate or identify IK holders since there is no established structure to identify them.

These findings are in line with various KM models (Davenport, 1998; Earl, 2001; Nonaka, Toyama and Konno, 2000) which emphasize that KM activities benefit from maps since they increase access to knowledge in the organizations. It is therefore important for local communities, public and private knowledge intermediaries to map IK holders for effective KM practices and integration of indigenous and exogenous knowledge in the surveyed local communities.

According to KM literature and models such as those by Jashapara (2004); Rowley (2001); Small and Tattalias (2000), cultural factors determine the extent to which people who possess the knowledge are willing to share it and place it in a social domain. It is thus important for village leaders and knowledge intermediaries to foster a knowledge sharing culture to facilitate its fast access and sharing among community members.

Other problems stem from the external environment because IK is not recognized or recorded. Similarly there are no rural knowledge resource centers and the existing IPR system leaves much to be desired. The number of extension officers is inadequate and worse still public extension officers are more concerned with conventional approaches and therefore are not useful sources of IK; excluding IK in the formal education system. These results show that while some problems can be solved by individual communities, some of the problems require public and private

partnership interventions. Such partnership interventions can improve the acquisition of agro-biodiversity IK in local communities.

5.5 Contribution of Indigenous Agro-biodiversity Knowledge Management Practices to Livelihoods of Local Communities and Opinions on Preservation of IK

5.5.1 Contribution of Indigenous knowledge to livelihoods

Respondents were asked why they plant crops and trees in the same plot. In response to this question, respondents indicated that they do so in order to ensure food security, generate income, and improve soil fertility through soil conditioning. They also do so in order to get manure firewood, veterinary medicine, human medicine and ornamentals. Few indigenous trees are left to grow in farms and around farm boundaries. Planted trees are mostly mango and guava trees which provide them with fruit and income.

5.5.2 Indigenous knowledge's contribution to biodiversity surrounding areas

Communities in the two districts surveyed use indigenous knowledge to extract a variety of non timber forest products (NTFPs) from the general land forests, farmlands and woodlands throughout the year for daily subsistence and income. This knowledge is about seasons of availability, type of plants, usage of wild plants, processing of edible plants and preservation of plants. Wild plant products collected include firewood, bamboo, poles, wild vegetables, charcoal, wild fruits and others. These also provide income to offset periods of food shortage.

The next section discusses wild products collected in Nachingwea and Masasi districts.

5.5.2.1 Firewood

Firewood is a major source of energy for cooking and heating in rural subsaharan African countries. In this study, findings revealed that most households use firewood as a source of energy that is cooking, heating and burning bricks because it is cheaper, readily available and affordable. Mud bricks are usually dried using firewood and this increases firewood consumption. These findings are in line with Lusambo (2009) who found that Tanzanian energy balance is dominated by biomass-based fuels, particularly wood fuel (firewood and charcoal) and account for over 90% of primary energy supply. In sub Saharan African countries firewood is the main source of energy for over 85% of the people in Namibia, 90% , in Malawi, 70% in Zambia and 80% in Mozambique (Mogaka, *et al.*, 2001). Similarly, Schaafsma, *et al.*, (2011) reported that, about 95% of respondents in Eastern arc forest are involved in firewood collection and use. Kilonzo (2009) found that 94% of respondents around Nyanganje Forest Reserve in Morogoro collect and use firewood. Msemwa (2007), also found that 98% of the households surveyed in Kilosa District use firewood as a primary source of energy . Abdallah (2001) found that about 84% of the people in Tabora Rural District depend on firewood for cooking and heating. Based on these examples, it is clear there is a high demand for firewood at household levels in Tanzania. In Kilosa district and Nyanganje Forest reserve firewood is a source of income (Msemwa, 2007, and Kilonzo, 2009).

This study identified similar firewood which were also identified by Kilonzo (2009) including *Burkea africana, Brachystegia bussei, Pseudolachnostylis maprouneifolia, Dalbergia melanoxylon*. Bevan (2003) identified a few similar tree species used for firewood in Nachingwea including *Pseudolachnostylis maprouneifolia*, *Dalbergia melanoxylon and "Msimbiti"* (local name). These have high calorific value, less ash and produce less smoke. Socio economic studies conducted in villages surrounded by forests show that one headload of firewood weighing 15 kilogram sells at TZS 1,000. Each household extracts on the average two headloads of firewood per week which is equivalent to 96 bundles of firewood per year.The annual value of firewood per household is TZS 96,000. Therefore, 12,096 bundles of firewood collected annually is valued at TZS 12,096,000.00.

Schaafsma, *et al*.,(2011) observed that in the eastern arch mountains (EAM), firewood collected is approximately 72 million head loads which is equivalent to TZS 36 billion per year. In another study Kilonzo (2009), observed that headloads of firewood weighing 20kg is sold at TZS 1,000 in the villages around Nyanganje Forest Reserve and Mhapa (2011) found that a headload of firewood at Ilembula and Makambako in Njombe district sold between 1,000 to 2,000 TZS. It is estimated that over 5 million bundles of firewood are harvested yearly in the coastal areas with the market value of almost $ 750,000. Most of this is for subsistence use, only a very small proportion brings in cash income (Richmond, *et al*., 2002: Kaale, *et al*., 2000).

Similarly, Maximillian (1998), noted the annual value of firewood in Northern Ruvu Forest Reserve, Kibaha District is approximately TZS 21,294,000 higher than what

this study found. The differences can be explained by the high demand for firewood in Kibaha township and Dar Es Salaam due to high cost of alternative sources of energy and individual household income.

5.5.2.2 Bamboo

Bamboo poles are useful materials for house construction and artisarnal purposes . In this study the respondents said they use bamboos to construct houses, fence and for roofing, extract wine (ulanzi) and to produce a wide range of artisanal items like baskets, mats, harvesting baskets, drying mats, winnowing basket (nyungo), large baskets (tenga), and for storage of agricultural produce (vihenge). Diversity of products obtained from bamboo non timber forest products have motivated most people in the study area to engage in bamboo collection and use. Therefore bamboo is a valuable product. For instance, Ingram, *et al*., (2010), reported that 77% of NTFPs collectors in Cameroon are involved in bamboo collection and use. 51 percent of bamboos are harvested throughout the year, 44% are harvested only in the dry season and 5 percent are harvested only in the rainy season. A headload of bamboo (15 bamboo poles) costs TZS 1,000 per headload. This price is low probably due to easy availability of firewood in the study area. It was found that 12,960 bamboo headloads are extracted from the forest annually. This is valued at TZS 12,960,000.

The high usage of bamboo can be attributed to the fact that they are cheaper and easily available for houses construction, roofing and fencing, big and small baskets, mats, ,,), and for storing agricultural produce (vihenge). A winnowing basket (ungo) is sold at TZS 1,000.

Studies conducted by Masanja (2004), in coastal forests, revealed that large baskets and winnowing baskets sell for TZS 1,000 and 1,500 respectively in coastal towns. This price is not different from the price in the study area. Ingram, *et al.*, (2010), reported that small scale bamboo collectors in Cameroon collect about 500 stems per year generating on the average about 236,208 CFAC (USD 535.4). Bamboo household consumption per year from adjacent forests produce a range of products which contributes significantly to household income and provide employment opportunities for people who sell bamboo products. Bamboo species commonly harvested in the study area is low land bamboo (*Oxytenanthera abyssinica*). Msemwa (2007), and Kilonzo (2009) found similar bamboo species in Kilosa District and in Nyanganje Forest Reserve.

5.5.2.3 Poles

Building poles are widely used for house construction in the surveyed districts. The usage rate for poles is lower compared to other places as reported by Kilonzo (2009), who observed that 91% of respondent were involved in pole collection in Nyanganje Forest Reserve. Paulo (2007), also observed that 97% of the respondents in Kilwa District collect building poles. The lower percentage of pole usage in the study area is because they use bricks and bamboo for building and for roofing. Because of the biodiversity richness of bamboo, the average extraction of poles is lower per household. On the average, a household extract about 10 poles per year. This differs from other studies which observed that about 500 poles are used to construct a three roomed house in Nyanganje forest reserve in Morogoro (Kilonzo, 2009). Rovero (2007), observed that 600 poles are needed to construct a two roomed

house in Mazumbai, Tanga, Tanzania. The differences might be due to availability of alternative construction materials (bricks and bamboo), size and design of constructed houses.

Findings from this study revealed that the most commonly used tree species for poles are: *Pseudolachnostylis maprouneifolia (msolo), Msimbiti, Dalbergia melanoxylon (mpingo), Millettias tuhlmannia (mpande),Pterocarpus angolensis (mtumbati) and mseva.* Kilonzo (2009) found that *Brachystegia bussei*, *Combretum adenogonium*, *Dalbergia melanoxylon*, *Uapaca nitida* and bamboo species such as *Oxytenanthera abyssinica* are the most preffered building poles for permanent houses because they are durable, straight, long and are resistance to insect damage.

Based on the findings of this study, 10 pieces of building poles is sold for TZS 1,000 per pole. Three hundred and seventy (370) bamboo poles are extracted from the forest annually and is valued at TZS 370,000.

Other reseachers for example, Kilonzo (2009) and Lema (2003), observed that households in Morogoro Rural District and Nyanganje Forest Reserve villages use about 19 headloads of poles per year. Maximillian (1998), and Paulo (2007), reported usage of about 113 and 152 headloads of poles per household per year in Kibaha and Kilwa Districts respectively. Masanja (2004), observed that the total net financial value (net value to households in terms of home consumption and cash income) from poles is estimated to be $9.2 million, or $575 per household per year in Coastal Forest (Rufiji and Bagamoyo) and a large proportion of this is realized as

cash income. Schaafsma et al.,(2011), observed that pole collection in EAM contributes to about TZS 957 per capital with a total annual quantity of 3.7 million poles, fetching a total value of TZS 2.2 billion per year. The findings on pole consumption per household per year in this study show that local people in the study area probably do not use poles for construction instead they use bricks and bamboo.

A study by Kilonzo (2009), around Nyanganje Forest Reserve, Morogoro estimated the annual current estimated value of poles to be about TZS 2,337,000. A study by Msemwa (2007), in Kilosa District, Morogoro estimated that the annual current value of poles was TAS 6.2 billion. The value of poles in the two districts is lower compared to other places due to availability of alternative construction materials such as bamboo and bricks.

5.5.2.4 Wild fruits

In the study area, fruits are collected on a seasonal basis by both male and female children especially during food shortages. Findings of this study show that 45 (33.1%) of respondents indicated that they collect wild fruits to sustain themselves during periods of food shortages.The results indicate further that few households are involved in wildfruit collection compared to results reported from other studies. For example, Kilonzo (2009), observed that 85% of respondents interviewed in Nyanganje Forest reserve, Morogoro collect and utilize wild fruits as their main food during famine. Mapolu (2002), noted that almost all (99%) of the respondents in Tabora District utilize wild fruits as a snack. The difference can probably be caused by few wild fruit species richness in the study area and inadequate knowledge on the

edibility of other wild fruits. Presence of other cultivated fruits such as mango and guava, discourages collection of wild fruits.

Fruits harvested that were frequency mentioned include: -*Syzygium cuminii* (Zambarau), *Adansonia digitata* (Ubuyu), *Tamarindus indica* (ukwaju), *Schererocarya birea* (embe ng`ongo pori) and *Annona senegalensis* (mtope mwitu). Other fruit tree species identified during focus group discussion by local names include *Nachipondo, Nakasonga, Msakalawe, Mpindimbi, Ndawatawa, Mpitimbi and Mpulukututu*. Similar utilization of wild food plants have been reported in other countries as well. For instance, Akuja (2010) reported that rural people in Ethiopia are endowed with profound knowledge of wild plants. The most common fruits consumed in Ethiopia are from plant species such as *Ficus spp*., *Carissa edulis* and *Roso abyssnica*. It is further reported that the consumption of wild plants is more common and widespread in food insecure areas. Thus local people know the importance and contribution that wild plants make to their daily diets.

Findings of this study revealed that a household collects 1 kg of wild fruits per day when they are in season, and 90 kgs per household is collected annually. This brings in about TZS 45,000. Therefore, 4050 kg of wild fruits are collected per year during the season which has an annual value of TZS 2,025,000.00 if sold at TZS 500 a kilo.

The price is low compared other researches on valuation of wild fruits. A study by Kilonzo (2009) observed that wild fruits collected every year in Nyanganje is worth TZS 654 500. Msemwa (2007), found that 44kgs of wild fruits are hervested

annually per household in Kilosa District Morogoro Region with the annual value of TZS 386. Mhapa (2011), study in Njombe district revealed that pricing of wild fruit varies from locality to locality and consumers' preference. For example in rural areas a 20 liter tin of wild fruits sells between TZS 2000 and TZS 3000 and in urban markets the price is between TZS 6,000 and TZS10, 000. The low wild fruit cost less in the villages is because anyone can collect what they need from all the surrounding forests. Akinnifesi, *et al.*, (2005) found that the price of wild fruits' vary depending on the season (availability) and location (the distance the markets the lower the price at the point of origin and vice versa).

5.5.2.5 Charcoal

Charcoal is the single largest source of household energy in urban areas, because it is cheap, easy to transport, distribute, and store (Christian, 2009). Few households reported that they are engage in charcoal production. A study by Kaale, *et al.*, (2000), revealed that at least 300 bags of charcoal leave the forest daily, this is about 9 000 bags or more per month from Coastal areas to Dar es Salaam. Total annual charcoal consumption in Tanzania is estimated at 1 million tons, and annual supply of wood needed for this is estimated at 30 million cubic meters. It is estimated that as many as 160,000 earth kilns are built each year, or 438 per day to meet the demand (Christian, 2009). In the study area results demonstrate that few respondents are involved in charcoal production perhaps due to the fact that 92.6% of the residences in the study area use fire wood as their main source of fuel for cooking. Few respondents are involved in charcoal production specifically during land clearing for agriculture; the logs from the farms are used to produce charcoal.

Commercial charcoal production is discouraged by bad market condition in the study area since there are few civil servants and these are the main users of charcoal.

This study identified tree species used for charcoal namely; *Julbernardia globiflora (mchenga), Pericopsis angolensis (Mwanga), Pseudolachnostylis mapronuneifolia (Msolo)* and other tree species identified by their local names like *Mchejesya, Mjembe, Mseva and Mjanda*. Bevan *et al*., (2003) identified few tree species in Nachingwea similar to what this study found. Studies conducted in villages surrounding the forests revealed that a 20 kilogram sack of charcaol sells at TZS 2,000 and each household extracts an average of 23 bags per week which is equivalent to 1,104 sacks annually. 39,744 bags annually translate to TZS 79,480,000. Charcoal is produced all the year around, but production increases dramatically during the dry and famine seasons, because people need money to buy food and other provisions.

The few households interviewed in the study area purchase or use charcoal because it is readily available. Bevan *et al*., (2003) estimated the price of a sack of charcoal weighing 20 kgs in Nachingwea to be between TZS1, 000-1,500. Income from charcoal is estimated to be TZS 10,000 profit per month, greater than the income from a four-acre field of cashew nuts which generates TZS 80,000 per year. The annual flow of benefits to charcoal producers in and around the EAM is 21 billion TZS per year (USD 15 million) (Schaafsma, *et al*.,2011). Few households use charcoal in the study area because they use firewood which is cheaper and is easily collected from surrounding forests.

5.5.2.6 Medicinal plants

Medicinal plants are agro-biodiversity resources which plays direct roles in health care. Findings revealed that only a few of the respondents interviewed are engaged in the collection or trading of medicinal plants even though these plants are said to be potent local wild products for treating various ailments. Results from key informants that is traditional healers and participants in Focus Group Discussions revealed that medicinal plants used are: *Pseudolachnostylis maprouneifolia (msolo), Julbernardia globiflora (mchenga), Annona senegalensis (mtope mwitu), Diplorhynchus mossambicensis (Mtomoni) and Crosscephalum mannii (mdaa).* Kilonzo, (2009); Kitula, (2007); and Abdallah, (2001) observed related fewer medicinal plant species and parts of plants used in Nyanganje Forest Reseve, New Dabaga Ulogombi Forest Reserve and Tabora Rural Distric in Tanzania. Identified medicinal plant species are used to treat a wide variety of diseases like stomach pain, headache, hernia, heart diseases, eye diseases, loss of appetite, degedege, stroke, chest pain, pnemonia and mental illnesses.

5.5.2.7 Wild animals

For people who live in close proximity to forests, wild animals are an important part of their daily diet and a key source of protein. The range of products consumed includes birds and their eggs, insects, rodents and other larger animals. The finding from this study show that only few respondents are involved in wildlife hunting. Only 13 (9.6%) of respondents reported to hunt wild life. Masasi and Nachingwea are not rich in wild animals except in a few villages surounded or located near Lukwika/Lumesule and Misenjesi game reserves, whereby some animals go astray from the reserve but they know it is illegal to hunt near game reserves.

Some of the animals that are hunted include: *Otamochoer usafricanus* (wild pig), *Tragelaphus scriptus* (Ndandala/mbawala), *Guinea fowl* (kanga), *Papis cynocephalus* (ngedele/nyani), *Cephalophus natalensis* (Ngolombwe), *Syncerus caffer* (nyati) and rats.These animal species are similar to those observed by Kilonzo (2009) and Kajembe, *et al*., (2000). The main hunters of wild animals are men.

5.5.2.8 Wild vegetables

Wild vegetables are extracted from the surrounding land in the two districts. The collected vegetables are used for relish during meals. Wild vegetables commonly harvested by their vernaculars names include: *intimbe mwii, lilende* (mlenda) *and haka* (mbegu za upupu). Many of these vegetables are eaten during seasons of food scarcity. FAO (2006) reported similar usage of wild vegetables in rural Ethiopia. During food shortages, people harvest new succulent shoots and leaves of *Solanum nigrum (black night shade)* which are cooked like cabbage. This has intensified because of repeated climatic shocks that have hampered agricultural production in this area. Similarly, 8 (5.9%) of the respondents indicated that they extract honey and 20 (14.8%) said they extract mushrooms.

Non-Timber Forest Products are a vital source of foreign exchange and revenue and are critical to the rural household's economy. Results from this study show that estmated total income accrued from NTFPs activities is TZS 106,939,000 annually. This value is what would have been paid or compensated if the local communities were denied access to NTFPs (Kajembe, (2007).Kilonzo (2009), noted that total income accrueing from the forest from NTFPs activities at Nyanganje forest reserve is TZS 45,169, 300 annually. Robison and Kajembe (2007), found the average value

of NTFPs collected by villagers around South Nguru Mountain Morogoro per week is TZS 580, equivalent to TZS 30,200 per year. This difference can be attributed to financial constraints faced by villagers, availability of alternative resource forest management systems and forest accesibility.The increase in the level of awereness regarding NTFPs increases the extraction rate per household, as people become aware of the economic contribution of NTFPs to their livelihood.

5.6 Contributions of Indigenous Agro-biodiversity Knowledge to Community Livelihoods' Strategies to Counter Vulnerabilities

During Focus Group Discussions respondents were asked to state how they cope with vulnerabilities related to climate changes such as decreased rainfall, declining soil fertility, and pests and diseases. The respondents admitted that they have noticed several climate change indicators including decreasing rainfall, increase in incidences of drought, unpredictable rain seasons and an increase in temperatures. The local communities said they use their indigenous knowledge to reduce these vulnerabilities in several ways including using different cropping systems, mainly mixed and row intercropping; soil moisture conservation technique such as growing crops on ridges instead of flat land and use of cover crops such as sweet potato; planting fast maturing crops like sesame; planting drought resistant crops like sesame, cassava and sweet potato; use of fruit tree stands that have been planted long time such as mango and cashew nut stands. Others include use of forest products to compensate for poor crop yield. For instance the families engaged in making various marketable products from bamboo, sell these to earn income that is used to buy food.

According to Jackson, *et al.*, (2007), the maintenance of agro-ecosystems using intercropping is beneficial in that there is a lower pest and pathogen incidence found in intercrops, and there is higher resource use efficiency of crops with different root systems and leaf morphology. Communities in the study area have practised intercropping for a long time ago exploiting the benefits that result from these cropping systems (sustaining the crop yield and hence ensured food security). Again all of the respondents gathered NTFPs to compensate for low income from crops sales. This was in turn used to buy food during low harvest seasons.

5.7 Overall Perception on Contribution of Indigenous Agro-biodiversity Knowledge Management on Meeting Community's Livelihoods

The study found that sex and age did not have statistical significant differences regarding communities' preferences in use of IK. That is to say there was no relationship in the preferences in the use of IK versus the two variables with use of Ch-square test.

With regard to education level, there was a statistical significant relationship between education level and preferences usage of IK. Thus, the five education levels were related. That is a null hypothesis that people with different education levels hold the same preference on the usage of IK is rejected. Knowing the education level for one person can tell you the value of preference for use of IK. It has been pointed out by many scholars who have studied IK that younger generations for instance underestimate the utility of indigenous knowledge systems (IKSs) because of the influence of modern technology and education (Ulluwishewa, 1993 cited in Ngulube,

2002). Thus, because the current young generation has been exposed to modern education than elderly people, they do not value IK. It can thus, plausibly be said that the higher the level of education the less the preference for IK. This is why Dube and Musi (2002) argue that IKS are threatened by socialization, education systems, and influence of western culture.

Results from the binary logistic equation indicate that the variables influencing perception on importance of IK in management of agro-biodiversity contribute 3.0% and 7.0% as explained by Cox and Snell R square and Nagelkerke R square values respectively. The model classified correctly 92.0% of all cases included in the model as indicated by PAC. That is SPSS classified (guessed) that all cases would not judge that IK is not useful for management of agro-biodiversity and does not contribute to livelihoods. None of the predictor variables showed a higher contribution to the predictor of the model since all the p-values for the Wald test were greater than 0.05.

The Wald statistics in this study are non-zero values, which imply that there is interaction between the dependent and independent variables. According to Norusis (1990) and Powers and Xie (2000), the non-zero Wald statistic values indicate the presence of relationships between the dependent and explanatory variables. Thus, on the basis of the results of this study the null hypothesis was rejected in favor of the alternative hypothesis that socio-economic factors influence the perception on importance of IK at 5% level of significance.

5.7.1 Farm size (acres)

Cultivated land size has positive regression coefficient (β) of 0.017 with odds ratio (Exp β) of 1.017 which was statistically insignificant at probability level of 5% (p = 0.656) (Table 51). In other words, increase in one unit of cultivated land size increases the chance of human activities in the farms by a factor of 1.017 and vice versa. This implies that if a household has a large piece of land to cultivate, it will harvest more and will thus become self-sufficient in terms of food security and income.

5.7.2 Literacy level

Literacy level has a positive regression coefficient (β) of 0.999 with odds ratio (Exp β) of 2.711. This implies that an increase in education, which was statistically insignificantly (p=0.168), increases human activities in agro-biodiversity management by a factor of 2.711. Education is an important issue in development of livelihood strategies as it determines which livelihood activities a household is involved. Therefore, education is an enabling factor that influences households in the study area to engage in various livelihood activities and therefore in valuing IK. Similar arguments were put forward by Shalli (2003) in the Coastal region of Tanzania. He emphasized that the level of education has a remarkable bearing on sustainable management of natural resources. It was generally acknowledged that education is perceived as being among the factors that influence an individual's perception on importance of IK. According to Mitinje et al. (2007), education is normally considered as the key to improved opportunities for development and accessibility to information and services.

5.7.3 Age of household head

Age of household head has negative regression coefficient (β) of -0.025 with odds ratio (Exp β) of 0.975 which was statistically insignificant at probability level of 5% (p = 0.275) (Table 51). In other words, decrease in one unit of age of household head decreases the perceived importance of IK by a factor of 0.975 and vice versa. Thus elders are much more likely to perceive the importance of IK positively that young people. The mean age of the respondents in this study was 46.04 years and 46.1% of the respondents are over 45 years. This could be the reason for the positive perception of the importance of IK.

5.7.4 Influence of parents

Parents have negative regression coefficient (β) of -0.175 with odds ratio (Exp β) of 0.840 which was statistically insignificant at probability level of 5% (p = 0.764) (Table 51). In other words, decrease in one unit of parents decreases the perceived importance of IK by a factor of 0.840 and vice versa. Thus, young people that do not accompany relatives are not likely to gain sufficient indigenous knowledge from parents than are those that interact with parents. Thus, they are more likely to perceive IK negatively. The study engaged mainly old people and opinions on this variable was mainly sought from parents. This could be the reason for the negative perception on this variable.

5.7.5 Influence of family

Family have negative regression coefficient (β) of -0.291 with odds ratio (Expβ) of 0.748 which was statistically insignificant at probability level of 5% (p = 0.764) (Table 51). In other words, decrease in one unit of parents decreases the perceived importance of IK by a factor of 0.796 and vice versa. This means that young people

that do not accompany the family in farming and wild activities are not likely to gain sufficient indigenous knowledge from than are those that accompany the family. Thus, they are more likely to perceive IK negatively. The study engaged mainly old people and opinions on this variable was mainly sought from parents. This could be the reason for the negative perception on this variable.

5.7.6 Neighbors/friends

Neighbors/friends have a positive regression coefficient (β) of 18.586 with odds ratio of 154,581,779.238 which was statistically insignificant at probability level of 5% (p=0.999) (Table 51). This means that the importance of IK perception increases by a factor of 154,581,779.238 for a unit change in this variable. In other words, increase in the number of neighbors/friends a household interacts with in the villages increases the skills, knowledge and experience on farming and use of NTFs and therefore increases the likelihood of the positive perception on IK.

5.7.7 Farming experience

Farming experience is related to duration of residence in the area and has a positive regression coefficient (β) of 0.022 with odds ratio of 1.022 which was statistically insignificant at probability level of 5% (p=0.392) (Table 51). This means that the importance of IK perception increases by a factor of 1.022 for a unit change in this variable. In other words, increase in the number of years of residence of the households in the villages increases the likelihood of the perception on farming activities and general land and forest products use. The more people stay in a given place, the more their families grow in size. Thus, more agricultural and forest

products are demanded from the adjacent surrounding and more land is required to meet the demands of the growing population.

5.7.8 Personal experience

Personal experience is related to duration of residence in the area as well and has a positive regression coefficient (β) of 0.005 with odds ratio of 1.005 which was statistically insignificant at probability level of 5% (p=0.994) (Table 51). This means that the importance of IK perception increases by a factor of 1.005 for a unit change in this variable. In other words, increase in the number of years of engagement in farming and use of NTFs for the households in the villages increases the likelihood of the positive perception on IK. The more people stay in a given place, the more they gain experience in farming methods and knowledge on different useful wild products. Thus, more experience on agricultural farming methods and forest products use are acquired due to increased experience by farmers in the study area.

5.7.9 Influence of extension staff

Extension staffs have a positive regression coefficient (β) of 18.841 with odds ratio (Exp β) of 1, 523, and 13,342.19. This implies that an increase in extension personnel visiting local communities, which was statistically insignificantly (p=1.000), increases human activities in agro-biodiversity management by a factor of 1, 523, 13,342.19. Extension service is related to education and is an important issue in convincing and teaching farmers to use certain farming techniques and useful NTFs. Therefore, is an enabling factor that influences households in the study area to engage in various livelihood activities and therefore in valuing IK. Although few

communities admitted that there is limited extension service in the area, it is considered an important factor to promote IK.

5.7.10 Influence of gender

Sex of household head has negative regression coefficient (β) of -0.494 with odds ratio (Expβ) of 0.610 which was statistically insignificant at probability level of 5% ($p = 0.382$) (Table 51). In other words, decrease in one unit of sex of household head decreases the perceived importance of IK by a factor of 0.610 and vice versa. Studies show that gender determines who does what in terms of collection of wild products (Kajembe *et al.,* 2000). Indigenous knowledge is unevenly distributed because it is closely tied to an activity and accessibility is determined by participation in related activities. Traditional healers, traditional birth attendants, farmers, livestock keepers and honey collectors for instance, access relevant local knowledge and acquire skills through active involvement in related activities, experimentation, adaptation and propagation of new ideas gained through experience (Koda, 2003). Both male and female participate in related activities differently. Thus, increase or decrease in participation by one sex in certain activities results in the observed differences.

5.8 Respondents Opinions on how Best to Preserve IK

Managing and preserving IK helps to reduce poverty, enhance equity, reduce environmental degradation and leads to sustainable development and increased local participation in the development process. In this study, local communities were asked to give opinions on how they would like to preserve indigenous knowledge for improved livelihoods. A majority need access to modern farming inputs and integrate them with local farming techniques. Some suggested that they need frequent visits

from extension staff to teach farmers how to integrate farmers' knowledge and external knowledge (EK). Others suggested that IK should be documented in various forms such as songs, text, dance, films and other storage devices. In addition, some suggested that IK should be integrated with EK. In addition, others suggested that usage of IK and other indigenous products should be promoted among youth so they can value it. Few indicated that local communities should be taught modern methods of IK record keeping.

These results corroborate those of Ngulube (2002) who argues that it is important to preserve and integrate IK into existing knowledge management systems for the benefit of society. He posits further that the recording of IK is nothing new. For instance, missionaries and colonial district officers collected information on customary patterns of land tenure, crop and livestock ownership and traditional beliefs and rites, to mention just a few. Until recently, the primary strategy for preserving IK has been ex situ preservation, i.e. isolation, documentation and storage in international, regional and national data archives (Brokensha, *et al*., 1980: Warren *et al*., 1993 cited in Ngulube, 2002). In the 1990s, the ex situ preservation strategy was used with remarkable success to document natural and supernatural healing practices of the Fulani pastoralists in the north-west province of Cameroon (Nuwanyakpa, *et al.,* 2000 cited in Ngulube, 2002).

Ngulube (2002) suggests further that information professionals should use proactive approaches to effectively manage societal knowledge resources and ensure that even though indigenous knowledge is used as oral tradition, it should be managed and preserved like documented knowledge and grounded in western codified knowledge

schemes. Further that they should devise strategies to ensure indigenous information and knowledge is accessible by:

- preparing inventories and registers of traditional knowledge systems and by taking into account intellectual property implications
- making IK accessible to communities particularly young people, through effective marketing strategies
- creating IK collection development policies but taking into consideration the implications of the storage media and preservation
- developing standardized tools for indexing and cataloguing IK systems
- Compiling bibliographies of IK resources.

Similar suggestions were made by IIRR (1996) who argued that in order to facilitate preservation of IK, the research community should record, document and use IK to its accessibility to both the scientific and local communities and to support formulation of sustainable development plans, create awareness on the value of IK (record and share IK success stories through songs, plays, storytelling, videos and other traditional or modern means of communication). Furthermore, key actors on IK should involve and encourage communities to take pride in their knowledge and in ensuring it is recorded and to document local practices. This means they should train local communities in research skills and empower them with documentation tools (computers and video equipment) and ensure that IK is available, accessible and disseminated back into communities via newsletters, videos, books and other media, and to be conversant with intellectual property rights and agreements so that IK is not misused but benefits the community from which it originates.

CHAPTER SIX

KEY CONTRIBUTION OF THE RESEARCH, SUMMARY, CONCLUSION, RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

6.0 Introduction

This chapter provides a summary, conclusions and recommendations on study of investigation on the contribution of indigenous agro-biodiversity knowledge management practices to the livelihoods of local communities: Case study of Masasi and Nachingwea districts in Tanzania.

6.1 Key Contribution of the Research

- This work has produced a detailed inventory of IK related to agro-biodiversity management in Masasi and Nachingwea districts which will be useful for researchers and project development planners working in related areas now and in future.
- It has created awareness on the importance of understanding the existing IKS and their integration with exogenous knowledge systems by development actors.
- It has generated information that can be used as baseline by later studies.

6.2 Summary

This study was carried out in Masasi and Nachingwea districts. The researcher investigated indigenous agro-biodiversity knowledge management approaches and their contributions to livelihoods of local communities in the surveyed districts. It sought specifically to identify existing indigenous knowledge related to agro-biodiversity management among local communities, to determine how local

communities access and share indigenous knowledge related to agro-biodiversity, to examine the barriers constraining access to and use of indigenous knowledge when managing agro-biodiversity at local levels, to find out how indigenous knowledge on agro-biodiversity management contributes to livelihoods of local communities and recommend better ways for preserving indigenous knowledge on agro-biodiversity management among local communities.

The key findings from the study are as follows:

In terms of socio-economic characteristics of respondents, the findings of this study indicate that local communities have low level of education and more women farmers are disadvantaged in terms of access to formal education in the surveyed areas. Moreover, most respondents in this study are not employed in the formal sector but are engaged in farming and collection of wild products. Furthermore, middle aged men and women have a lot of accumulated experience and knowledge on sources of wild vegetable, honey and pole species and can distinguish between poisonous and non-poisonous species of wild vegetables. This implies that both young and adults have some forms of indigenous knowledge on wild products for improving their livelihoods.

For indigenous knowledge related to agro-biodiversity management among local communities, a wealth of knowledge was found among them. The study revealed that local communities possess a wide range of indigenous knowledge on soil fertility matters (especially good and bad soil characteristics). They also know soil characteristics or indicators of good soil fertility: black soil, good crop performance,

presence/ vigorous growth of certain plants, presence of plants in a dry environment and abundance of earth worms in the soil. They also mentioned some characteristics indicating poor or bad soils such as presence of yellow and red soil, compact soil, stunted plant growth, appearance of certain bad species of plants, and presence of sands, rocks and stones. In this study, local communities cited occurrence of plant species known in local vernacular as *Nambanawe (Bidens pilosa), Chikungulu (Striga weed) and Mbuta (Cyperus rotundus)* which signify decline in soil fertility. The study found that intercropping is a widespread practice in Masasi and Nachingwea and, the dominant intercropped crops are mainly maize + pigeon peas and maize + cassava + pigeon peas, followed by mono-cropping systems. The findings from the interviews revealed that both traditional and conventional approaches are used for seed storage even though applicability of indigenous methods outnumbered exogenous methods. However, the study did not find use of some common local materials used for seed storage that have been used in other communities to preserve seeds such as chili pepper and neem. They also have knowledge on planting methods such as use of ridges because they preserve moisture for a long time compared to flat land. Those who use rows also inter- plant other crops between rows of major crops (intercropping) to spread risk in case of unreliable weather especially rainfall. When planted randomly, crop ground cover is increased and hence reduces moisture loss from the soil. The findings show that farmers have a wide range of knowledge on local practices and traditional methods of preserving crops. Most of them use traditional methods than conventional inputs and facilities. They store harvests mainly in granaries which are located outside farmers' houses and hanging cobs of maize on tree because there are very few cases

of theft. In terms of plant pest and disease control, findings of this study differed with previous studies because none of the respondents reported the use of indigenous materials to control crop diseases/pests, instead they use fire, patrols, leave land fallow to allow plant regeneration, making buffer zones in the general land to demarcate areas allowed for public use and protected area, and observation of village by laws that govern land usage.

In terms of access to and sharing agricultural indigenous knowledge, farmers do not make full use of formal sources of knowledge such as books, posters, newspapers, seminars and agricultural shows. Findings of this study show that farmers rely heavily on local (internal) sources of knowledge to acquire IK, rather than external and formal sources of knowledge. These are predominantly tacit and local sources, which include personal experience, parents/guardian/family, neighbours, friends/relatives, social group gatherings, village meetings, and village leaders and farmers groups.

The study found little identification and integration of indigenous knowledge with exogenous knowledge in the farming communities by knowledge providers. The fact that few farmers were involved in the participatory research activities to generate knowledge indicates that knowledge is mainly created within the social paradigm rather than the scientific paradigm. The knowledge development process therefore shows that farmers create new knowledge through socialization processes such as face-to-face interactions, group interactions (that is, social gatherings and farmer groups meetings and village meetings), and cultural roles such as initiation rites

during adolescence and direct observation. This socialization process enables local communities to combine their knowledge with that of others to solve problems and to adapt knowledge to their own environment.

Apart from socialization, other sub-processes in Nonaka and Konno's (1998) knowledge creation model were partially fulfilled in this study, which include externalization, combination and internalization. In the externalization process, these findings show that farmers externalize their tacit knowledge into explicit knowledge although the practice is very low. Only a few farmers convert indigenous tacit knowledge into explicit forms, which include written formats, folklore and carvings. As for the combination process, the study findings showed that farmers do not create new knowledge through the use of multiple bodies of explicit indigenous and exogenous knowledge.

They combine their knowledge with printed materials like books, newspapers, newsletters and posters. In the internalization process, these findings show that created explicit knowledge is shared with farmers through learning by doing, extension services, farmers' groups and folklore. This study further found that folklore practices, farmers' groups and initiation rites are the major vehicles through which communities share their IK on agro-biodiversity. This study found that IK is largely transferred through oral tradition and demonstrations and is preserved in human minds, hence there is IK disappearance.

Major constraints preventing acquisitions, sharing and preservation of IK related to agro-biodiversity management: include; personal barriers (include poor recognition of IK; lack of trust; selfishness and reluctance to share knowledge; age, gender, social, and economic status; illiteracy; some indigenous techniques are not effective in solving farmers' problems); social-cultural barriers which result in none recognition of IK; poor knowledge sharing culture, and the disappearance of culture that influence knowledge acquisition in the communities. Most traditional cultures have disappeared due to modernization, ICTs, population pressure and education. External environmental problems such as failure by government to recognize and record IK, establish rural knowledge resource centers or improve the existing IPR system are also important factors. At the technological level, advancements in ICTs such as TV and radio have replaced oral tradition and folklore. The current generation is interested in listening to radio music and films and therefore do not involve themselves in traditional folklore activities.

Other problems stem from inadequate number of extension officers even though they are more concerned with conventional approaches and therefore are not useful sources of IK and excluding IK in the formal education system. In terms of contributions to livelihoods, Communities in the two districts surveyed use indigenous knowledge to extract a variety of non timber forest products (NTFPs) throughout the year for their daily subsistence and income generation. The knowledge includes seasons of availability, type of plants, use of wild plants, processing of edible plants and preservation of these plants. The wild plant products collected include firewood, bamboo, poles, wild vegetables, charcoal, wild fruits and

others. These have potential to provide income to offset periods of food shortage when sold.

Local communities said they use indigenous knowledge to reduce climate change vulnerabilities including mixed and row intercropping; soil moisture conservation technique such as growing crops on ridges instead of flat land and use of cover crops such as sweet potato; planting fast maturing crops like sesame; planting drought resistant crops like sesame, cassava and sweet potato; use of fruit tree stands that have been planted long time such as mango and cashew nut stands. Others include use of forest products to compensate for poor crop yield. For instance the families engaged in making various marketable products from bamboo, sell these to earn income that is used to buy food.

6.3 Conclusions

The Makua and Makonde are the dominant ethnic groups in Nachingwea and Masasi districts. Middle aged men and women were the dominant group and are engaged mainly in farming and utilization of biodiversity. However this does not mean that young people do not utilize indigenous knowledge. Studies show that those aged above 30 years possesses vast amounts of IK. In terms of knowledge on wild products, most extract wild product from forests. This means that both young and adults have some forms of indigenous knowledge on wild products which they apply to improve their livelihoods.

In terms of gender, more men participated in this study compared to women. The gendered nature of social, economic and policy systems may have limited women's participation. Male farmers are more likely to participate in developmental activities (such as, agricultural extension services, agricultural shows etc.) compared to female farmers. In some communities, women are forbidden to talk to men in the absence of their husbands. This was the case in some of the surveyed households. Thus, more efforts are needed to link gender issues to rural KM activities to ensure equal gender participation in KM practices.

The literacy level in terms of the ability to read and write in the national language (Kiswahili) was quite high in all the research sites surveyed. Overall, more male farmers had more education compared to their female counterparts. The fact that most respondents have primary school education implies that most can utilize a wide range of oral and written knowledge sources to manage IK in their local communities.

Local communities possess a broad base of IK which has proved to be valuable over centuries and respond well in case sources are scarce in their communities. Findings revealed that local communities possess a wide range of knowledge on various soil types and on soil fertility and infertility, intercropping and monocropping.. These findings corroborate those of other researchers for example, Dejene, *et al.*, (1997), who found that the most commonly cited indicator of soil fertility decline is a decrease in crop yields, leaves turning yellow, stunted crops, occurrence of weeds, termite mounds and disappearance of grass and palatable species. In this study, local

communities cited occurrence of fertility decline in the following plant species Nambanawe (*Bidens pilosa*), Chikungulu (Striga weed) and Mbuta (*Cyperus rotundus*).

This indicates that the communities know the benefit potentials of cropping systems for their survival. Major driving forces pushing farmers to practice intercrop are: land scarcity, easy management of intercropped plants, insufficient labour, crop diversification to avert risk, inadequate knowledge about other farming methods, culture and conservation of soil fertility. Centuries of practical experience have given local farmers unique knowledge and decision-making capabilities on what to conserve and how to store crops. Even though farmers have broad knowledge on and use of plant insect repellants, post control medicinal plants, diseases and preservation of crops is generally low in the sampled areas.

Interviews with maize, pigeon peas and cassava growers identified three major planting/sowing methods for these crop including cultivating land in rows on flat land without proper spacing, random planting/sowing and ridges. Overall, most farmers prefer rows for all crops followed by random planting/sowing and ridges. The respondents also had a wide range of knowledge on plant pests, diseases and predators which are identified based on symptoms. In some cases, the knowledge and resources are there, but what is lacking is an effective mechanism for identifying IK holders, from who they can acquire, share and preserve IK.

On access to and acquisition of IK, findings revealed that the primary sources of agricultural IK is predominantly tacit and local knowledge, which includes personal experience, parents, guardians or family members, neighbours, friends and relatives. Other sources of IK include social group gatherings, village meetings, village leaders, and farmers groups. Farmers do not make full use of formal sources of knowledge such as books, posters, newspapers, seminars and agricultural shows, public and private extension services including print materials. These findings are supported by those of other scholars such as Earl (2001) and Meyer and Boon (2003) who contends that face-to-face communication is the major channel for acquiring knowledge in the organizations and local communities.

In terms of the most frequency accessed sources findings again revealed that parents/guardians/family members, neighbours/friends, social groups and village meetings are the most frequently cited primary sources of IK. A majority of the respondents obtain knowledge on new crop varieties, crop planting methods, harvesting, processing, storage, utilization of non timber forest products and soil fertility improvement from tacit and explicit knowledge. It was reported that parents' experience is a major source of tacit indigenous knowledge followed by friends, relatives and exogenous sources such as mass media/extension/farmer groups. Major means of acquiring knowledge on wild food plants in descending order were accompanying relatives during harvesting, initiation rites for adolescents and direct observation.

Usage of indigenous knowledge and techniques to improve soil fertility, acquisition of planting materials, cropping systems, and crop planting systems, weed control, and control of predators is a common phenomenon as opposed to conventional inputs. There is also high usage of exogenous knowledge and techniques for preserving seeds and crops harvested, and usage of local herbs and conventional inputs to control plant diseases and pests. The extensive use of exogenous knowledge in preserving crops is attributed to ignorance because when farmers acquire exogenous knowledge, they ignore other knowledge including their own knowledge. In view of the above there is a need for awareness creation to enable farmers to balance between unhealthy and healthy ignorance for effective Knowledge Management in the study areas. Further that, identification of IK types is important in determining and increasing understanding on what farmers know and how that knowledge can be located and used to add value to agricultural productivity. Agricultural development can be best achieved if researchers and extension officers are educated on the significance, complexity and usefulness of local knowledge as suggested by Hart (2007).

The findings are in line with the socialization sub-process of Nonaka and Konno's (1998) knowledge creation model (socialization, combination, externalization, and internalization) these were practiced by local communities to create new knowledge for farming purposes, but externalization, combination and internalization is low. On the whole, it can be concluded that knowledge is mainly created within the social paradigm and not in the scientific paradigm through creativity and problem solving at individual levels, but is generated through learning from others at collective and

individual levels. In view of this, there is a need to increase communities' participation in agricultural participatory research activities, and to nurture the knowledge sharing culture. This is important in order to externalize their knowledge, and combine multiple sources of explicit knowledge to create new knowledge.

These findings demonstrate that internal knowledge may be combined with other internal or external knowledge to create new knowledge. Thus, new knowledge may be indigenous knowledge or a blend of indigenous and other forms of knowledge which are closely related to agro-ecological conditions of a certain locality. It can thus be concluded that it is important to identify and recognize local innovators or IK bearers as entry points in order to link holders of local and conventional knowledge in a better-functioning participatory manner in local communities as suggested by Waters-Bayer, *et al.*, (2006).

In terms of knowledge sharing, the study findings corroborate those of Probst, Raub and Romhardt's (2000) KM model which stresses the use of various instruments that facilitate the sharing and distribution of organizational knowledge which cover all physical, technical and organizational individual and group working contexts. The findings of this study indicate that various indigenous cultures and structures enable the sharing of knowledge among farmers' groups, and through apprenticeships, folklore and initiation rites. However, these cultural practices are not widely used in fostering the sharing of indigenous agro-biodiversity knowledge. Therefore, it is important to strengthen these cultural practices to facilitate the sharing of IK among local communities in the surveyed areas.

Even though few farmers belong to farmers groups, these groups are a useful channel for sharing indigenous agro-biodiversity knowledge. Farmers' groups mainly share knowledge on conventional farming methods rather than indigenous farming methods, a factor which explains the dominance of exogenous knowledge related groups in the study area. Twenty one percent of agricultural related associations are registered, and only six percent are informal. Most of the registered farmer's groups have access to training opportunities offered by public and private agricultural actors. This factor activates knowledge creation and sharing activities through a scientific paradigm. Informal social gatherings and self-managed farmers' indicate that Cooperatives already exist and they need to be nurtured and strengthened for effective knowledge sharing within communities.

In terms of preservation, the findings revealed that most agricultural IK is preserved in human minds. Usage of explicit sources of knowledge and artifacts to preserve IK in surveyed local communities is low. Based on these findings, it can be concluded that IK is limited by knowledge loss due to low level of awareness, prescribed structures and rules that facilitate preservation of knowledge as in formal organizations. There is thus a need to select knowledge from many events, persons and processes that are worth retaining, preserving and updating.

Several barriers deter management (acquisition, sharing and preservation) of agro-biodiversity related IK, including personal, social, and technological, the external environment such as lack of IK records, IK policy, rural knowledge resource centers, and IPR that protect IK. In view of this, the lack of policies, infrastructure,

resources, skills and cultural beliefs are major barriers hindering farmers and knowledge intermediaries from acquiring, sharing and preserving IK in surveyed communities.

In terms of contributions to livelihoods, farmers mentioned several benefits they gain when managing agro-biodiversity using indigenous knowledge including, food, improved soil fertility and utilization of non timber forest products as well r food crops such as maize, pigeon peas and cassava. Communities benefit in terms of soil fertility from the interaction that crops and trees have with the soil. A number of NTFs are extracted from the land and forests adjacent to the communities. These include firewood, bamboo, poles, fruits, wild vegetables, charcoal, wild fruits and others. These have potential to provide income to offset periods of food shortage when they are sold.

6.4 Recommendations

Based on the study findings, discussions and conclusions, the study recommends the following:

- Since knowledge is the collective expertise of every community member, it is recommended that KM practices should be the responsibility of everyone in the community including village authorities, public and private sectors. According to Noeth (2004), KM practices should be embedded in the community and government departments as they currently function in the local communities.

Government and Private agro-biodiversity actors:

- The government and private agro-biodiversity actors should foster KM practices in local communities by engaging community leaders and rural people in the whole process.
- It is recommended that knowledge should not be separated from individuals who hold it; instead efforts should be made to enable communities to manage their own knowledge, and to adapt other knowledge systems that meet their local contexts for effective KM practices and sustainable agricultural development.

Knowledge intermediaries:

- The study recommends that knowledge intermediaries such as NGOs should identify, map out and assess existing IK in terms of its value to agro-biodiversity activities. In addition they should conduct user studies to determine areas that need intervention, and in the process enable local communities to locate knowledge they need.
- Furthermore, knowledge intermediaries should empower local communities and should involve them in knowledge identification to ensure a sense of ownership, so they can manage their knowledge and adapt to other knowledge systems.
- Knowledge intermediaries should capture, disseminate and facilitate access to IK by communities and increase communities' confidence and willingness to adapt new knowledge. Knowledge intermediaries should also consider the differences in access to IK according to location and gender so that women and other vulnerable groups are not marginalized in implementing KM strategies.

Village leaders, knowledge intermediaries, private and government institutions:

- It is further recommended that village leaders, knowledge intermediaries, and private and government institutions should encourage rural communities to build strong relationships, collaborations, mutual trust and to foster a knowledge sharing culture especially knowledge that is safeguarded in secrecy. This means local farmers should be motivated to accept and share new knowledge to prevent knowledge hoarding which inhibits knowledge sharing.

- The findings indicate that IK can effectively be applied in communities with similar agro-ecological conditions, or to stimulate experimentation and innovation in other communities. It is therefore recommended that IK should be recognized, identified and scaled up in the local communities to improve farming activities by extension staff.

Extension approaches:

- It is further recommended that multiple extension approaches such as face to face communication and, participatory approaches and print materials should be deployed to recognize, identify and share IK and access to relevant exogenous knowledge for sustainable agro-biodiversity management and development. Moreover, knowledge creation and sharing activities through face-to-face interactions between individuals and groups, and demonstration and observation should be encouraged to enhance knowledge acquisition.

Knowledge intermediaries and village leaders:

- Knowledge intermediaries and village leaders should ensure that print materials are used to store IK for future reference.
- Knowledge can be constructed in social and scientific paradigms. Therefore it is s recommended that village leaders, knowledge intermediaries, and government officers should create a conducive environment to enable individuals and groups to share their knowledge, and experiment or try out new knowledge in order to create new knowledge in the social paradigm. Therefore it is recommended that farmers who take risks and try out new ideas; and who promote positive attitudes towards change and tolerance when mistakes are made should be rewarded. This will encourage individual farmers and groups to be innovative and to generate new knowledge.

- Furthermore, knowledge intermediaries should conduct capacity building trainings on KM for village authorities and opinion leaders, in order to empower them to foster a knowledge sharing culture in their communities.

- Most IK is preserved in peoples' minds because there are no structures for preserving IK. Therefore, it is recommended that mechanisms should be set up to enable communities to continuously create, share and preserve both tacit and explicit knowledge. These mechanisms will enable communities to prevent knowledge loss and to make knowledge readily available within and outside their communities.

Information Professionals:

- It is further recommended that information professionals should prepare inventories and registers of traditional knowledge systems, taking into account the intellectual property rights implications. Similarly, they should market IK especially to young people, using effective marketing strategies. In addition, they should create IK collection development policies, standardized indexing and cataloguing and should also compile bibliographies of identified IK materials.

Government:

- The government should increase the number of extension officers, and should equip them with adequate resources and skills in modern farming methods in order to ensure effective extension services in the country. Both public and private extension officers should build capacities of local leaders and communities in order to ensure access to exogenous knowledge and its effective use. In addition they should coordinate their efforts and rural KM strategies for effective integration of indigenous and exogenous knowledge systems.
- Policies are needed in both public and private sectors to foster the creation of a national IK policy for effective protection and management of IK in the country. Such a policy should address protection of IK, management of IK, incorporation of IK into the mainstream knowledge systems, and capacity building of both local communities and knowledge intermediaries.
- Women's empowerment and equal participation in KM practices and IK should be recognized in key policies.

- The existing IPR system should be reviewed and should address issues related to the protection of IK and genetic resources.
- The creation of a knowledge culture should involve awareness creation on the value of knowledge since IK is not well recognized in the surveyed communities.
- It is further recommended that culture should not only ensure change of attitudes towards knowledge, but it should also involve desire and willingness of individuals and groups to enhance learning and sharing of knowledge in the communities.
- Active participation and involvement of communities in knowledge production processes is critical to the integration of effective KM practices and knowledge. Therefore, social capital of local leaders should be strengthened and their roles in KM activities should be clearly defined.
- The establishment of basic infrastructure in rural communities should be a priority of the government and local communities. The government should focus on improving rural electrification, telecommunication and road infrastructure. This would foster access to and use of both indigenous and exogenous knowledge.
- Local communities and public and private sectors should also establish knowledge resource centers in their localities to enhance learning, sharing and preservation of IK.
- Knowledge with local and relevant content should be promoted among the community.

- Knowledge maps should be used to identify IK holders so that the local people can easily locate knowledge sources in their communities.
- The knowledge intermediaries should incorporate IK in their extension services and disseminate knowledge that is relevant to farmers' needs.

6.5 Areas for Future Research

Since this study examined IK issues related to crops and non timber forest products components of agro-biodiversity, further research is needed in the following areas:

- A study should be conducted on IK related to fisheries, soil organisms, water resources and other biota.
- Furthermore, another study should be conducted on packaging and repackaging of local knowledge for use in production of various commodities and market assessments for such commodities and the added value to local knowledge for entrepreneurship development (commodity production). A study should be conducted to assess existing policies and laws with respect to property rights on related local knowledge systems.
- Another study should be conducted to determine power relations between local knowledge and modern knowledge systems.
- A study should be conducted to determined gendered power relations at household level over local knowledge systems.

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APPENDICES

Appendix 1: Interview guide with local communities

INTRODUCTION

Tanzania is a country endowed with enormous agro-biodiversity species. However, these are being threatened by various factors. The maintenance and use of agro-biodiversity relies on extensive indigenous knowledge systems and management, which address aspects such as cultivation practices, uses, and genetic resource management of such plant and animal species. This study strives to elicit information on household's management of this agro-biodiversity and their contribution to the livelihoods of selected areas of Masasi and Nachingwea districts, Tanzania: thereby contributing to efforts towards improvements of management of agro-biodiversity in the country. Your household has been selected in a random process to participate in this exercise. You are kindly requested to participate in this interview by providing information to the questions in this questionnaire.

This interview will take between 15-20 minutes of your time. I would like to assure you that the information in this questionnaire will be used only for the intended research purposes. No names of respondents are required in this questionnaire: this will make the respondents anonymous. I greatly appreciate your participation in this study.

The interview guide aims at eliciting communities' perceptions with regard to the way indigenous agro-biodiversity knowledge is managed in the local communities in Tanzania. Local communities will include farmers, traditional leaders, village leaders, traditional healers and traditional entertainers.

SECTION A: PERSONAL INFORMATION

1. Ethnic group:……

2. Sex

1=[ ] Female

2=[ ] Male

3. Age (years): ……

4. Highest level of education

1=[ ] Informal schooling 4=[ ] Secondary education

2=[ ] Primary education 5=[ ] Illiterate

3=[ ] Post secondary (specify)……

5=Occupation:……

6=Region:……..

7=District:…….

8=Division:……

9=Ward:…….

10=Village:……...

11=Date of interview:……

SECTION B: INDIGENOUS KNOWLEDGE MANAGEMENT

12=What is the size of your farm (acres)?

……

13=How long have you been involved in crop production? (Please explain briefly).....

.....

14=What main crops do you grow? Where did you learn how to cultivate these crops? How much do you cultivate?

	Crop	**Where did you learn how to cultivate this**	**How much do you cultivate?**

		crop?	
1			
2			
3			
4			
5			

15. What do you benefit from the crops you grow?

1=[ ] Food

5=[ ] Fuel

7=[ ] Income

2=[ ] Veterinary medicine

4=[ ] Human medicine

6=[ ] Ornaments

16.What benefits do different types of crops provide to your farm?

1=[ ] Soil conditioner

2=[ ] Manure

3=[ ] Others:……

17. What was the total production of **major crops** listed in qn. 14 above for the last season?

Crops (a)	**Total production (b)=d + e**	**Unit (c)**	**Own use (d)**	**Sold (e)**	**Price per unit (f)**	**Total value (b*f)**

18. Do you collect wild products?

1=. Yes……...

2=. No ……

19. If YES, what types of wild products non timber forest products-NTFPs) did you collect for the last season? (tick all that apply from the checklist.)

Wild product	**Quantity collected last month**	**Unit of the product (HL, Pcs, Kgs, bags)**	**Use of product**	**Price per unit if the item is sold or bought**	**Gross income (QxP)**
Firewood					
Poles					
Plant medicine					
Honey					
Mushrooms					
Fruits					
Vegetables					
Wild animals					
Fruits					
Withies					
Charcaol					
Bamboo					
Timber					

20.What types of trees do you grow/leave in your crop farms?

	Tree	**Name of trees**
1	Indigenous trees	
2	Exotic trees	

3	Fruit trees	
4	Indigenous/fruit trees	

21.How does you household benefit from the trees you grow/leave in the farm/forest?

1=[ ] Food 4=[ ] Soil conditioner 6=[ ] Fuel

8=[ ] Sale

2=[ ] Veterinary medicine 5=[ ] Human medicine 7=[ ] Ornaments

9=[ ] Shade

3=[ ] Livestock feeds [ ] Other:……

22. What is the link between the crops and trees that you grow?

1=[ ] Crop residues as mulch for fruit trees

2=[ ] Wind breaks

3=[ ]Natural manures from leaves for crops

4=[ ] Tree supports for crops

5=[

]Other…….

23.What type of soil do you have on your farm?

……

24.What are the characteristics of different types of soils? (Please explain briefly)

	Type of soil	**Characteristics of different types of soils**
1	Sandy (kichanga)	
2	Clay (mfinyanzi)	

3	Loam (tifutifu)	

25. What crops grow best in these types of soils??

	Type of soil	**Types of crops**
1	Sand	
2	Clay (mfinyanzi)	
3	Loam (tifutifu)	

26. Where do you get your planting materials?

	Crop	**Seeds**	**Roots**	**Cuttings**	**How is it acquired?**
1					
2					
3					
4					
5					

27.What methods do you use to store seeds for the next season?

	Crop	**Methods that are used for seed storage**
1		

2		
3		
4		
5		

28.Which methods do you prefer for storing your seeds?

1=[ ] Indigenous ……

2=[ ] Exogenous ……

29.What criteria do you use to select on which piece of land you should plant crops?

1=Plot's suitability for specific crops [ ]

3= Fertile lands [ ]

5= Type of soil [ ]

2= Water holding capacity [ ]

4= Weather e.g. Rain season [ ]

5= OTHER:… [ ] ……

30.How do you plant crops?

	Crop	**Methods that are used for planting**
1		
2		
3		
4		

31.What type of cropping system do you use in your farm?

1= Inter-cropping [ ]]

2= Mono-cropping [ ]

3= OTHER:…… [ ]……...

32.What types of crops are being intercropped? What types of crops are being mono-cropped?

	Crop	**Intercropped**	**Mono-cropped**
1			
2			
3			
4			
5			
6			
7			

33.Why do you intercrop?

……

34.Why are crops mono-cropped?

……

35.What methods do you use to control weeds? (tick as many as apply)

1=[ ] Long-term fallow (over 4 years)
2=[ ] Short-term fallow (1-3 years)
3=[ ] Seasonal organic matter from planted crops
4=[ ] use of herbicides
5=[ ] Selective weeding
6=[ ] Dry grasses
7=[ ] Intercropping
8=[ ] Dry leaves

OTHER:……

36.What methods do you use to preserve crops?

1= Hearth over kitchen [ ]
2= Polythene bags [ ]
3= In granary outside the house [ ]
4= Mix with mud [ ]
5=In granary inside house [ ]
6=Plastic containers [ ]
7=Synthetic insecticides [ ]
8=Mix with Ash [ ]
9=Place on tree top [ ]
10= Clay pot [ ]
11= OTHER [ ]

……

37.What methods do you use to protect wild surroundings and their products?

1=Fire to control pests [ ]
2=Fallow to allow plant regeneration [ ]
3=Make buffer zones in the general land [ ]
4=Observes village by laws for use of wild surroundings [ ]

5=Patrol wild surroundings [ ]

38.What common plant disease symptoms do you know?

	Crop	**Disease**
1		
2		
3		
4		
5		

39.What common pests do you know?

	Crop	**Pests**
1		
2		
3		
4		

40.What types of control measures do you use to control plant diseases?

	Plant disease	**Control measure**
1		

2		
3		
4		
5		

41.What types of control measures do you use to control pests?

	Plant pest	**Control measure**
1		
2		
3		
4		
5		

42. Which insect repellent plants do you grow?

……

43. How do you control wild animals? (Please explain briefly)

……

44. Which methods do you prefer for controlling plant diseases?

1=[ ] Indigenous ……

2=[ ] Exogenous ……

45. Where do you obtain knowledge on indigenous farming?

1=[ ] Personal experience

2=[ ] Parents/ guardian/family

3=[ ] Neighbour/Friends

4=[ ] Women meetings

5=[ ] Wild products gathering

6=[ ] Demonstration and observation

7=[ ] Magazines

8=[ ] Newsletters

Conference/workshops/seminars

9=[ ] Posters

10=[ ] Church/mosque

11=[ ] Social group gatherings

12=[ ] Village leaders

13=[ ] Farmers' groups

14=[ ] Village meetings

15=[ ] Newspapers

16=[ ] Books

17=[ ]

18=[ ] Agricultural shows

……

46. How frequently are you in contact with the sources of agricultural indigenous knowledge?

	Source	**Very often**	**Often**	**Probably**	**Seldom**	**Very seldom**
1	Parent/guardian/family					
2	Neighbour/Friends					
3	Social group gatherings					
4	Religious leader					
5	Women meetings					

6	Farmers' groups					
7	Herding livestock					
8	Village meetings					
9	Agricultural shows					
10	Newspapers					
11	Magazines					
12	Books					
13	Newsletters					
14	Conference/workshops/seminars					
15	Posters					

47. What type of sources do you obtain the following information?

Information	**Source**
New crop variety	
Crop planting	
Crop harvesting, processing and storage	
Crop disease or pest problem	
Varieties of wild food products	
Harvesting and utilization of non timber forest products	
How to improve soil fertility	

48. Do the information providers inquire about your indigenous knowledge before disseminating agro-biodiversity technologies in the village?

1=[ ] Yes

2=[ ] No

3=[ ] Don't know

49. If YES, how do they inquire about your indigenous knowledge?

50. Do the information providers integrate your indigenous knowledge into the agro-biodiversity technologies that they disseminate in the village?

1=[ ] Yes

2=[ ] No

3=[ ] Don't know

51. If yes, please give an example

……

52, Would you be willing to provide your indigenous knowledge to the development agencies so that they can combine it with exogenous knowledge for improved agro-biodiversity management activities?

1=[ ] Yes 2=[ ] No 3=[ ] Don't know

53. Does the existing indigenous agro-biodiversity knowledge in the local community meet your farming requirements?

1=[ ] Yes 2=[ ] No 3=[ ] Don't know

54. If NO, please explain.

……

55. What kind of folklore are practiced in the village? (Tick all what apply).

1=Drama [ ]

2=Songs [ ]

3=Plays [ ]

4= Poetry [ ]

5=Puppet shows [ ]

6=Story telling [ ],

7= Festivals [ ]

8=Debates [ ]

9=Dance [ ]

OTHER [ ]……..…

56. When are folklore related activities DONE? (Please explain briefly)……

……

57. What key messages are portrayed in folklores?

……

58. Are you a member of any village associations?

1= Yes [ ]

2= No [ ]

60. If yes above, which associations are you a member of and are they formal or informal and what are their objectives?

	Group	**Type *(formal/informal)***	**Objective**
1			
2			
3			

61.Where do members meet and how often**?**

	Group	**Where do members meet**	**Frequency**
1			
2			
3			

62. What farming activities do these training ways provide to children?

	Kind of training	**Crop production**	**Animal husbandry**	**Selling produce**
1	Training by parents			
2	Training by other elders			
3	Apprenticeships			
4	Direct observation			
5	Initiation rites during adolescent age			
6	Learnt in School			
7	Accompanying relatives/parents during farming activities			

63. How do you acquire knowledge on the usage of wild food plants?

Key: 1. Accompanying relatives/parents during farming activities; 2. Trained by other elders; 3. Apprenticeships; 4. Direct observation; 5. Initiation rites during adolescent age

	Knowledge	**Means of acquiring knowledge**

1	Location of wild plants	
2	Seasons of availability	
3	Preservation of wild plants	
4	Processing of wild plants	
5	Uses of wild plants	

64 Overall, how useful is indigenous knowledge in management of agro-biodiversity and contribution to your livelihoods? (Tick as many as apply)

1=Very useful [ ]

2=Useful. [ ]

3= Somehow useful [ ]

4= Not useful… [ ]

5= Very un useful…. [ ]

65. What problems do you encounter with regard to indigenous agro biodiversity management activities?

1=[ ] Lack of access to IK information 5=[ ] Lack of recognition of IK value

2=[ ] Disappearance of traditional plant species 6=[ ] Poor infrastructure

3=[ ] Lack of access to exogenous information 7=[ ] Lack of agricultural inputs

4=[ ] Lack of credits 8=[ ] Restricted access to and use of wild products

66. What problems do you face when it comes to acquiring, sharing and preserving indigenous agro-biodiversity knowledge?

	Problem	**Acquisition**	**Sharing**	**Preserving**
1=	Poor knowledge sharing culture			
2=	Lack of trusts			
3=	Social status			
4=	Poor recognition of IK			
5=	Lack of information materials (records) on IK			
6=	Lack of a nearby library			
7=	Lack of appropriate intellectual property rights to govern IK			

67. What problems do you face in accessing indigenous agro-biodiversity knowledge?

1=[ ] Low level of literacy

3=[ ] Lack of extension services

2=[ ] Lack of information materials in local language

4=[ ] Lack of a nearby library

5=[ ]OTHER

68, Do you use any ways to preserve indigenous agro-biodiversity knowledge (Example, written, carvings)?

1=[ ] Yes

2=[ ] No

3=[ ] Don't know

69. If YES, how do you preserve indigenous agro-biodiversity knowledge?

1=Written [ ]

2=Carvings [ ]

3=Rock painting [ ]

4=Folklore [ ]

5..OTHER:…… [ ]……

70. Who keeps records of indigenous agro-biodiversity knowledge in the community? (Please explain briefly)----------

---

71. Which among the following tools do you use to manage farms/farm products/wild surroundings?

Tool	**Make (Local/Bought)**	**Estimated market value**	**Uses**
Hand hoes			
Axe			

Machetes			
Slashers			
Knives			
Baskets			
Ox-carts			
Mats			
Spears			

72. In your opinion, what is the best way to preserve IK?

……

ANY OTHER COMMENTS?

……

Thank you for your cooperation

Appendix 2: Guide for interviews with indigenous knowledge intermediaries

INTRODUCTION

This interview aims at soliciting attitudes and perceptions of indigenous knowledge (IK) intermediaries with regard to the management of agro-biodiversity IK in the local communities in Tanzania. The IK intermediaries include the following:

extension officers, district agricultural officers and agricultural researchers, forest officers, and Non-governmental organization (NGO) officers.

SECTION A: INFORMATION ABOUT RESPONDENT

1. Designation

   [ ] Extension officers

   [ ] District agricultural officers

   [ ] Agricultural researchers

   [ ] Forest officers

   [ ] Non-governmental organization (NGO) officer

2. Organization…….…….. ….
3. Sex

   [ ] Female [ ] Male

4. Age (years): ……
5. Highest education level

   [ ] PhD [ ] Masters [] Bachelor [ ] Diploma [ ] Certificate []High school

6. Region:…… …….
7. District:…… …….
8. Division:…… ……
9. Ward:…… …….
10. Village:…… ……...
11. Date of the interview:…… …….

SECTION B: INDIGENOUS KNOWLEDGE MANAGEMENT

1. The management of indigenous agro-biodiversity knowledge in the local communities

12. Are you aware about any farmers who possess indigenous agro-biodiversity knowledge?

    [] Yes [ ] No [ ] don't know

13. Do you capture indigenous agro-biodiversity knowledge from the local communities?

    [] Yes [ ] No [ ] don't know

14. What strategies do you use for collecting indigenous agro-biodiversity knowledge in the local communities?

    ……

    What type of indigenous agro-biodiversity knowledge do you capture from the local communities?

    ……

    What is the purpose of collecting indigenous agro-biodiversity knowledge?

    1= [ ] Raise the profile of IK 3= [] Interest in managing IK 5= [] Research

    2= [] Extension services 4=[ ] Marketing agricultural inputs 6= [] Teaching

    [ ] Others: ……

15. What strategies do you use for preserving indigenous agro-biodiversity knowledge?……

16. What strategies do you use for disseminating indigenous agro-biodiversity knowledge in the local communities?

1= [] Training 3= [] Conference/meeting 4= [] Face-to-face

2= [] Agricultural shows [] Others: on farm trials……

……

Do you integrate farmers' indigenous knowledge into the agro-biodiversity technologies that you disseminate in the village?

1= [] Yes 2= [ ] No 3= [ ] don't know

17. If yes, please specify

……

What print materials do you use for disseminating indigenous agro-biodiversity knowledge?

1=[ ] Newspapers 4=[ ] Books 6=[ ] Pamphlets 8=[] Magazines

2=[ ] Brochures 5=[ ] Newsletters 7=[ ] Leaflets 9=[] Posters

3=[ ] Training modules [] Others:…...……

18. Are the print materials effective in disseminating agro-biodiversity IK?

[] Very effective [ ] Effective [ ] Probably effective [ ] Ineffective [ ] Very ineffective

19. Is the traditional oral communication system (face-to-face interaction) effective in disseminating agro-biodiversity IK?

[ ] Very effective [ ] Effective [ ] Probably effective [ ] Ineffective [ ] Very ineffective

20. Do you think it is important to have a specific policy on indigenous knowledge within the country?

[] Very important [ ] Important [ ] Probably important [ ] Least important [ ] Not important

21. Why do you think it is important to have a specific policy on indigenous knowledge?..……W hat should the indigenous knowledge policy address with regards to the ownership of indigenous agro-biodiversity knowledge?
22. How do you perceive your contribution to the management (acquisition, processing, preservation and dissemination) of indigenous agro-biodiversity knowledge in the local communities?

……

2. Dissemination of exogenous knowledge in the local communities

23. Are local communities aware about the agro-biodiversity knowledge services provided by your organization?

    [] Yes [ ] No [ ] Don't know

24. How close is your organization to the farmers?

    [ ] Within one km[ ] Five km [ ] 10 km [] More than 20 km

25. Do farmers access the agro-biodiversity knowledge provided by your organization?

    [] Yes [ ] No

26. If yes, how?.....
27. If no, why not?.....
28. How frequent do farmers access the agro-biodiversity knowledge provided by your organization?

    [ ] Very often [] Often [ ] Seldom

29. Do you determine what farmers needs before sharing new knowledge to them?

    [] Yes [ ] No [ ] Don't know

30. How do you seek what farmers' needs before disseminating new knowledge to them?……Do you think it is important to seek first what farmers need before disseminating agro-biodiversity knowledge to them?

    [] Yes [ ] No [ ] Don't know

31. If yes, why?……

    If no, why not?……

    Do you think your institution satisfies most of the users' needs?

    [] Yes [ ] No [ ] Don't know

32. Do you prioritize farmers' information needs in the disseminated agro-diversity technologies in the village?

    [] Yes [ ] No [ ] Don't know

33. If yes, please specify

    ……

    Do you involve farmers when developing agro-biodiversity technologies?

    [] Yes [ ] No [ ] Don't know

34. If yes, please

    specify?.....

35. If no, why not?

    ……

    Do you involve farmers when disseminating agricultural technologies?

    [] Yes [ ] No [ ] Don't know

36. If yes, please specify?

……

If no, why not?

……

What print materials do you use for disseminating agro-biodiversity knowledge?

1=[ ] Newspapers 4=[] Books 6=[ ] Pamphlets 8=[] Magazines

2=[ ] Posters 5=[] Newsletters 7=[ ] Leaflets 9=[] Brochures

3=[ ] Training modules []

Others:…….....

37. Are the print materials effective in disseminating agro-biodiversity technologies?

[] Very effective [ ] Effective [ ] Probably [ ] Ineffective [ ] Very ineffective

38. What other strategies do you use for disseminating agro-biodiversity technologies to the farmers?

1=[] Training 3=[ ] Conference/meeting 5=[] Exchange visits

2=[] Agricultural shows 4=[] Personal visits [ ]Others:……

……

Do you have a follow up mechanisms to ensure that farmers adopt the agro-biodiversity technologies that you disseminate to them?

[] Yes [ ] No [ ] Don't know

39. If yes, please specify……

40. If no, why not?

……

41. How do you perceive your contribution to the access of agro-biodiversity knowledge in the local communities?.....

3. Barriers that hinder the effective management of indigenous knowledge and external knowledge on agro-biodiversity management in the local communities

42. What problems do you face in acquiring, preserving and disseminating indigenous agro-biodiversity knowledge?

Problem	**Acquisition**	**Sharing**	**Preserving**
Poor knowledge sharing culture in the local communities to provide their knowledge			
Lack of farmers' trusts			
Social status in the local communities			
Lack of appropriate intellectual property rights to govern IK			
Lack of a specific indigenous knowledge policy			
Lack of training to manage indigenous knowledge			

43. What problems do you face in disseminating external agro-biodiversity knowledge?

[] Lack of facilities [ ] Long distance

[ ] High illiteracy on the part of farmers [] Inadequate trained personnel

[] Financial constraints []

Others:……..

Thank you for your cooperation

Appendix 3: Guide for interviews with key informants

INTRODUCTION

This interview aims at soliciting attitudes and perceptions of key informants with regard to the management of agro-biodiversity IK in the local communities in Tanzania. The key informants include village government leaders within the villages

(hamlet chairpersons, village chairpersons, village executive officers and ward executive officers).

SECTION A: INFORMATION ABOUT RESPONDENT

44. Designation

    [ ] Hamlet chairperson

    [ ] Village chairperson

    [ ] Village Executive officer

    [ ] Ward Executive Officer

45. Sex

    [ ] Female [ ] Male

46. Age (years): ……

47. Highest education level

    [ ] Diploma [ ] Certificate [ ]High school [ ] Primary school

48. Region:…… …….

49. District:…… …….

50. Division:…… ……

51. Ward:…… …….

52. Village:…… ……...

53. Date of the interview:…… …….

SECTION B: INDIGENOUS KNOWLEDGE MANAGEMENT

1. The management of indigenous agro-biodiversity knowledge in the local communities

54. Are you aware about any farmers who possess indigenous agro-biodiversity knowledge?

[ ] Yes [ ] No [ ] Don't know

55. Do agro-biodiversity specialists capture indigenous agro-biodiversity knowledge from the local communities?

[ ] Yes [ ] No [ ] Don't know

56. What strategies do they use for collecting indigenous agro-biodiversity knowledge in the local communities?

……

What type of indigenous agro-biodiversity knowledge do they capture from the local communities?

……

What is the purpose of collecting indigenous agro-biodiversity knowledge?

1= [ ] Raise the profile of IK 3= [] Interest in managing IK 5= [ ] Research

2= [ ] Extension services 4=[ ] Marketing agricultural inputs 6= [ ] Teaching

[ ] Others: ……

57. What strategies do they use for preserving indigenous agro-biodiversity knowledge?……

58. What strategies do they use for disseminating indigenous agro-biodiversity knowledge in the local communities?

1= [ ] Training 3= [ ] Conference/meeting 4= [ ] Face-to-face

2= [ ] Agricultural shows [ ] On farm trials……

59. Do the agro-biodiversity specialists integrate farmers' indigenous knowledge into the agro-biodiversity technologies that they disseminate in the village?

1= [] Yes 2= [ ] No 3= [ ] Don't know

60. If yes, please specify

……

61. What print materials do they use for disseminating indigenous agro-biodiversity knowledge?

1=[ ] Newspapers 4=[ ] Books 6=[ ] Pamphlets 8=[] Magazines

2=[ ] Brochures 5=[ ] Newsletters 7=[ ] Leaflets 9=[] Posters

3=[ ] Training modules [] Others:…...……

62. Are the print materials effective in disseminating agro-biodiversity IK?

[] Very effective [ ] Effective [ ] Probably effective [ ] Ineffective [ ] Very ineffective

63. Is the traditional oral communication system (face-to-face interaction) effective in disseminating agro-biodiversity IK?

[ ] Very effective [ ] Effective [ ] Probably effective [ ] Ineffective [ ] Very ineffective

64. Do you think it is important to have a specific policy on indigenous knowledge within the country?

[] Very important [ ] Important [ ] Probably important [ ] Least important [ ] Not important

65. Why do you think it is important to have a specific policy on indigenous knowledge?

……

66. What should the indigenous knowledge policy address with regards to the ownership of indigenous agro-biodiversity knowledge?
67. How do you perceive your contribution to the management (acquisition, processing, preservation and dissemination) of indigenous agro-biodiversity knowledge in the local communities?

……

2. Barriers that hinder the effective management of indigenous knowledge and external knowledge on agro-biodiversity management in the local communities

68. What problems do you face in acquiring, preserving and disseminating indigenous agro-biodiversity knowledge?

Problem	**Acquisition**	**Sharing**	**Preserving**
Poor knowledge sharing culture in the local communities to provide their knowledge			
Lack of farmers' trusts			
Social status in the local communities			
Lack of appropriate intellectual property rights to govern IK			
Lack of a specific indigenous knowledge policy			
Lack of training to manage indigenous knowledge			

69. What problems are faced by agro-biodiversity specialists in disseminating external agro-biodiversity knowledge?

[] Lack of facilities [ ] Long distance

[ ] High illiteracy on the part of farmers [] Inadequate trained personnel

[] Financial constraints []

Others:……..

Thank you for your cooperation

Appendix 4: Guide for Focus Group Discussions

A: Indigenous agro-biodiversity management

1. What type of indigenous agro biodiversity knowledge is obtained from the source

	Source	Type of indigenous agro biodiversity knowledge obtained
1		
2		
3		
4		
5		
6		

2. How frequently are you in contact with them?

	Source	Very often	Often	Probably	Seldom	Very seldom
1						
2						
3						

4						
5						
6						

3. How easy it is to make contact with them (e.g. are they always available, or is it difficult to find them?) 1 = very reliable; 2=moderately reliable; 3=not reliable

	Source	**Very reliable**	**Moderately reliable**	**Not reliable**
1				
2				
3				
4				
5				
6				

4. How satisfied are you with the source of knowledge?

	Source	**Satisfied**	**Moderately satisfied**	**Not satisfied**
1				
2				
3				
4				
5				
6				

5. What has been the major problems in acquisition, sharing and preservation of indigenous agro-biodiversity among the local communities?.....
.....

6. How do you preserve the planting materials for the next season?.....
.....

7. What methods do you prefer to use for planting various crops and why do you prefer them? ……

8. What methods do you prefer to store harvested crops and why do you prefer

them?.....

.....

B: The contributions of indigenous agro-biodiversity knowledge and its management to the livelihoods of local communities

(i) Do you perceive the problem of soil fertility decline on your cultivated land? 1. Yes 2. No

(ii) If yes has it been (a) increasing.....(b) decreasing.....(c) unchanged.....

(iii) What indicators do you use to determine the decrease in the fertility of a soil?

(a) Appearance of stones on soil

(b) Appearance of sandy soils

(c) Poor crop yield

(d) Appearance of plant species indicative of poor soils such as.....,

(iv) What indicators do you use to determine the increase in the fertility of a soil?

(a) Appearance of black soils

(b) High crop yield

(c) Appearance of plant species indicative of fertile soils such as.....,.....

(v) What methods do you use to improve the quality of soil that has declined?

1=[ ] Mineral fertilizers 5=[ ] Rotation of crops 9=[ ] Animal manure

2=[ ] Leguminous crops 6=[ ] Ash from burning 10=[ ] Agro-forestry

3=[ ] long-term fallow (over 4 years) 7=[ ] Mulching 11=[ ] Tree leaves

4=[ ] Short-term fallow (1-3 years) 8=[ ] Organic materials 12=[ ] Intercropping 13=[ ] Others:…….

(vi) If you rotate crops what types of crops are being rotated in order to increase the quality of soil?.....

(vii) How do you cope up with the following climate changes?

1. Rising temperatures
2. High or low rainfall
3. Occurrences of droughts

(viii) How do you cope up with occurrences of p**est** (human, livestock, crops and disease pests) invasions?

(ix) How do you cope up with occurrences of food shortages?

C: Wild plant gathering and uses

List down the wild plant species you gather from surroundings and state their uses

S/N	Local name	Botanical name	Uses

Appendix 5: Research clearance letters

UNIVERSITY OF DAR-ES-SALAAM
OFFICE OF THE VICE-CHANCELLOR
P.O. BOX 35091 ♦ DAR ES SALAAM ♦ TANZANIA

Ref. No: AB3/12(B)
Date: 9th July, 2012
To: The Regional Administration Secretary,
Lindi Region.

UNIVERSITY STAFF AND STUDENTS RESEARCH CLEARANCE

The purpose of this letter is to introduce to you **Mr. Andrew Malekani** who is a bonafide student of the University of Dar es Salaam and who is at the moment conducting research. Our staff members and students undertake research activities every year especially during the long vacation.

In accordance with a government circular letter Ref.No.MPEC/R/10/1 dated 4th July, 1980 the Vice-Chancellor was empowered to issue research clearances to the staff and students of the University of Dar es Salaam on behalf of the government and the Tanzania Commission for Science and Technology, a successor organization to UTAFITI.

I therefore request you to grant the above-mentioned member of our University community any help that may enable him to achieve his research objectives. What is required is your permission for him to see and talk to the leaders and members of your institutions in connection with his research.

The title of the research in question is **"The Contribution of Indigenous Agro-biodiversity Knowledge Management Approaches to the Livelihoods of Local Communities: A Case Study of Masasi and Nachingwea Districts".**

The period for which this permission has been granted is **August, 2012** to **December, 2012** and will cover the following area: **Nachingwea District.**

Should the area be restricted, you are requested to kindly advise him as to which alternative places could be visited. In case you may require further information, please contact the Directorate of Research, Tel. 2410500-8 Ext. 2087 or 2410743.

VICE CHANCELLOR
UNIVERSITY OF DAR-ES-SALAAM
P.O. BOX 35091
DAR-ES-SALAAM

Prof. Rwekaza S. Mukandala
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UNIVERSITY OF DAR-ES-SALAAM

OFFICE OF THE VICE-CHANCELLOR
P.O. BOX 35091 ♦ DAR ES SALAAM ♦ TANZANIA

Ref. No: AB3/12(B)
Date: 9th July, 2012
To: The Regional Administration Secretary,
Mtwara Region.

UNIVERSITY STAFF AND STUDENTS RESEARCH CLEARANCE

The purpose of this letter is to introduce to you **Mr. Andrew Malekani** who is a bonafide student of the University of Dar es Salaam and who is at the moment conducting research. Our staff members and students undertake research activities every year especially during the long vacation.

In accordance with a government circular letter Ref.No.MPEC/R/10/1 dated 4th July, 1980 the Vice-Chancellor was empowered to issue research clearances to the staff and students of the University of Dar es Salaam on behalf of the government and the Tanzania Commission for Science and Technology, a successor organization to UTAFITI.

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The title of the research in question is **"The Contribution of Indigenous Agro-biodiversity Knowledge Management Approaches to the Livelihoods of Local Communities: A Case Study of Masasi and Nachingwea Districts".**

The period for which this permission has been granted is **August, 2012** to **December, 2012** and will cover the following area: **Masasi District.**

Should the area be restricted, you are requested to kindly advise him as to which alternative places could be visited. In case you may require further information, please contact the Directorate of Research, Tel. 2410500-8 Ext. 2087 or 2410743.

Prof. Rwekaza S. Mukandala
VICE-CHANCELLOR

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JAMHURI YA MUUNGANO WA TANZANIA

OFSI YA WAZIRI MKUU - TAWALA ZA MIKOA NA SERIKLI ZA MITAA

SIMU YA UPEPO: "REGCOM"
SIMU NA:- 023-220-2098
FAX NA. 023-220-2502
Unapojibu tafadhali taja:

OFISI YA MKUU WA MKOA,
S.L.P. 1054,
LINDI

Kumb. Na. EA.144/296/01/96

3 Septemba, 2012

Katibu Tawala Wilaya,
Wilaya ya Nachingwea
S.L.P. 32
NACHINGWEA

YAH. KUMTAMBULISHA BW. ANDREW MALEKANI

Tafadhali rejea somo hapo juu.

Mtajwa ni mwanafunzi kutoka Chuo Kikuu cha Dar es Salaam ambaye anakuja katika wilaya yako ili kufanya utafiti kuhusu "*The contribution of Indigenous Agro-biodiversity knowledge management approaches to the livelihoods of Local communities: A case study of Masasi and Nachingwea Districts*" kwa kipindi cha August, 2012 hadi Desemba 2012. Utafiti huo ataufanya katika vijiji vya:

1. NAMATULA
2. NAIPINGO
3. MWENGE
4. IKUNGU

Natumaini atapewa ushirikiano unaostahili.

Nakutakia utekelezaji mwema.

Greyson Mwaigombe
Kny. KATIBU TAWALA MKOA
LINDI

Nakala:

Bw. Andrew Malekani,
Chuo Kikuu cha Dar es Salaam.

UNITED REPUBLIC OF TANZANIA
PRIME MINISTER'S OFFICE
REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

MTWARA: REGION
Telegrahic Address: MTWARA
TELEPHONE: 023-2333014
Fax NO: 023-2333194
Ref. No. FA.73/258/01C/64

Regional Commissioner's Office
P.O. Box 544
MTWARA

Date: 04.09.2012

District Administrative Secretary
MASASI.

RE: PERMISSION TO CONDUCT RESEARCH

Attention is drawn on the caption above.

The Regional Commissioner's Office has granted permission to Mr. Andrew Malekani who is a bonafide student of the University of Dar es salaam to conduct research titled "**The contribution of indigenous Agro-biodiversity knowledge Management Approaches to the Livelihoods of Local communities: A case study of Masasi District**".

Please assist him accordingly.

Attached here with, please find a copy of a letter from University of Dar es salaam for more details.

Lucas Kambelenje
For: REGIONAL ADMINISTRATIVE SECRETARY
MTWARA

CC: Vice-Chancellor,
University of Dar es salaam,
P.O.Box 35091.
DAR ES SALAAM.

Andrew Malekani,
University of Dar es salaam,
P.O.Box 35091.
DAR ES SALAAM.

JAMHURI YA MUUNGANO WA TANZANIA
OFISI YA WAZIRI MKUU
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

MKOA WA LINDI:

OFISI YA MKUU WA WILAYA,
S.L.P. 32,
NACHINGWEA.

Kumb.Na. AB.364/487/01/53

05 Septemba, 2012.

Maafisa Watendaji wa Vijiji,
1. Namatula (A na B)
2. Naipingo
3. Mwenge
4. Ikungu

YAH: KUMTAMBULISHA NDG. ANDREW MALEKANI.

Mtajwa hapo juu ni Mwanafunzi wa Chuo Kikuu cha Dar es Salaam ambaye anakuja katika maeneo yenu kufanya Utafiti kuhusu "The contribution of indigenous agro-biodiversity knowledge management approaches to the livehoods of local communities" kwa kipindi cha Mwezi Agosti hadi Desemba, 2012.

Natumaini atapewa ushirikiano

(Mokka, S.I.A.)
KAIMU KATIBU TAWALA WILAYA
NACHINGWEA
Kny Katibu Tawala Wilaya
Nachingwea

Nakala:
Mkurugenzi Mtendaji Wilaya,
S. L. P 291,
NACHINGWEA.

Andrew Malekani,
Chuo Kikuu,
DAR ES SALAAM.

JAMHURI YA MUUNGANO WA TANZANIA
OFISI YA WAZIRI MKUU
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

WILAYA YA MASASI
Anuani ya Simu MASASI
Simu Nambari 023-2510112
Simu Nambari 023-2510194
Fax Na. 023-2510027

OFISI YA MKUU WA WILAYA
S.L.P. 18
MASASI.

Kumb. Na. CPA.49/101/01/10

Tarehe: 5 September, 2012

Watendaji wa Vijiji,
Kijiji cha Muungano
Kijiji cha Kivukoni
Kijiji cha Mkwapa
Kijiji cha Nambaya

YAH: KUMTAMBULISHA MR. ANDREW MALEKANI

Tafadhali husika na mada tajwa hapo juu.

Mtajwa hapo juu ni Mwanachuo katika chuo kikuu Dar es Salaam. Amepewa kibali na Ofisi ya Mkuu wa Mkoa kuja katika vijiji tajwa hapo juu ili aweze kufanya utafiti kuhusu mchango wa maarifa asili katika utunzaji wa kilimo BIOANUAI na mchango wake katika maisha ya wakazi wa Nachingwea. na Masasi

Aidha, kwa barua hii namtambulisha kwenu ili muweze kumpa ushirikiano katika kazi yake.

Nawatakia kazi njema.

Jenifer Joseph
Kny: KATIBU TAWALA WILAYA
MASASI

KNY:KATIBU TAWALA (W)
S.L.P. 18
MASASI