

**STRENGTHENING AGRICULTURAL KNOWLEDGE SYSTEMS FOR IMPROVED
RURAL LIVELIHOODS IN MOROGORO REGION OF TANZANIA**

by

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DECLARATION

I declare that “Strengthening agricultural knowledge systems for improved rural livelihoods in Morogoro region of Tanzania” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Signed:  Date: 01 March 2017

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ABSTRACT

The importance of agricultural knowledge systems (AKS) especially in rural communities cannot be overemphasized. AKS are important for creation, sharing and enhancing access and usage of agricultural knowledge. They link agricultural research and farms; increase adoption of good agricultural practices; improve the performance of agricultural marketing systems; and enhance effective post-harvest management. Despite the importance of agriculture to the economy and livelihoods of majority of Tanzanians, there is a consensus from scholars that the sector has been performing poorly. This is partially due to limited access to agricultural knowledge resulting into irrational decisions on agricultural activities thus dwarfing the sector. The modified Knowledge Management Processes Model guided the study in investigating how AKS can be strengthened to enhance access and usage of agricultural knowledge among stakeholders. The study adopted a pragmatic paradigm and used mixed method research by applying a survey, key informant interviews, focus group discussions (FGDs) and document reviews. Structured questionnaires were administered to 314 farmers while key informant interviews involved 57 respondents among village executives, councillors, input-suppliers, information providers, buyers, agricultural extension officers and researchers. Moreover, three FGDs involving 24 farmers were conducted. Qualitative data were analysed through classical content and constant comparison analysis, while SPSS software was used to analyse quantitative data. Quantitative and qualitative data were mixed during analysis, interpretation and discussion of results. The study identified farmers, the private sector and the government as major actors, but not working in unison. Most actors used human based systems while few used ICT and paper based systems. Actors needed agricultural knowledge on weather, farm preparation, seeds, crop maintenance, post-harvest practices, agricultural marketing and credits. Most actors shared agricultural knowledge through face-to-face interactions and mobile phones, few through internet. It was concluded that poor linkage among actors limited accessibility of agricultural knowledge. To improve accessibility to agricultural knowledge, a model for strengthening AKS usage is proposed. It is recommended that actors should be linked together and involved in enhancing access and usage of agricultural knowledge. Moreover, the proposed model should be validated before applying it.

Keywords: Agricultural knowledge systems; knowledge management; agricultural sector; ICTs; agricultural information; agricultural knowledge processes; agricultural services; Morogoro region; Tanzania; farmers; agricultural sector.

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DEDICATION

This thesis is dedicated to the Almighty God; my late beloved daughter Antonia; and to my lovely family.

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ABBREVIATIONS

AEO	African Economic Outlook
AKS	Agricultural Knowledge Systems
AKIS	Agricultural Knowledge and Information System
ARS	Agricultural Research System
CTA	Technical Centre for Agricultural and Rural Cooperation

DRD	Division of Research and Development
IARI	Ilonga Agricultural Research Institute
ICT	Information and Communication Technology
ICTs	Information and Communication Technologies
IMF	International Monetary Fund
IS	Information System
KATRIN	Kilombero Agricultural Training and Research Institute
KM	Knowledge Management
KMS	Knowledge Management System
KMSs	Knowledge Management Systems
NARS	National Agricultural Research System
NBS	National Bureau of Statistics
NRI	Natural Resources Institute
TCRA	Tanzania Communication Regulatory Authority
TPC	Tanzania Postal Corporation
TPTC	Tanzania Postal and Telecommunication Corporation
TTCL	Tanzania Telecommunication Limited
TV	Television
URT	United Republic of Tanzania

CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 Introduction

This study focuses on how agricultural knowledge systems can be strengthened to enhance timely access and usage of knowledge among agricultural stakeholders in Tanzania. The current chapter introduces the research topic by first explaining the broader concept of knowledge management and knowledge systems and roles played in agricultural development. The chapter creates a link between agricultural knowledge management and agricultural knowledge systems. It gives the contextual setting where descriptions regarding Tanzania and the study area are given. Thereafter background to the problem is given followed by the statement of the problem, the objectives and research questions. The significance and contribution of the study is given followed by the scope and limitation of the study. Thereafter, key concepts and terminologies used are defined followed by statement of the originality of the study. The overview of the research methodology, ethical considerations and thesis structure are given. The chapter ends by a chapter summary.

Knowledge is recognized as an important weapon for sustaining a competitive advantage (Lee and Choi 2003). It has become the major driver of social and economic transformation in the world (Asenso-Okyere and Mekonnen 2012). Knowledge is a factor of production alongside land, labour, and capital (Rollet 2003) because it enables people to combine the other factors of production more rationally for optimal production.

Knowledge is used by individuals, teams, organizations and communities in their daily operations. Business processes, best practices, lessons learned, common mistakes, design rationales, stories and histories are important sources of knowledge (Rollet 2003). Broadly; knowledge is categorized into know what, know - how and know why (King 2009). Know what knowledge determines action to take when one is presented with a set of stimuli; know how knowledge enables knowing how to decide on an appropriate response to stimuli; while the know why knowledge enables understanding casual relationships, interactive, effects and uncertainty levels associated with stimuli (King 2009).

For knowledge to be effectively used it must be timely accessed, this can be possible when knowledge rich sources interact with people in need of knowledge. People are the custodians and major knowledge sources; knowledge is shared and can be created when people socialize (Rollet 2003; Nonaka and Konno 1998). When people interact knowledge is transferred explicitly or implicitly (Rollet 2003). Explicit knowledge transfer occurs through teaching while implicit knowledge transfer happens through observations of an expert working on something. Knowledge may be transferred among people or when people interact with physical systems. When people interact among themselves knowledge is shared and combined (Nonaka and Konno 1998). Knowledge rich sources externalize knowledge while those in need of knowledge access and assimilate it. When knowledge is being internalized there is a possibility of combining it with the already existing knowledge of those with need of new knowledge. Knowledge must be managed whenever any of the four processes takes place; the process of managing knowledge is called knowledge management.

Through knowledge management, organizations generate value from their intellectual and knowledge assets (Uriarte 2008). Knowledge management involves the management of process by which knowledge is identified, created, gathered, shared and used. Knowledge management is important in facilitating accessibility of the right knowledge at the right place, at the right time and in the right format. Knowledge management involves the entire organization/community; it considers different roles played by each element of the organization (Dalkir 2013). Knowledge management involves the deliberate and systematic coordination of people, technology, processes, and organizational structure in order to add value through reuse and innovation (Dalkir 2013). This coordination is achieved through managing the creation, storage, sharing, and usage of knowledge. Thus, knowledge management involves creation, storage, sharing and usage of knowledge. There are times when knowledge creation and sharing processes happen at the same.

Processes of knowledge creation, storage, sharing and usage involve a network of people who collectively form social networks. Members of social networks frequently interact thus creating and using knowledge. When members of a social network interact for the purpose of creating, sharing or using knowledge they form the so called knowledge system. A knowledge system is made up of social networks which facilitate creation, storage, dissemination and usage of knowledge (Smedlund 2008; Alavi and Leidner 1999). Basically,

a knowledge system is an information system which enhances knowledge creation, storage and dissemination within a social network.

Agricultural knowledge systems are important for the creation and sharing of agricultural knowledge. These systems are important for enhancing access to and usage of agricultural knowledge. The systems are important for linking agricultural research and farms; increasing adoption of good agricultural practices; improving the performance of agricultural marketing systems for marketing agricultural produce/products; and enhancing effective post-harvest management (Bertolini 2004). Timely access to relevant agricultural knowledge enables farmers to make informed decisions regarding agricultural production, post-harvest management and marketing of agricultural produce/products (Lwoga 2010). For this to happen, agricultural knowledge systems must be effective and efficient. In this regard, agricultural knowledge system's components must be linked together and interact effectively.

A formal agricultural knowledge system (AKS) consists of three functions namely: agricultural research, education, extension and advisory service (Nemes and High 2013; Islam, 2010). There are different actors acting within the system for enhancing productivity of the agricultural sector and improved livelihoods of all stakeholders. For this case, AKS is made up of different components which interact in processes of creation and sharing of agricultural knowledge. Each component of the system has an effect on the functioning of the whole; each element is affected by at least one other element in the system (Ackoff 1989). Thus, the efficiency of AKS depends on the way different components including agricultural research and training institutions, extension and advisory systems, farmers, policy makers, agro-input suppliers, marketers and other actors in the agricultural sector interact. For this sense, AKS like other systems form a group of interacting components that conserves some identifiable set of relations with the sum of the components plus their relations (i.e. the system itself) conserving some identifiable set of relations to other entities including other systems (Laszlo and Krippner 1998).

Among AKS components, agricultural research and training enhance the creation of new knowledge; education enhances knowledge externalization, internalization and combination; while knowledge is shared through extension and advisory services. When AKS components interact they form different agricultural communities of practice. Agricultural communities of practice are constituted of people who share a concern, a set of problems, or a passion about a

topic, and who deepen their knowledge and expertise by interacting on an ongoing basis (Wenger, McDermott and Snyder 2002). These communities of practice are the sub systems of AKS. The efficiency of AKS depends much on how effective agricultural communities of practice are. Communities of practices are very important in the creation and dissemination of agricultural knowledge. Communities of practice become efficient when members share a lot of features in common. Within a particular agricultural commodity value chain there may be several agricultural communities of practice.

AKS has to link all actors with an agricultural knowledge value chain. A knowledge value chain encompasses knowledge flow and value flow within a sector; it is the dominant factor of value transfer (Zhang 2013). Knowledge value chain consists of the knowledge management infrastructure and the knowledge management processes, activities and knowledge performance. Components of knowledge value chain are important in increasing the level of productivity, quality of products and margins. Agricultural knowledge value chain includes all actors who generate new agricultural knowledge through research and those disseminating knowledge to those using it for increasing value of the produce/products. The chain moves further to those who add value to the agricultural produce/products and finally to consumers who in one way or the other influence production and marketing of agricultural products.

Information and Communication Technology (ICT) can be used to link the actors along an agricultural knowledge value chain. The ICTs may be used for collecting, analyzing, storing and disseminating information (Asenso-Okyere and Mekonnen 2012). ICTs reduce communication and information costs and provide new opportunities to obtain access to information on agricultural technologies (Aker 2011). ICTs facilitate the collection, processing, storage, dissemination and usage of information in multiple formats to meet the diverse requirement and needs of people (Asenso-Okyere and Mekonnen 2012). Through ICTs agricultural knowledge is shared and/or created. This is possible as ICT tools have the capacity of linking together agricultural sector stakeholders (Kapange 2004). However, for the agricultural sector to benefit from ICTs, it is important to have adequate ICT infrastructure and have ICT literate communities which is not always the case in most developing countries including Tanzania (Lwoga 2010). This study was set to investigate how AKS can be effectively used to enhance access to agricultural knowledge and hence

improve livelihoods among agricultural actors. Empirical evidence from different studies (Lwoga, Stilwell & Ngulube 2011a; Godtland, Sadoulet, Janvry, Murgai & Ortiz, 2004) indicates that access and usage of agricultural knowledge among actors in the agricultural sector increases the level of productivity and profitability hence improving livelihoods.

1.2 Contextual setting

United Republic of Tanzania is a union of Tanganyika and Zanzibar; it is among the developing countries found in Africa. Tanzania is located in eastern Africa between longitude 29⁰ and 41⁰ East and Latitude 1⁰ and 12⁰ South. Tanzania covers an area of approximately 945,087 square kilometers whereas Tanganyika covers 881,000 square kilometers, Zanzibar 2,000 square kilometers, 62,000 square kilometers are covered by water mass, and 3,350 square kilometers covered by forest and woodlands (URT 2014). Neighboring to Tanzania are Kenya and Uganda to the North, Burundi, Rwanda and Democratic Republic of Congo to the West, Zambia, Malawi and Mozambique to the South and Indian Ocean to the East (URT 2014). Administratively, Tanganyika is divided into 26 regions, and the island of Zanzibar into five regions. The country is further subdivided into 129 districts (NBS 2012).

The Tanzanian population has been growing from time to time, NBS (2013) shows that by 2012 when the last census was done, Tanzania had a population of 44,928,923 people where 21,869,990 (48.7%) were males and 23,058,933 (51.3%) females. Moreover, 52.2% (23,466,616 people) of the total population made the total Tanzanian working force. Furthermore, almost 80% of the total working force in Tanzania consisted of farmers and more than 90% of them were smallholder farmers living in rural areas. It was known that 49.9% of the rural farmers were males and 50.1% were females (NBS 2013).

1.2.1 Major economic activities in Tanzania

Tanzania depends much on mining, agriculture and manufacturing. Other sectors including the wholesale and retail trade, tourism, and transport and communication have a remarkable contribution to the Tanzanian economy. Tanzania's economy relies on the exports of minerals, coffee, cashews, tourism, manufactured products, cotton and cloves (AEO 2013). The country also relies on fisheries, industries, social services, real estate and forestry (URT 2013d). However, agriculture remains to be the most important sector to livelihoods of the

majority because it employs more people, it feeds the nation, and it is the source foreign earnings (URT 2011).

Tanzania's Gross Domestic Product (GDP) has been growing at an average of 07% per annum for the past ten years (URT 2008a). However, the economic growth has not been equitably shared; the rural population is the disadvantaged party principally due to the relatively slower growth rate of 4.4% for the agricultural sector despite employing a larger proportion of the population (URT 2008a). The basic needs and food poverty vary across geographical areas, with the rural areas being worse off. According to URT (2013a), about 16.6% of the Tanzanians live below the food poverty line where 18.4% of them are from rural areas and 12.9% from urban areas. Moreover, among those who live below basic needs poverty line 37.6% are from rural areas and 24.1% from urban areas.

For poverty reduction and enhancing food security, Tanzania has been implementing various strategies including the National Strategy for Growth and Poverty Reduction. These strategies aim at accelerating poverty reduction by pursuing pro-poor interventions and addressing implementation bottlenecks (International Monetary Fund (IMF 2011). Through the implementation of these strategies Tanzania can be transformed into mid-income country by 2025.

1.2.2 The agricultural sector in Tanzania

Agricultural sector in Tanzania comprises the crops, livestock, fisheries, forestry and hunting sub sectors. The sector is the key driver of social and economic development in Tanzania, it employs about 80% of men in the labour force and 84% of women and most of them (98%) live in rural areas (Schrock, Gugerty, Anderson, and Gugerty 2011; URT 2013d). The sector generates 25 per cent of GDP, 24 percent of exports and employs over 75 per cent of the population (URT 2011). In the year 2012 crop production contributed to about 17.6 per cent of GDP and grew by 4.7 percent, livestock production on the other hand contributed to about 4.6 per cent of the GDP and grew by 3.1 percent (URT 2013b). Despite minimal growth, the agricultural sector remains to be an important sector to livelihoods of the majority and the economy at large. IMF (2011) mentions the sector's minimal growth to have resulted from a combination of many factors including poor infrastructures to support agriculture, inadequate extension services, and poor production technologies.

Tanzania has moderate rainfall; in between 1950 and 2010 annual rainfall were ranged from 200 to 1200 mm (URT 2013d). The northern and eastern Tanzania has long rainy season from March to May and a short rainy season from October to December. Other areas of Tanzania have one rainy season per annum. Tanzania has seven agro-ecological zones: the Coast, the arid lands, semi-arid lands, plateau, southern and western highlands, northern highlands and the alluvial plains (URT 2007). Moreover, Tanzania is endowed with about 44 million hectares of arable land out of which only 10.8 million hectares (24%) are under crop production (URT 2013d). Furthermore, due to differences in agro-ecology zones crops grown in one zone may not be grown in the other.

Agricultural research and development (ARD) play a central role in enhancing increased agricultural productivity, improved quality of agricultural produce, and help farmers produce what the market needs (Arnon 1968). In most developing countries, ARD becomes more important now when farmers need seeds which can cope with climate changes and enhance food security and livelihoods of those who rely on agriculture.

1.2.3 Agricultural research and development in Tanzania

The history of agricultural research and developments in Tanzania goes back to the colonial era when the first agricultural experiment was conducted at Amani Research Station which was the first centre to be founded in Tanganyika (Chota 1986). The other station founded by the German administration was the Central Veterinary Laboratory at Mpwapwa in Dodoma region. Under the British rule agricultural research centres most for cash crops were introduced at Lyamungo, Ukiriguru, Ilonga, Mlingano and Naliendele (Mukama and Yongolo 2005).

After independence the National Agricultural Research System (NARS) comprising the Division of Research and Development (DRD) of the then Ministry of Agriculture, Cooperatives and Food Security; universities; and Tanzania Forestry Research Institute was formed (Kapange 2004). The current setup of NARS includes few private research institutes involved in tobacco, coffee and tea research. The DRD is responsible for strengthening agricultural research in order to enhance productivity, competitiveness and profitability of the agricultural sector (URT 2013a). It comprises a network of 16 agricultural research institutes located in seven agro-ecological zones of the country (Kapange 2004). These institutes

include Ilonga, Ifakara, Dakawa, Kibaha, Mlingano and Mikocheni. Others are the Makutupora, Hombolo, Ukiriguru, Maruku, Selian and HORTI-Tengeru (Northern Zone); Naliendele (Southern Zone); Uyole and Kifyulilo (Southern Highlands Zone) and Tumbi (Western Zone). Together with these institutes are the University of Dar es Salaam and the Sokoine University of Agriculture which are also under the NARS. Since the locations of these institutes are based on agro-ecological zones, each institute conducts research activities related to crops grown and animals kept in the respective zone. However; cereal and leguminous crops are priority crops for each institute because of their importance to food security.

1.2.4 Agricultural extension and advisory services in Tanzania

Agriculture extension services facilitate technology transfer from agricultural research institutes to farmers; enhance the provision of relevant information, skills, experiences and technologies needed for increased productivity and improved livelihoods among farmers (NRI 2011; CUTS International 2011). Agricultural extension services in Tanzania include a wide range of assistance to farmers which assist farmers identify opportunities, tackle problems, assess capabilities and provide needed advice (CUTS International 2011). In Tanzania, these services are mostly provided and financed by the public sector (Rutatora and Mattee 2001). For years the agricultural sector in Tanzania has been experiencing a drawback of support services while the demand for such services has been increasing, both in terms of quantity and quality (URT 2008). The Tanzania agricultural extension and advisory system needs to take a holistic view of all farms' and farmers' services throughout the value chain. The agricultural extension and advisory system in Tanzania tends to focus on national food self-sufficiency and agricultural productivity and is based on the traditional model of transferring technology from experts to farmers (URT 2008).

1.2.5 The profile of the districts that were involved in the current study

The current study was conducted in Morogoro region which is located in the Eastern Agricultural Zone of Tanzania. Morogoro region was established in 1962 after dividing the then Eastern Province into regions. According to NBS (2013), by the year 2012 the region had a total of 2,218,492 people (1,093,302 males and 1,125,190 females) with an average household size of 4.4. Administratively, Morogoro region is divided into six district councils

namely the Gairo, Kilombero, Kilosa, Ulanga, Morogoro and Mvomero (see Figure 1.1 for details). The region is endowed with abundant agricultural land suitable for crop production and have good climate favorable for agriculture and other economic investments. Among the six district councils Kilombero, Kilosa and Mvomero were involved in the current study. All of the three district councils are homogenous in terms of the major crops grown, availability of agricultural research institutes, and ICT infrastructure.

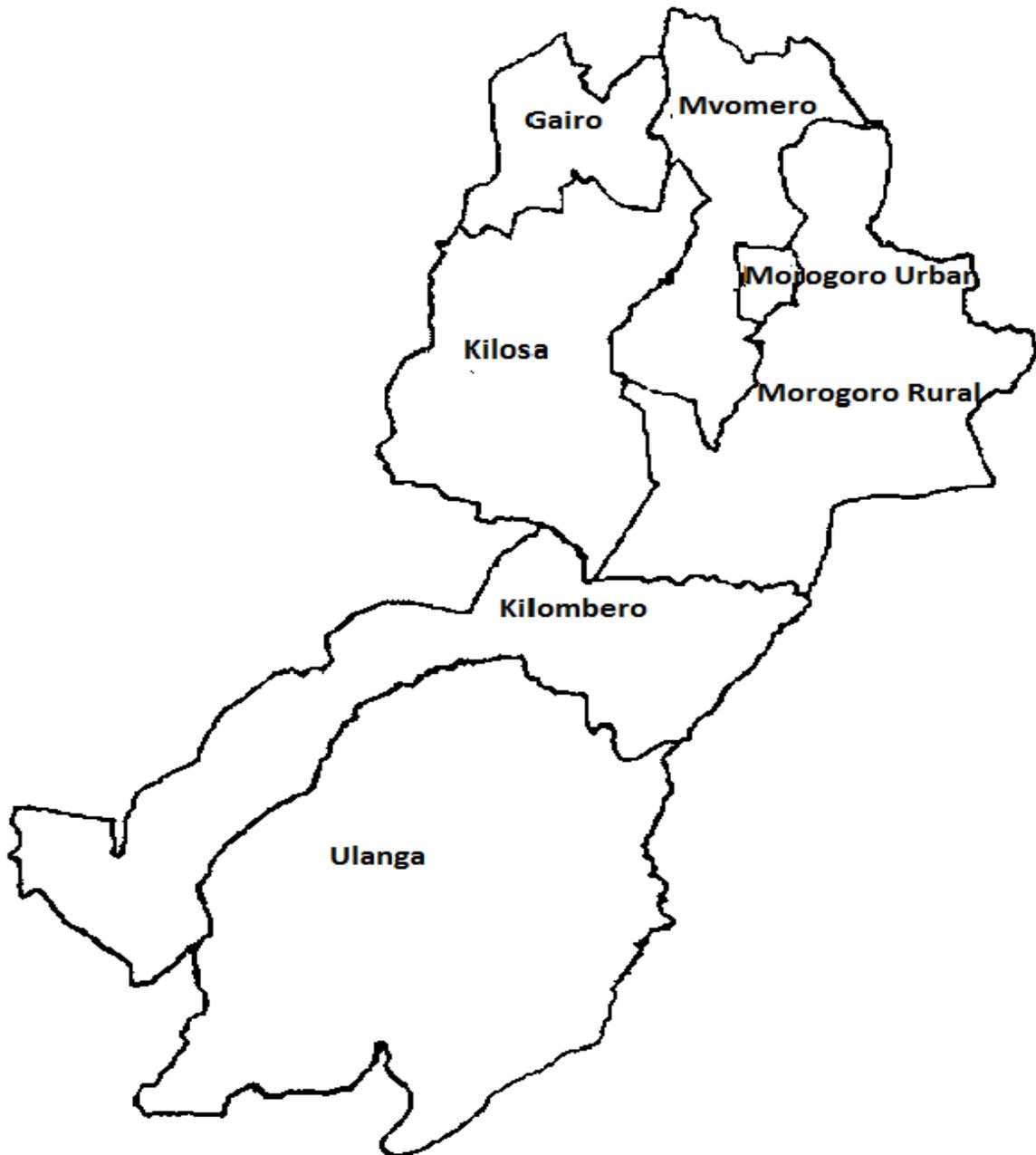


Figure 1.1: Map of Morogoro region showing administrative districts

Source: NBS (2013)

Agriculture has been the main industry in Morogoro region as it employs about 71.4 percent of the labor force (URT 2016). Maize, paddy, sorghum cassava, sweet potatoes and legumes/pulses are among the major food crops grown in the region. Due to the great agricultural potential the region has, the Tanzanian government considers it to be the national grain reserve. Despite the fact that Morogoro region is very potential for agricultural production and have four agricultural research institutes, agricultural production has remained to be low (URT 2012a). The penetration of improved agricultural technologies and developments in the region is very low (NBS 2010). Moreover; Morogoro is among the regions with the lowest average yield per hectare (NBS 2010). The region's great agricultural potential; its limited penetration of improved agricultural technologies; the low agricultural yield per hectare; and the availability of basic ICT infrastructure and agricultural research institutes, set Morogoro region and particularly the three districts most suitable for the current study.

Sections 1.2.5.1 to 1.2.5.3 give details of the three districts (Kilombero, Kilosa and Mvomero) in-terms of location, economic activities, rainfall and temperature, communication channels used in accessing knowledge and literacy levels among residents.

1.2.5.1 Kilombero District

Kilombero District lies along the Kilombero valley which is part of Rufiji Basin. The valley extends below the Udzungwa Mountain from the east towards the southwest. The district is a home to Wandamba, Wapogoro, Wabena and Wambunga ethnic groups. There are other small ethnic groups which migrate to Kilombero valley from time to time. According to NBS (2013), Kilombero District had a total of 407,880 people (202,789 males and 205,091 females) by the year 2012. The District has an average household size of 4.3. About 309,426 people (75%) in Kilombero live in rural areas and the five to nine age group has more people than other age groups. Geographically, the district is located between 08° 00' to 16° South and 36° 04' to 36° 41' East, with elevation ranging from 262 to of 550 meters (Balama *et al.* 2013). Kilosa and Morogoro rural districts border the District to the north, Lindi region to the east, Ulanga district to the south east, Iringa region to the west and Njombe region to the south west.

Kilombero District has tropical to sub-humid climate with annual rainfall ranging between 1200 to 1400 mm and temperatures ranging from 26°C to 32°C. The valley has bimodal rainfall, with the shorter rains starting in November to January and the longer rains in March to June (URT 2008). This makes the District suitable for most of economic activities including farming, fishing, livestock husbandry and tourism. The district covers an area of 14,246 square kilometres. The District has 400,000 hectares of a plain land suitable for agricultural activities but only 154,516 hectares are put usable (URT 2012a). Despite the limited acreage put into use, the district remains among the major producers of cereal crops primarily rice in Tanzania.

Kilombero is the home of the Kilombero Agricultural Training and Research Institute (KATRIN) which is among the centres of excellence in rice research in Eastern Africa and is mandated to co-ordinate rice research activities in Tanzania (URT 2012b). Among other factors including suitable land, adequate rainfall, availability of KATRIN, and enough water resources have made the district to be one of the cereal (rice) reserves in the country. Despite being considered as one of the cereal reserve, the level of agricultural production in the district is low due to the limited level of usage of good agricultural practices and high production costs (NAFAKA 2012).

Most households in Kilombero District are literate, URT (2012) describes that the literacy level among both male and female household heads was at 80%. However, the District suffers from limited access to agricultural knowledge among farmers. Siyao (2012) shows that farmers in Kilombero district lack access to the current, relevant and appropriate agricultural information. Siyao (2012) mentions that barriers to accessing agricultural information in Kilombero district are associated with lack of means and facilities by which information can be easily accessed. Benard, Dulle and Ngalapa (2014) show that inadequate number of extension officers, inadequate funds, lack of awareness on information sources and the inaccessibility of some information limited usage of agricultural knowledge among farmers in Kilombero district.

1.2.5.2 Kilosa District

Kilosa District is in Morogoro Region, it is bordered by Gairo District to the north and Morogoro District to the east. To the south, it is bordered by Kilombero District and part of

Iringa Region. The District is located between latitudes 5°55' and 7°53' south of the Equator and longitudes 36°30' and 37°30' East of Greenwich (URT 2007). Kilosa District covers a total area of 14,245 square kilometres, of which 536,590 hectares are suitable for agriculture, 483,390 are under natural pasture, 323,000 comprises the Mikumi National Park, 80,150 are under forestry cover and the remaining 14,420 hectares comprise urban areas, water and swamps (URT 2007; URT 2012c).

Kilosa District has several agro-ecological zones differing in land characteristics, rainfall and temperature. Lengale (2013) describes the gently undulating to rolling plains and plateau, rolling plains at low altitude to strong uplands, flat alluvial plains, and strong dissected mountains with steep slopes to be the agro-ecological zones in the District. The District receives rainfall ranging from 400 to 1400 mm per year (URT 2008). The annual temperature varies between 18°C and 30°C, with an average temperature of 25°C in most parts of the district. The district experiences an average of eight months of rainfall (October–May) with the highest levels between February and March. Rainfall distribution is bimodal in good years with short rains (October–January) followed by long rains in mid-February to May (Kajembe, Silayo, Mwakalobo and Mutabazi 2013).

The District is the home to Wasagara and Wakaguru major ethnic groups while the Maasai, Wasukuma and other minor groups are currently migrating in. It has a total population of 438,175 people among them 218,378 being males and 219,787 females with an average household size of 4.2 (NBS 2013). Moreover, 311,946 people (71%) live in Kilosa rural areas among them 156,549 being males and 155,397 females.

The major economic activities in the District are crop farming, livestock keeping, and tourism. Crops grown in the district include paddy, maize, cassava, sweet potatoes, cotton, sorghum and legumes while cash crops grown are cotton, sisal and oil seeds (Kajembe *et al.* 2013). Livestock kept include cattle, goats, sheep and pigs (URT 2012a).

Kilosa District is the home of Ilonga Agricultural Research Institute (IARI) which has been conducting various experiments including seed breeding and multiplication. According to Coulson and Diyamett (2012), IARI is one of the important centres for maize breeding in Tanzania. URT (2011a) describes the institute to be an important stakeholder in rice, cotton and other crops grown in the Eastern Zone of Tanzania too. Despite having the all necessary

setup for agriculture, studies (Mtega 2012; Mtega and Malekani 2009; Sife, Kiondo and Lyimo-Macha 2010) indicate that access to agricultural information among agricultural stakeholders in the district is still a problem.

1.2.5.3 Mvomero District

Mvomero is one of the seven districts of Morogoro Region; it lies at northeast of Morogoro Region at 06 ° 26' South and longitude 37 ° 32' East (Lyatuu 2013). The district is bordered by Tanga and Manyara regions to the north; and by Coast Region to north east. It is bordered by Morogoro Rural District and Morogoro Municipality to the east; and by Gairo and Kilosa districts to the west. Mvomero District also borders Kilosa District to the east, Ulanga and Kilombero districts to the south, Kilosa District to the west and Arusha Region to the North (Lyatuu 2013). The district occupies a total of 7,325 square kilometres.

Mvomero District is characterized by high rainfall; there are two rainy seasons in the District where the first season begins in October and ends in December and the second one starts from March to May (Akyoo 2008). Annual rainfall is between 600mm and 2000mm being lowest at the foothill and highest between 400m to 2000m altitudes above sea level. The temperature in the district ranges from 18 – 30 degrees centigrade (Akyoo 2008).

Administratively, Mvomero District is divided into 17 wards. The District has a total population of 312,109 people where 154,843 are males and 157,266 are females with an average household size of 04.3 (NBS 2013). The greatest proportion of the population is for those in the zero to four years of age followed by those in the five to nine age group (NBS 2013).

The main economic activities in Mvomero District are farming and livestock keeping. Maize, rice, horticultural crops, leguminous plants, simsim and sunflower are common crops in Mvomero (URT 2012a). The District has also sugar cane and teak plantations. Dakawa rice irrigation scheme and one of the largest schemes in the country is in Mvomero district too. The district hosts Dakawa Agro-Scientific Research Centre which conducts experimental research in rice.

Majority of residents of Mvomero District are literate, URT (2012a) shows that the literacy rate is generally higher for male heads of households (80%) compared to female heads of

households (65%). Like other semi-urban and rural areas in Tanzania, farmers and other stakeholders in Mvomero District had inadequate access to agricultural information (Mtega and Benard 2013).

1.3 Background to the statement of the problem

Agriculture is source of livelihoods to most households in developing countries. About 70% of the total populations in developing countries rely on agriculture for a living (Asenso-Okyere *et al.* 2008). For rational decision making stakeholders in the agricultural sector need several agricultural information services. At farm level, farmers need adequate skills and technical knowledge necessary for properly combine the four factors of production namely the land, labour, entrepreneurial skills, and capital thus optimizing production and revenues from agricultural activities.

In Tanzania, the agricultural sector plays a very important role in the economy as it employs more than 80% of the total population, contributes about 25% to the GDP, brings about 66% of the foreign exchange, and provides raw materials for local industries (URT 2013a). Despite the importance of the sector to the economy, low productivity, under-utilization of the available land, water and human resources, lack of agricultural support services, and low incomes and profitability are the key features of the agricultural sector in Tanzania (URT 2013). Limited access to these agricultural information services is known to be the major factor hindering growth of the agricultural sector and has been contributing to prevalence of poverty among the stakeholders in the sector (Mtega and Benard 2013).

To enhance access to agricultural knowledge, stakeholders in the agricultural sector use several channels. Since pre-colonial era knowledge is predominantly shared among community members through oral communication (Lwoga 2011). In the agricultural sector, sharing of agricultural knowledge has been through the word of mouth (Mtega and Benard 2013; Lwoga 2011). This mode of sharing agricultural knowledge has remained outstanding for centuries. Despite its usefulness, oral communication is known for the distortion of meaning carried by the message (Aryal 2009). This reduces efficiency of knowledge in solving problems being faced by farmers. Moreover, oral communication is only effective when communicators have adequate communication skills which are not always the case in

Tanzania as most people lack the basic communication skills (Mboera, Rumisha, Senkoro, Mayala, Shayo, and Kisinza 2007).

To limit the shortfalls of oral communication in knowledge sharing the print media was introduced in the then Tanganyika in 1888 when the first newspaper was published (Sturmer 1998). In Tanzania there are many registered newspapers/magazines and newsletters but very few have agricultural contents (CTA 2008). Moreover, more than 90% of print media in Tanzania is supplied in urban areas where only 20% of Tanzanian population lives (CTA 2008). Lack of or inadequate print media in most rural areas is explained by geographical isolation mostly because of the poor and impassable rural roads particularly during the rainy season when agricultural activities take place (Mtega and Benard 2013). Moreover, the network of Tanzania Postal Corporation (TPC) has been limited to urban and semi urban areas (TCRA 2013) thus being unable to disseminate print resources to most rural areas.

Agricultural extension and advisory services are important for optimal agricultural production. In Tanzania, the history of agricultural extension and advisory services are linked with the agricultural research and developments which started in 1904 when the first crop experiment took place at the Amani Agricultural Research Station (Carr, Ndamugoba, Burgess, and Myinga 1992). To-date Tanzania has a chain of government and private agricultural research institutes generating agricultural knowledge and new developments. The agricultural extension and advisory system is responsible for linking agricultural research and farmers. Studies (Mtega and Benard 2013; Sanga, Mlozi, Tumbo, Mussa, Sheto, Mwamkinga and Haug 2013) show that there is a limited number of agricultural extension staff in Tanzania. Moreover, the system is characterized by lack of adequate resources to facilitate the operations of agricultural extension officers (CUTS International 2011). This calls for a new strategy for enhancing access to agricultural knowledge among agricultural stakeholders.

Increased investments in ICTs in Tanzania have brought about a new opportunity for enhancing access to agricultural knowledge among agricultural stakeholders. Empirical evidence from other countries including India, South Africa and Ghana have shown how such technologies have enhanced access to and usage of agricultural knowledge among farmers (Goyal 2011). In Tanzania, the history of ICTs can be traced back to the pre-independence era. Before 1951 the British Broadcasting Corporation (BBC) radio was accessible in

Tanganyika and it was in July 1951 when “*Sauti ya Dar es Salaam*” (The Voice of Dar es Salaam) started broadcasting from Dar es Salaam (Sturmer 1998). After independence, investments in the ICT sector increased tremendously and it was by June 2006 when the country had 49 licensed radio stations (TCRA 2012). Television broadcasts in Tanzania started in 1970 and 1994 when Television Zanzibar (TVZ) and the Television Tanzania (TVT) came into operation respectively (Sturmer 1998). By the year 2012 there were several television stations and in 2013 digital TV broadcasts started in the country (TCRA 2013). Despite these developments not all Tanzanians have access to all broadcasts as about 85% had access to radio broadcasts while only 27% had access to TV broadcasts by 2010 respectively (Murthy 2011). Moreover, most of those accessing radio and TV broadcasts were urban dwellers. Furthermore, studies conducted in Tanzania (CTA 2008; Mtega and Benard 2013; Sanga, Kalungwizi and Msuya 2013) point out that radio and TV stations have very limited agricultural programmes.

The ICT enhancements to agricultural knowledge sharing employed in Tanzania are the mobile phones and land lines. Investments in land lines and mobile phones in Tanzania started in 1978 by the establishment of the Tanzania Posts and Telecommunications Corporation (TPTC). In 1993 TPTC was split into Tanzania Posts Corporation (TPC), The Tanzania Telecommunications Company Limited (TTCL) and Tanzania Communication Commission (later Tanzania Communication Regulatory Authority abbreviated as TCRA). To date, TTCL provides telecommunication services, TPC deals with postal services and the TCRA regulates all communication undertakings in the country.

TTCL alone could not provide land lines and mobile phone services in Tanzania that other companies were allowed to operate. By December 2012, TCRA licensed seven mobile and fixed phone operators. Moreover, there were seventeen other companies licensed to provide network services. Similarly, the number of subscribers to mobile phone services has been increasing at a very fast rate and by December 2012 the number of subscribers was reported to be 27,395,650 (TCRA 2012). Despite these developments, CTA (2008) describes that mobile and fixed phone infrastructure is more concentrated in urban and semi-urban areas than it is in rural areas where the majority of Tanzanians live. Furthermore, the usage of internet services has been slowly increasing from year to year. The number of users of internet services in Tanzania has increased from 50,000 people in the year 2000 to 4,932,535

in 2011 (Miniwatts Marketing Group 2012). Despite this remarkable increase in level of usage of internet services, studies (Mtega and Benard 2013; CTA 2008) show that internet services are predominantly urban services in Tanzania.

ICTs have been used successfully to enhance access to agricultural knowledge in India, South Africa and Ghana (Goyal 2011). These technologies form a potential platform for agricultural knowledge access and sharing in Morogoro region too.

1.4 Statement of the problem

Despite the importance of agriculture sector to the economy and livelihoods of majority of Tanzanians, the sector has been performing poorly (URT 2013c). Limited access to agricultural knowledge has resulted into irrational decisions on agricultural production and related activities thus dwarfing the sector (Pinda 2012; URT 2011; CTA 2008; URT 2008). At farm level most farmers have inadequate access to and usage of the most important agricultural knowledge needed for production and post-harvest activities leading to dismal growth of agricultural sector and prevalence of poverty among households whose livelihoods rely solely on agriculture (Mtega and Benard 2013; Lwoga 2011; URT, 2011; CTA 2008; URT 2008). The problem has become more serious because the government relies on the agricultural extension and advisory systems whose model has become inefficient for years now (CUTS International 2011).

The agricultural sector in Tanzania is characterized by poor research-extension-farmers linkage, low participation of private sector in extension services delivery, insufficient knowledge regarding technological advancements, weak coordination of agricultural extension services and inaccessibility of agricultural knowledge (URT 2013a). The inaccessibility of agricultural knowledge is more serious in rural areas where most agricultural activities are taking place (Pinda 2012; URT 2012a; URT 2008). This is exacerbated by the fact that most agricultural research institutes in Tanzania are located in urban or semi urban areas. Inadequate number of agricultural extension staff and lack of facilities to support agricultural extension services has been accelerating the inaccessibility of agricultural knowledge and other information services among actors (CUTS International 2011). More than 50% of the small scale farmers in Tanzania have no access to agricultural extension and advisory services (Pinda 2012; URT 2011). Despite the limited number of

agricultural extension agents, studies (Benard *et al.* 2014, Kiplangat 2013; Siyao 2012; Lwoga 2011) indicate that extension officers are among the most preferred sources of agricultural knowledge. To a great extent this has not only deprived farmers' access to knowledge rights but also has been contributing towards the dwarfing of the sector and increasing poverty prevalence in the country.

The increasing investment in the ICT sector has a potential to agricultural knowledge accessibility and usage. To date traditional ICTs (radio, television (TV) and telephony) have not enhanced the provision of agricultural knowledge in rural areas. Currently, radio and broadcast services are limited to urban and semi urban areas; have limited agricultural contents; and their accessibility rely much on power which most rural people lack (CTA 2008; Mtega and Benard 2013; Mtega 2012). Moreover, the introduction of TV digital broadcasts might face out most rural people from benefiting from these advancements due to un-affordability. Similarly, the mobile phone network has been growing at a very fast rate from 2005 to date and the level of subscription of mobile phones services has been increasing very fast too (TCRA 2012). However, mobile phone infrastructure in Tanzania is well developed in urban than it is in rural areas (TCRA 2013). Furthermore, the high tariffs charged to mobile phone services can hardly be afforded by rural people who suffer from both income and food security poverty.

In addition to the ICTs, the print media has been very useful and successful in disseminating knowledge in various sectors of the economy. In the agricultural sector in Tanzania the media has not been much effective (URT 2013d; Mtega 2012; Siyao 2012; Lwoga 2011; CTA 2008; Mboera *et al.* 2007). The accessibility of print media in rural areas has been a problem (Benard *et al.* 2014; Mtega and Benard 2013). Studies (Chilimo 2010; Lwoga 2011; Mtega and Malekani 2009) have shown that the government of Tanzania through the Ministry of Regional Administration and Local Governments and the Ministry of Agriculture, Livestock and Fisheries through DRD did not have strategies set for disseminating print resources to farmers. Some print resources were disseminated during the “*Nane Nane*” exhibitions (farmers' week) celebrated from 1st to 8th August of each year. Unfortunately these exhibitions are celebrated only once per year and are held in urban areas thus not involving target audience who are the farmers. The other limitation to usage of print resources in sharing agricultural knowledge is illiteracy; studies (Mwalukasa 2013; Siyao 2012; Mtega

and Malekani 2009) show that the few print resources available in rural areas were used by few farmers mainly because of high level of illiteracy.

1.5 Aim of the study

The overall aim of the study was to investigate how AKS can be strengthened for improving rural livelihoods in Tanzania so as to recommend a model for enhancing access to agricultural knowledge among actors.

1.5.1 The specific objectives

The specific objectives of the study were:

- i. To identify key AKS actors and the roles they play in the study area;
- ii. To categorize agricultural knowledge needs of AKS actors in the study area;
- iii. To determine factors hindering or stimulating access to agricultural knowledge among AKS actors in the study area;
- iv. To determine how agricultural knowledge sharing processes take place among actors in AKS in the study area;
- v. To find out how ICTs support agricultural knowledge management and AKS among actors in the study;
- vi. To assess the role of the Government in enhancing access to and use of agricultural knowledge;
- vii. To formulate a model for strengthening AKS.

1.5.2 Research questions

The study was guided by the following research questions:

- i. Which types of AKS are used in the study area?
 - a. Who are the major AKS actors?
 - b. What roles are played by AKS actors?
 - c. How are farmers and agricultural research linked?

- ii. What categories of knowledge do AKS actors need in the study area?
 - a. Which sources of knowledge are preferred by AKS actors?
- iii. Which factors hinder access to agricultural knowledge among AKS actors in the study area?
 - a. What factors stimulate access to agricultural knowledge among AKS actors in the study area?
- iv. How is agricultural knowledge shared among actors forming the AKS in the study area?
- v. How do ICTs support agricultural knowledge management and AKS in the study area?
- vi. What roles are played by the Government in enhancing access to and use of AKS in the study area?
- vii. What are the significant variables that influence AKS usage among actors in the study area?
 - a. What is the suitable model for enhancing access to agricultural knowledge along the AKS?

1.6 Significance and contribution of the study

The focus of this study was to determine how to strengthen AKS and enhance timely access to agricultural knowledge among stakeholders in Tanzania. Studies conducted in Tanzania on agricultural knowledge have concentrated on agricultural knowledge seeking behaviour of farmers (Benard *et al.* 2014; Mwalukasa 2013; Mtega 2012; Lwoga 2011; Chilimo 2010; Mtega and Malekani 2009; CTA 2008). These studies have concentrated only on how farmers' access agricultural knowledge. They have not taken a holistic view of the entire agricultural knowledge value chain. Moreover, they have not integrated traditional and modern knowledge systems in enhancing the creation, storage and sharing of agricultural knowledge.

The ultimate intention of the study was to recommend a suitable framework for effective sharing of agricultural knowledge among actors along a knowledge value chain. The study

findings might thus help researchers and scholars in the study area to make informed decisions on improving access to agricultural knowledge among actors in the agricultural sector. Agricultural education and extension service providers may use findings from this study to set appropriate strategies necessary for improving provision of their services. ICT service providers may use the findings to design appropriate agricultural information services linking actors throughout the value chain. In addition, findings from this study contribute to the scholarly research and literature in Information Science field.

1.7 Scope and delimitations of the study

This study was set to investigate how agricultural knowledge systems can be strengthened that they enhance access to agricultural knowledge in Tanzania. The study did not only focus on traditional knowledge system but rather concentrated on how modern technologies can improve the efficiency of an agricultural knowledge system. This study employed quantitative and qualitative research techniques in studying and understanding human action in its natural settings. The modified Knowledge Management Processes Model guided this study. The framework helped the study to have a broader view of AKS because the study focused on how to improve traditional knowledge systems and on how modern technologies can be used to increase the effectiveness and efficiency of AKS.

The scope of the study was restricted to the rural, semi-urban and urban areas of the three districts of Morogoro region that is in the Eastern Agricultural Zone of Tanzania. The study was also restricted to maize and rice value chains in Kilombero, Kilosa and Mvomero districts.

1.8 Operational definition of terms and concepts

This section provides the definition of key terms and concepts that were used in this study. These key terms and concepts include the following: knowledge, knowledge sharing, knowledge management, knowledge systems, agricultural knowledge systems, information and communication technologies, and rural livelihoods.

1.8.1 Knowledge

Knowledge is the know-how, or known skills necessary for doing something (Frické 2007). It is the combination of information, context and experience (Ponelis and Fairer-Wessels 1998). King (2009) defines knowledge as the justified personal belief. King (2009) goes further by categorizing knowledge into tacit and explicit. Tacit knowledge exists into a person's mind while explicit knowledge exists in the form of words, sentences, documents, organized data, and computer programs and in other explicit forms (Nonaka and Takeuchi 1995). For knowledge to exist there must be carriers which maintain it from time to time. Knowledge carriers are capable of incorporating coded knowledge and to storing, preserving and transporting knowledge through space and time independent of its human creators (Havlíček, Hron and Tichá 2006).

In this study, knowledge means all of the necessary skills and understanding which can be shared among people and used to solve practical problems. The definition of knowledge encompasses both the tacit and explicit knowledge. The definition of knowledge adopted by this study takes into consideration the fact that some people use the term knowledge interchangeably with information.

1.8.2 Knowledge management

Knowledge management is the deliberate and systematic coordination of an organization's people, technology, processes, and organizational structure in order to add value through reuse and innovation (Dalkir 2013). Knowledge management engages the creation, sharing, and using knowledge. In organizations, knowledge management is linked to learning. King (2009) views learning as the goal of knowledge management. Thus, when knowledge management processes (creating, sharing and using knowledge) are promoted in a given community then the learning process becomes effective too.

In this study, knowledge management refers to the systematic coordination of organizations, people, technologies and processes involved in creation, storage, sharing and using knowledge. The definition encompasses the creation, sharing, storage and usage of both tacit and explicit knowledge.

1.8.3 Knowledge sharing

Knowledge sharing can be defined as a social interaction culture, involving the exchange of knowledge, experiences, and skills through the whole community/organization (Lin 2007). Nonaka (1994) describes socialization to be an important process in transferring tacit knowledge from one person to the other. With advancement in technology some ICTs particularly phones can mediate the process of sharing tacit knowledge among people who are separated by distance. Explicit knowledge can be conveyed in documents, email, data bases, as well as through meetings and briefings (Nonaka 2008). It can be described, written down and documented, and is largely acquired in formal educational settings (Hess 2006). Generally, knowledge is shared through traditional interpersonal channels, mediated communication and through documented resources.

In this study, knowledge sharing refers to the exchange of skills and understanding from a knowledgeable unit to the one in need of knowledge.

1.8.4 Knowledge systems

Knowledge systems are networks of linked actors, organizations, and objects that perform a number of knowledge-related functions that link knowledge and know-how with action (McCullough and Matsonb 2011). Knowledge systems are applications of the organization's information systems to support the various knowledge management processes (King 2009). Effective knowledge systems promote communication and translation across actors and serve as venues for negotiation and mediation (Cash Clark, Alcock, Dickson, Eckley, Guston, Jäger, and Mitchell 2003).

In this study, knowledge system is a network of interlinked actors who create; share; and use knowledge. Knowledge systems include communities of practice, institutes, organizations, and individuals who create knowledge and store knowledge, systems that are used for transmitting knowledge and individuals who access and use knowledge for solving encountered problems.

1.8.5 Agricultural knowledge systems (AKS)

AKS is a collection of actors in research, extension services, education and training and support systems that act on the knowledge of farmers and generate innovations in response to problems and opportunities, desired outcomes, system drivers and regulatory policies and institutions (Rudman 2010). In this study, agricultural knowledge systems refers to the networks of linked agricultural actors, organizations, and objects that perform a number of knowledge-related functions that link knowledge and know-how with action.

1.8.6 Information and Communication Technologies

Information and Communication Technologies (ICTs) generally refer to an expanding assembly of technologies that are used to handle information and aid communication (Asenso-Okyere and Mekonnen 2012). ICTs are devices, tools, or applications that permit the exchange or collection of data through interaction or transmission (Goyal 2011). They include hardware, software, and media for collection, storage, processing, transmission and presentation of information in any format (i.e., voice, data, text and image). Computers, the Internet, CD-ROMs, email, telephone, radio, television set, video and digital cameras are some of the common ICTs. When used effectively, ICTs enhance access to information (Khodamoradi and Abedi 2011; Goyal 2011).

In this study, ICTs mean the electronic technologies that facilitate collection of data, storage, dissemination, and those facilitating communication and information exchange among actors. In this study ICTs is limited to radio, television, mobile phones, internet and computers. In agriculture, ICTs are used by all actors of an agricultural knowledge value chain and enhance knowledge creation and sharing.

1.8.7 Rural livelihoods

Livelihood is the means of gaining a living, including livelihood capabilities, tangible assets and intangible assets (Chambers and Conway 1992). Rural livelihoods refer to the capabilities, assets and activities that rural people require for a means of living (FAO 2003). Rural livelihood is sustainable when it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets both now and in the future while not undermining the natural resource base (Chambers and Conway 1992). In this study, rural

livelihood refers to the capabilities, assets and activities that rural people require for sustaining their living.

1.9 Originality of the study

The originality of the study based on making original contribution to knowledge (Phillips and Pugh 2005). It involves carrying out empirical work that has not been done before and bringing about a synthesis that has not been made before (Dunleavy 2003). It also involves using already known materials but with a new interpretation; bringing new evidence to bear an old issue; and looking at areas that people in the discipline have not looked at before (Phillips and Pugh 2005; Philips 1993 cited in Phillips and Pugh 2005). Further, originality constitutes the following: trying out something in a particular country that has previously only been done in other countries; taking a particular technique and applying it in a new area; and being cross-disciplinary (Philips 1993 cited in Phillips and Pugh 2005).

Although this study is built on previous studies on agricultural knowledge management from various parts of Africa, it brings new knowledge by focusing on how agricultural knowledge systems operate and how traditional and modern technologies can be used to strengthen agricultural knowledge systems in the Tanzanian context. Previous studies in Tanzania have focused on access to agricultural information among farmers (Benard *et al.* 2014; Mtega and Benard 2013; Mwalukasa 2013; Lwoga 2011; Chilimo 2010; Lwoga, Ngulube and Stilwell 2010a; Lwoga 2009; Mtega and Malekani 2009; CTA 2008; Kora 2006; Rutatora and Mattee 2001). The other study conducted in Tanzania describes how traditional knowledge systems and modern knowledge systems can be integrated (Nawe and Hambati 2013). The present study seeks to fill the gap by providing the empirical evidence of how agricultural knowledge systems can be strengthened, and how different actors in the agricultural knowledge systems can be linked together. This study is based on Knowledge Management Function Model. This model takes into account the different knowledge management processes taking place in a knowledge system. The findings of this study explicitly focuses to the Tanzanian context, hence they are original in this viewpoint.

Further, most studies on agricultural knowledge sharing conducted in Africa have concentrated on traditional systems of sharing agricultural knowledge (Droppelmann, Mapila, Mazunda, Thangata and Yauney 2013; Slikkerveer 1992). Most of them have not considered

the role played by modern technologies in enhancing access to agricultural knowledge and in most cases they have not taken the agricultural knowledge value chain perception (Mang'ombe and Saiibiti 2013). UNDP (2012) describes how ICTs can link agricultural research and farmers but it does not take a holistic view of actors in the sector. Aker (2010) describes how ICTs provide access to agricultural knowledge but has not considered how traditional knowledge systems and modern knowledge systems can be integrated to enhance access to agricultural knowledge. Other studies conducted in Africa have involved few actors of the agricultural knowledge systems as key actors which is not always the case (Munyua and Stiwell 2009; Abalu 2001). Other studies acknowledge that there are several elements making up agricultural knowledge systems but have not explained how the elements interact (Droppelmann *et al.* 2013; Abalu 2001). Few of these studies have considered the role of ICTs in managing agricultural knowledge but they have not considered how ICTs link actors along and within agricultural communities of practice. They have not considered how actors along agricultural knowledge value chain interact through the integration of traditional and modern communication channels including ICTs. Hence, this study seeks to fill the gap by providing the empirical evidence of how traditional and modern communication channels can be integrated and strengthen agricultural knowledge systems hence provision of agricultural information services along the maize and rice value chains. Therefore, the study is based on the work that has not been done before and the synthesis of the conceptual framework never made before. As a result, the findings of this study are specific to Tanzania context thus being original in that perspective.

1.10 Overview of the research methodology

The study employed explanatory and descriptive research designs to explain and describe constructs surrounding the usage of AKS in Tanzania. It involved a survey where the relationships among variables influencing agricultural knowledge creation, storage and sharing were identified and explained. The study involved farmers, agricultural researchers, agricultural extension officers, input suppliers, buyers of agricultural products, policy makers and consumers. It employed a combination of random and non-random sampling in selecting the villages and respondents to be involved in the study. Both qualitative and quantitative research approaches were employed while collecting data. Primary data were collected

through questionnaire-based surveys, key informant interviews and focus group discussions while secondary data were collected through review of documents.

Collected data was edited, classified, coded and tabulated to make them amenable to analysis. Data was analyzed using the Statistical Package for Social Sciences (SPSS) (quantified data), classical content analysis, and constant comparison analysis (qualitative data). Details of research methodology are described in Chapter Four.

1.11 Ethical issues

According to Jowell (1986), ethical issues are series of obligations to society which all researchers must fulfil, obligations to funders and employers, to colleagues, and to subjects. They are codes of conduct or expected societal norm of behaviour while conducting research (Kripanont 2007). Kripanont points out further that ethics must be maintained at each step of the research process including data collection, data analysis and reporting as well as dissemination of information. Mwanje (2001) describes other ethical issues considered when conducting social science research to include:

- Scientific merit - any research must be merited, and the methods must be appropriate to the aims of the investigation;
- Equitable selection of subjects (through random sampling);
- Seeking formal approval of the respondents as well as institutions is important before the onset of data collection;
- Informed consent - study's sample/individuals must understand the nature of the study and possible implications;
- Confidentiality - responses from the respondents should be used for the research purpose only and;
- Feedback of results - the community must know the findings. This would reinforce future interest in community-based research.

This study was ethically cleared by UNISA. Additionally, the researcher took into consideration all of the above ethical issues and all those stipulated under “Item 5: Rights and Responsibilities of Researchers at UNISA” of the Policy and Research Ethics (UNISA 2007). These ethical issues guided the researchers in each step of the research process from data

collection, data analysis and reporting of information. Moreover, the researcher observed all research ethics stipulated by the Commission of Science and Technology in Tanzania which include obtaining formal approval from the Morogoro Regional Commissioner's Office, Kilombero, Kilosa and Mvomero District Administrative Secretaries before embarking on actual research activities. Moreover, individual consent was sought during data collection. This was done through describing the aim and importance of the study. The other important ethical issue considered was confidentiality where information given by respondents and other parties involved in the study served the intended goal only and not otherwise. With regard to data collection tools, while setting data tools embarrassing questions were avoided. And for adhering to writing standards all sources of information used while writing the thesis were cited, this is important for avoiding plagiarism.

1.12 Thesis structure

This Thesis comprises seven chapters as outlined below:

Chapter One: Background to the study

The chapter introduces the study. It introduces the concept of knowledge system and agricultural knowledge systems. The chapter also presents the problem statement; general and specific objectives of the study; research questions; the scope and limitations of the study; significance of the study; ethical issues considered and originality of the study. The chapter contains definitions of key concepts; a brief outline of the research methodology; summary of the chapter; and the thesis structure.

Chapter Two: Conceptual and theoretical framework

The chapter reviews and discusses theories and models as a basis for formulating a suitable research model of the study.

Chapter Three: Literature review

The chapter presents the review of literature related to knowledge systems and agricultural knowledge management. The purpose of this review is to position the study within similar works as well as explore the available knowledge in the study discipline.

Chapter Four: Research methodology

The chapter presents the procedures that were used to carry out this study. It presents the details of the entire research process including sampling procedures, data collection methods and statistical procedures used in data analysis.

Chapter Five: Presentation of research findings

The chapter presents the study findings from both descriptive and inferential statistics. For better understanding of the findings from the study, data are presented in various formats like tables, figures, graphs and narrations.

Chapter Six: Interpretation and discussion of research findings

The chapter discusses and interprets the findings emanating from the study. The chapter also describes the implications of the results and possible reasons for the findings.

Chapter Seven: Summary, conclusions and recommendations of the study

The chapter presents the overall summary, key conclusions, recommendations of the study and areas for further study.

1.13 Summary of the Chapter

This Chapter introduces the research topic by first highlighting the concepts of knowledge management, knowledge systems and AKS and their importance in agricultural development. It outlines that the agricultural sector in Tanzania is characterized by poor research-extension-farmers linkage; low participation of private sector in extension services delivery; insufficient knowledge regarding technological advancements; weak coordination of agricultural extension services and inaccessibility of agricultural knowledge. The inaccessibility of agricultural knowledge is more serious in rural areas where most agricultural activities are taking place. Limited access to agricultural information services has been one of the factors contributing to dismal growth of agricultural sector and prevalence of poverty among households (Lwoga *et al.* 2011a) whose livelihoods rely on agriculture in Tanzania and thus a need for this study is recommended. Based on this background, the research problem is formulated followed by the aim as well as specific objectives of the study. Research

questions addressed by the study are derived from the specific objectives. Thereafter, the scope and limitations as well as the significance of the study are provided. The definitions of key concepts that are used throughout the study are also provided. The research process used by the study is outlined and finally the thesis chapter structure is presented at the end of this Chapter. The following chapter reviews common models for the purpose of identifying and/or formulating the most suitable research model to guide this study.

CHAPTER TWO

CONCEPTUAL FRAMEWORK

2.1 Introduction

The previous chapter introduced the topic under study. This Chapter presents the conceptual framework that provided the philosophical and theoretical foundation of the present study. A conceptual framework is described as a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation (Reichel and Ramey 1987). The conceptual framework is important because it enhances a conceptual thinking (Berman 2013). The conceptual framework helps in defining the research problem, establishing theoretical coherence, organizing research design and implementation and framing conceptual conclusions (Berman 2013). The framework is a tool used in research to assist a researcher to make meaning of subsequent findings, it is a starting point for reflection about the research and its context, and assists a researcher to develop awareness and understanding of the situation under scrutiny.

The current chapter discusses the research model adopted by the study. It starts by describing the relationship existing between theory, models and research. The chapter describes research conceptual framework which was used for guiding the current study. It gives descriptions of models for measuring the success of Information Systems and forms the research conceptual framework from Information System (IS) Success Model and the Agricultural Knowledge and Information System Model. It ends by giving a summary of the chapter.

2.2 Theories in research

A theory is a set of systematically interrelated constructs and propositions intended to explain and predict a phenomenon or behaviour of interest, within certain boundary conditions and assumptions (Bhattacharjee 2012). Glanz, Rimer and Viswanath (2008) define theory as a set of interrelated concepts, definitions, and propositions that present a *systematic* view of events or situations by specifying relations among variables, in order to *explain* and *predict* the events or situations). It is an explanation about how and why something is as it is, it relates to reflection, thinking about things, abstract ideas and contemplation (Koutsoumpos 2007). Theories provide complex and comprehensive conceptual understandings of things that

cannot be pinned down: how societies work, how organizations operate, and why people interact in certain ways (Udo-Akang 2012; Reeves, Albert, Kuper and Hodges 2008). Theories help in accumulating knowledge (Gregor 2002), they provide explanations of social or natural phenomenon (Bhattacharjee 2012).

Theories are used for analyzing, describing, understanding, predicting and explaining systems; they are for designing systems (Gregor 2002). Authors develop theories by combining observations from previous literature, common sense, and experience (Eisenhardt 1989). In research activities, theories give researchers different “lenses” through which to look at complicated problems and social issues, focusing their attention on different aspects of data and providing a framework within which to conduct their analysis (Reeves *et al.* 2008). In research, theories are used for formulating hypothesis, explaining or predicting phenomena.

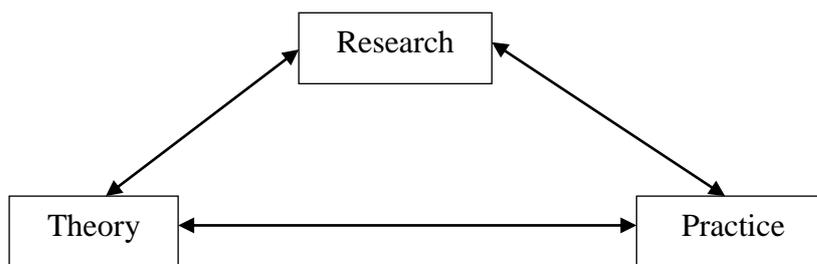


Figure 2.1: The relationship between theory and research

Source: Udo-Akang (2012)

Usually theories start as ideas which must be tested to meet some criteria. Theories must provide conceptual definitions, domain limitations, predictions and enhance relationship building (Wacker 1998). Theories must be logically consistent, must be interrelated and should have mutually exclusive propositions (Krishnaswami 2002). They must have exclusive statements covering the full range of variations concerning the nature and phenomena in question and must be capable of being tested through research (Krishnaswami op. cit). Generally, good theories must be comprehensive, precise and testable, simple, empirically valid, and both of heuristic and applied value (Cramer 2013). Therefore, theories that do not meet the generally accepted criteria are usually considered to be mere ideas.

There is a strong link between research and theory. Research seeks to give responses to practical problems facing the society. By definition, research is a studious inquiry or

examination, especially investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in light of new facts, or practical applications of such new or revised theories or laws (Glatstein 2002). The link between research and theory is dialectic; theories determine what data to be collected during a study and research findings provide challenges to accepted theories (Fawcett and Downs 1986). Research is used to validate, approve, modify or reject theories. Through research facts are established and new conclusions are researched. Research helps solve questions asked before one embarks on the study. It determines the potential mediating variables that lead to behaviour change; theories organize the mediating variables into a mental map (Contento 2008). Without theory, research is impossibly narrow and without research, theory is mere armchair contemplation (Silverman 2000).

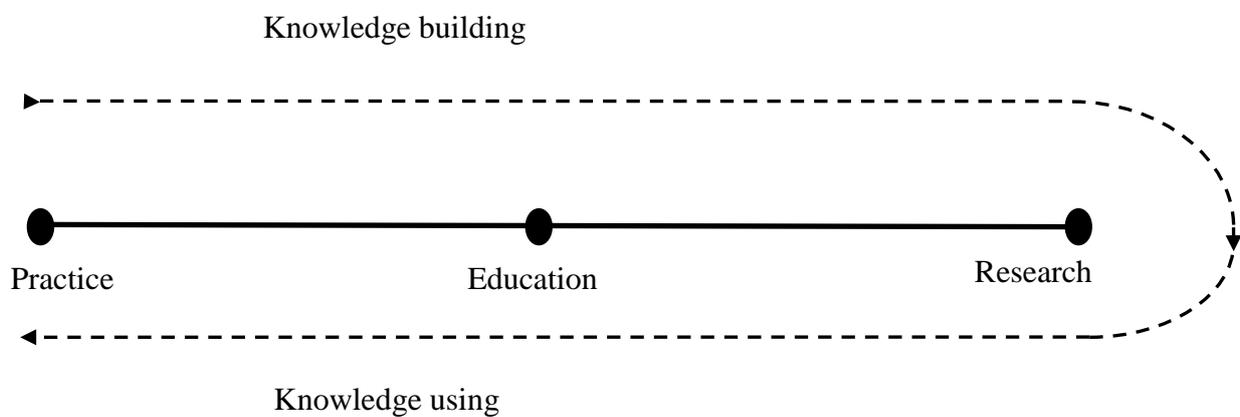


Figure 2.2: Relating research and practice

Source: Lee and Lee (2003)

Moreover, there is a strong relationship between research activities; theories and practice (see Figure 2.2 for details). The relationship existing between research and practice is related to knowledge creation and usage. Through research knowledge is created and is used through practice (Lee and Lee 2003). People learn as they conduct research and use generated knowledge; they learn more when knowledge is put into practice. When knowledge is being used theories are either justified or rejected. Practice uses theories to develop interventions while research tests the efficiency of implemented interventions (Contento 2008). When one conducts research theories may be developed, tested, modified or rejected; when generated knowledge is put into use the need for further research may emerge leading into developing, testing, modifying or rejecting theories.

2.2.1 Types of theories

There are different types of theories; Gregor (2002) categorizes theories into: (i) theory for analyzing and describing, (ii) theory for understanding, (iii) theory for predicting, (iv) theory for explaining and predicting, and (v) theory for design and action. This categorization is based on the functions performed by theories.

Analysis and description theories provide descriptions of the phenomena of interest, analysis of relationships among constructs, the degree of generalisability in constructs and relationships and the boundaries within which relationships and observations hold (Järvinen 2011). Descriptive theories are the most basic type of theories, they describe or classify specific dimensions or characteristics of individuals, groups, situations, or events by summarizing the commonalities found in discrete observations (Gregor 2006; Järvinen 2006). They state “what is”, they are needed when nothing or very little is known about the phenomenon in question (Fawcett and Downs 1986).

Explanation theory provides an explanation of how, why and when things happened, relying on varying views of causality and methods for argumentation (Järvinen 2011). The theory intends to promote greater understanding or insights by others into the phenomena of interest (Gregor 2002). Explanation theories assist in determining “how” and “why” something has occurred. The theory helps researchers explain the link existing between cause and event. Explanations can be provided with the intent of inducing a subjective state of understanding in an individual (Gregor 2006). Explanation theory describes individual intentions to use information systems (Ajzen 2005). It is through explanations researchers may be able to answer the “how” and “why” questions.

Prediction theories are used to predict behaviours; they state what will happen in the future if certain preconditions hold (Järvinen 2011). This type of theories assist in responding to “what is”, “how”, “why” and “what will be” (Gregor 2002; Gregor 2006). The degree of certainty in the prediction is expected to be only an approximation or probability (Järvinen 2011).

Other theories explain and predict human behaviours. These theories answer the “what is”, “how”, “why” and “what will be” questions (Gregor 2006). Explanations establish

substantive meaning of constructs, variables, and their linkages while predictions test substantive meaning by comparing it to empirical evidence (Bacharach 1989).

Theory for design and action is concerned with the methodologies, tools and design principles used in the development of information systems (Järvinen 2011). The theory for design and action says how to do something; it gives explicit prescriptions (Gregor 2006). Designers may use a combination of the other theories before employing the theory for design and action. This is because analysis, explanations and predictions are important for creating designs.

2.3 Constructs under study

Constructs are derived from concepts; Howitt and Crame (2008) define a concept as a verbal abstraction drawn from observation of a number of specific cases. The purpose of a concept is to simplify thinking by including a number of events (or the common aspects of otherwise diverse things) under one general heading (Ary, Jacobs and Razavieh 1985). Constructs are built from the logical combination of a number of more observable concepts. A construct is an abstract concept that is specifically chosen (or created) to explain a given phenomenon (Howitt and Crame 2008). A phenomenon explained by a construct may vary when some conditions are changing. A construct may be a simple concept (uni-dimension) or a combination of a set of related concepts (multi-dimension) (Bhattacharjee 2012). Constructs are not directly measurable (Howitt and Crame 2008); their proxy measures are called variables. A variable is a concept which can take on different quantitative values; it is a measurable representation of an abstract construct (Bhattacharjee 2012; Kothari 2004). Constructs are conceptualized at the theoretical plane, while variables are operationalised and measured at the empirical plane (Bhattacharjee 2012). Depending on their intended use, variables may be classified as independent, dependent, moderating, mediating, or control variables (Kothari 2004). Variables that explain other variables are called independent variables, those that are explained by other variables are dependent variables, those that are explained by independent variables while also explaining dependent variables are mediating variables (or intermediate variables), and those that influence the relationship between independent and dependent variables are called moderating variables (Bhattacharjee 2012).

The current study had several constructs from which variables were derived (see Table 2.1). Constructs were derived from the general and specific objectives. These constructs help in determining the relationship existing between different variables and AKS usage and enhancing access to agricultural knowledge.

Table 2.1: Constructs understudy

Construct	Description
Demographic characteristics of AKS actors'	Players' level of education, age, sex, occupation and experience of AKS actors. Demographic profiles were measured by nominal, ordinal, interval and ratio scales.
Knowledge behavior and types of AKS used	Players' knowledge/information needs and how they go satisfying their needs, categories of knowledge needed, commonly used knowledge sources and channels and how knowledge is shared, nature and type of knowledge. This construct was measured by nominal and ordinal scales/
Factors influencing AKS effectiveness	These factors influence usage of AKS. The factors were identified through primary and secondary data collected. Nominal, ordinal, interval and ratio scales were used to measure this construct.
Factors influencing agricultural knowledge sharing processes	These factors influence agricultural knowledge sharing processes among actors in AKS. The factors were identified through primary and secondary data collected. Nominal, ordinal, interval and ratio scales were used to measure this construct.
Roles of ICTs in agricultural knowledge management and AKS	ICTs influence agricultural knowledge sharing processes among actors in AKS. Roles of ICTs in AKS usage were identified through primary and secondary data collected. Nominal, ordinal, interval and ratio scales were used to measure this construct.
Government interventions in the access and use of AKS	Government interventions influenced AKS usage. Types of interventions influencing AKS usage were identified through primary and secondary data collected. Nominal,

	ordinal, interval and ratio scales were used to measure this construct.
Level of AKS usage	Level of usage of AKS was determined by independent factors. This was measured by a likert scale

Developed constructs can be used to formulate models and conceptual/theoretical framework for the research. Scholars (Venkatesh, Thong, Chan, Hu, and Brown 2011) mention that researchers may either use constructs to extend existing models or formulate new ones. Adoption of existing models depends much on the similarity of the study and constructs being studied with existing models. Constructs for the current study were broadly used to assess how the relationship existing among variables influenced the efficiency and effectiveness of AKS. A study by Laszlo and Krippner (1998) gives criteria of an effective AKS and other systems which include: socially desirable, culturally acceptable, psychologically nurturing, economically sustainable and technologically feasible. Others include operationally viable, environmentally friendly and generationally sensitive. These criteria form a benchmark for measuring the efficiency of AKS.

2.4 Models and their roles in research

A model is a representation in a certain medium of something in the same or another medium (Booch, Rumbaugh and Jacobson 1999). It is a simplification of reality (Hsiao 2005). It is a framework for thinking about a problem and may evolve into a statement of the relationships among theoretical propositions (Wilson 1999). As stated by Klein and Romero (2007), a model is a system of functions and conditions that yield formal results. Models help people to appreciate and understand such complexity by enabling them to look at each particular area of the system in turn (Abdullah, Benest, Evans and Kimble 2002).

Developers of systems use models in developing systems. Models are used in drawing blueprints of systems. Models have two major aspects: semantic information (semantics) and visual presentation (Booch *et al.* 1999). The semantic aspect captures the meaning of an application as a network of logical constructs, such as classes, associations, states, use cases, and messages while visual presentation shows semantic information in a form that can be seen, browsed, and edited by humans (Booch *et al.* 1999). When models are being built it is important to think about the key activities that will be taking place, the potential user of the

system, environments into which the system will be put into use, system components, and how users will easily interact with system components.

2.4.1 The relationship between models and theories

The distinction between theory and model is not very clear. Wilson (1999) describes a theory as a framework for thinking about a problem and may evolve into a statement of the relationships among theoretical propositions. On the other hand Glanz *et al.* (2008) describe a theory as set of interrelated concepts, definitions, and propositions that present a systematic view of events or situations by specifying relations among variables, in order to explain and predict the events or situations. Not all models are theories since many models do not have all the prerequisites of theoretical constructions; theories may be represented by various models, particularly if the concepts contained in them are abstract (Andersen 1992).

2.5 The proposed research conceptual framework

There are several models related to knowledge management. This study adapted the Knowledge Management Functions Model to provide theoretical guidance for the research. This study was guided by the modified Knowledge Management Process Model developed by Botha, Kourie and Snyman (2008).

2.5.1 Knowledge management model

The effectiveness of AKS depends much on the efficiency of agricultural knowledge management processes. The basic concept of conceptual framework for this study is based on knowledge management function model developed by Aranganathan and Lakshmi (2010). According to this model knowledge usage depends on other knowledge processes namely knowledge creation, knowledge storage and processing, and knowledge acquisition and sharing.

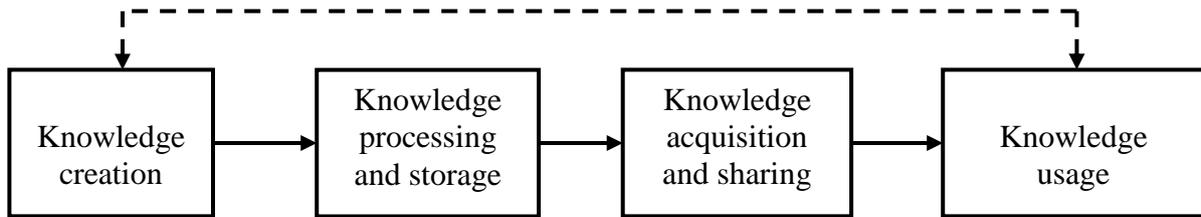


Figure 2.3: Knowledge management model

Source: Aranganathan and Lakshmi (2010)

According to Aranganathan and Lakshmi (2010), effective knowledge management involves two major processes namely: building, renewal and organization of knowledge assets (knowledge creation, sourcing, knowledge compilation and sourcing), and effective distribution and application of knowledge assets (knowledge dissemination and knowledge application and value realization). Therefore, any efficient AKS must enhance the performance of all knowledge management processes.

2.5.2 The Knowledge Management Process Model

The Knowledge Management Process Model developed by Botha *et al.* (2008) has three broad categories of knowledge management processes overlapping and interacting with one another. These broad categories are: knowledge creation and sensing, knowledge organizing and capturing and knowledge sharing and dissemination. Among the three broad categories, knowledge creation and sensing and knowledge organizing and capturing involve more human focus while knowledge sharing and dissemination need more technology focus (Botha *et al.* 2008).

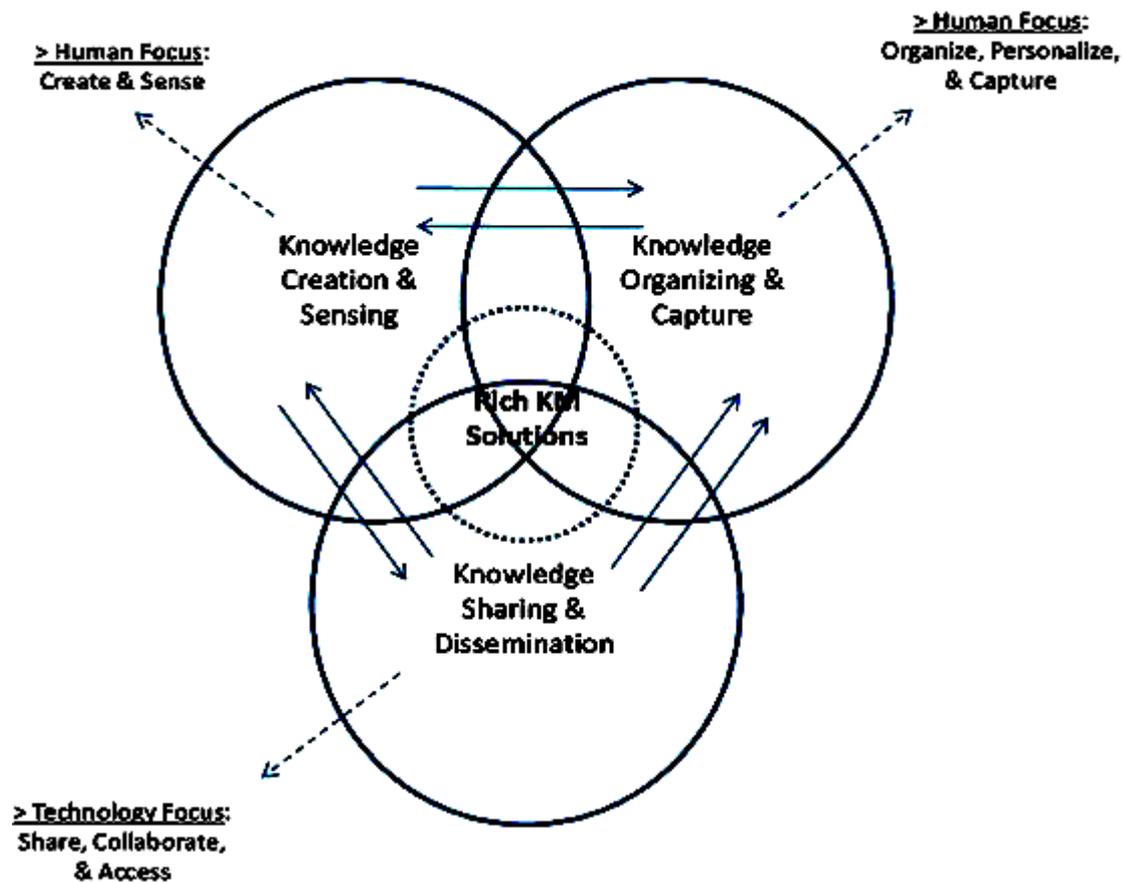


Figure 2.4: The knowledge management process model

Source: Botha *et al.* (2008)

As the three broad knowledge management processes categories overlap and interact, they create an intersection which is a knowledge rich zone (see Figure 2.4 for details). The efficiency of the knowledge management system depends on its ability to create knowledge rich zone and access and use knowledge from the zone to satisfy knowledge needs.

The Knowledge Management Process Model enhances the creation, organization and sharing of agricultural knowledge. People and/or technologies enhance the efficiency of knowledge management processes. This study adapted and modified the Botha *et al.* (2008) Knowledge Management Process Model. As found in Figure 2.5, the modification involved inserting the ‘Agricultural knowledge needs’ which is an independent variable influencing the performance knowledge management processes (knowledge creation and sensing, knowledge organizing and capture, and knowledge sharing and dissemination).

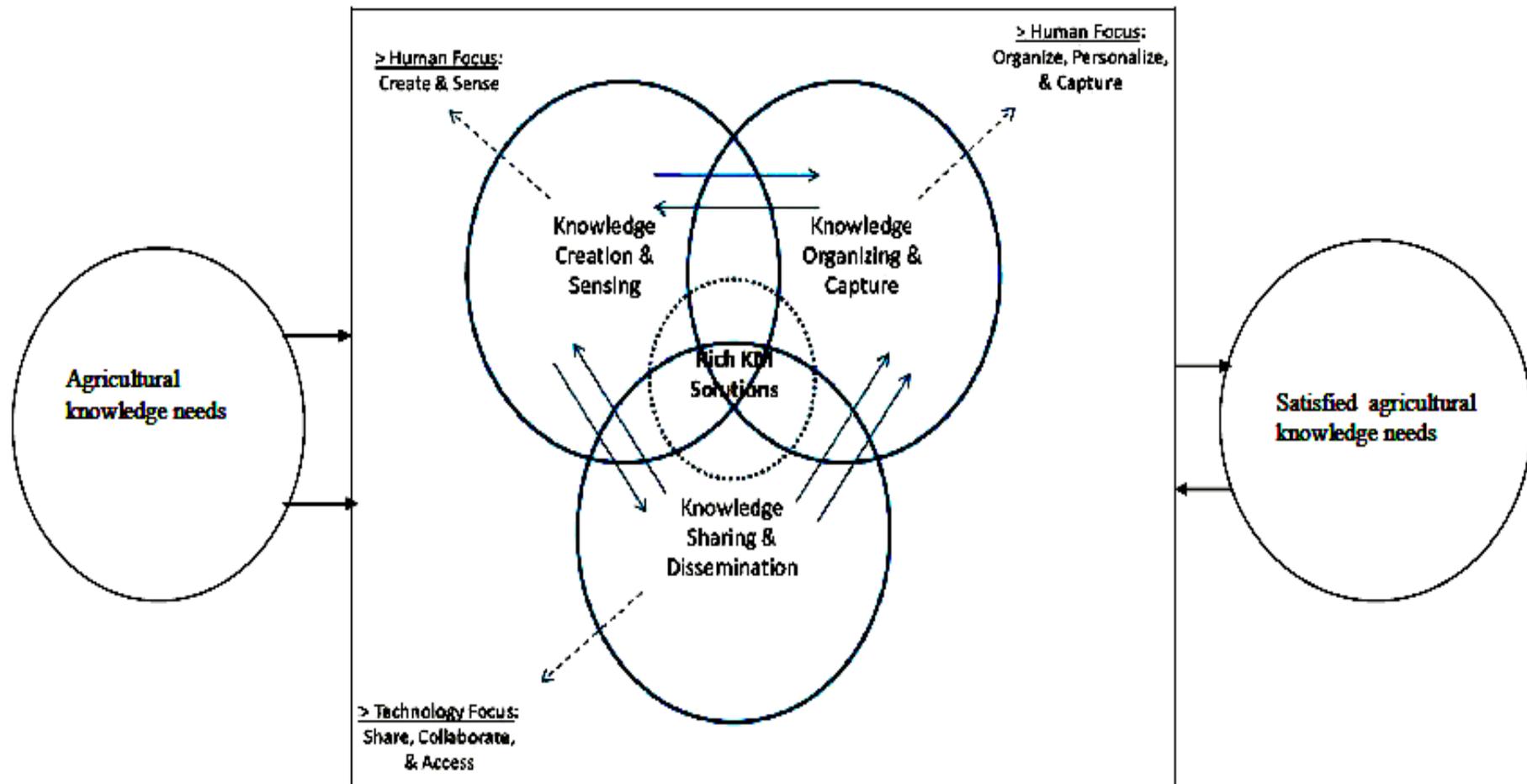


Figure 2.5: The modified knowledge management process model

Source: Modified from Botha *et al.* (2008)

The independent variable ‘agricultural knowledge needs’ is a reason for performing knowledge management processes. The dependent variable ‘satisfied agricultural knowledge needs’ has been inserted to show the outcome of the knowledge management process. It shows the goal of the activities taking place when the broad categories of knowledge management processes were interacting and overlapping among themselves. Therefore, this model leads to improved AKS usage hence enhancing access to agricultural knowledge among actors.

2.6 Chapter summary

This Chapter presents the theoretical and conceptual framework which guided the current study. It starts by discussing the importance of theoretical and conceptual frameworks in research and describes the relationship existing between theory and research. A thorough discussion on models and their role in research is made where different types of theories are described. Constructs under study are then developed and described. This is followed by a thorough discussion on the various models used in measuring the success of Information Systems and adaption of the research model to guide this study. The following chapter reviews relevant literature to the current study.

CHAPTER THREE

LITERATURE REVIEW

3.1 Introduction

The previous chapter discussed the conceptual framework which guided the current study. The current chapter discusses the literature related to this study. Literature review is an evaluative report of information found in the literature related to the selected area of study (Murthy and Bhojanna 2009). It is central to the research process because it surveys books, scholarly articles, and any other sources relevant to a particular issue, area of research, or theory, and by so doing, provides a description synthesis, and critical evaluation of these works in relation to the research problem being investigated (Labaree 2014). Literature review is important because it assists the researcher to understand and identify a problematic area of research through gaining a sound knowledge in the field being studied and helps to determine information relating to the current study (Pathirage, Amaratunga and Haigh 2005). It is through literature review that the knowledge gap to be filled by a study being undertaken can be identified. Thus, the chapter describes, summarizes, synthesizes, evaluates, clarifies literature and determines the nature of the research. The chapter reviews and discusses the literature on issues around AKS with a focus on enhancing access to agricultural knowledge among actors in the agricultural sector. Specifically, the chapter addresses the following research areas which are based on the study objectives:

- i. To identify key actors in AKS and the roles they play;
- ii. To categorize agricultural knowledge needs of AKS actors;
- iii. To determine factors hindering or stimulating access to agricultural knowledge among AKS actors;
- iv. To investigate how agricultural knowledge sharing processes take place among actors in AKS;
- v. To find out how ICTs support agricultural knowledge management and AKS;

- vi. To assess the role of the Government in enhancing access to and use of agricultural knowledge;
- vii. To formulate a model for strengthening AKS.

Thus, the chapter discusses agricultural knowledge management processes and factors influencing agricultural knowledge creation, sharing and usage. Finally, the chapter describes how ICTs and government interventions influence agricultural knowledge management and access to agricultural information services among actors in the agricultural sector.

3.2 Positioning knowledge in the information hierarchy

Knowledge originates from data; the information hierarchy shows how data, information and knowledge are related. An information hierarchy is a collection of relational information that is arranged in a ranking organization where each entity is subject to a single other entity, except for the top element (Rusu, Santiago and Jianu 2007). Information hierarchy creates a relationship between data, information and knowledge. Data are defined as symbols that represent properties of objects, events and their environment (Rusu *et al.* 2007). Data is usually raw and unprocessed in nature and usually has no meaning. Traditionally, data is captured using human sense organs through observing, hearing, touching, tasting and smelling. With scientific development it is now possible to have some devices to capture data.

To become information, data must be manipulated through tabulation, statistical analysis, interpretation, synthesis or any other operation that leads to greater understanding of a situation (Rusu *et al.* 2007). Information can be defined as the facts organized to describe a truths and beliefs, perspectives situation or condition (Wiig 1993). It is a message meant to change the receiver's perception (Van der Spek and Spijkervet 1997). Case (2002) defines information as the message expressed in some medium and has the potential of altering person's consciousness. Information is carried by information carriers. Information carriers (print and electronic media) are used to transfer information from a point to the other. Newspaper, booklets, pamphlets, books, magazines, journals and leaflets are some of the print information carriers. In these

carriers information is presented in the form of symbols. The same information can be shared through web pages, portals, CD-ROMs and other portable electronic devices.

When one internalizes, uses or applies information knowledge is generated. Knowledge is experiences, values, insights and contextual information; it is the text that answers questions why and how (Quigley, and Debons 1999; Van der Spek and Spijkervet 1997). In the twenty first century knowledge is regarded as a strategic asset that is important for competitiveness. Dalkir (2013) describes it to be a valuable commodity embedded in products and persons and that it is an important intellectual asset. The value of knowledge is increased when it has a key purpose and focuses on mission, core values and strategic priorities (Smith 2001). Unlike information and data, knowledge be stored and carried through print and electronic carriers, it can also be stored in the human brain (Aktharsha 2010). Knowledge is a renewable, reusable, and accumulated resource of value to the organization when applied in the production of products and services (Aktharsha 2010).

Generally, knowledge can be categorized into tacit and explicit knowledge. According to Smith (2001), tacit knowledge is practical, action-oriented or ‘know-how’ based on practice, acquired by personal experience, seldom expressed openly and often resembles intuition. It is the individual skills a person has gained over a period of time; it is not always gained through learning but often through doing and practicing. Polanyi (1966) stated that tacit knowledge is the background knowledge a person uses when trying to understand anything that is presented to him. Tacit knowledge is intuitive and practice-based, which makes it both valuable and difficult to pass on to others (Stover 2004). On the other hand, Smith (2001) defines explicit knowledge as the academic knowledge or “know-what” that is described in formal language, print or electronic media, often based on established work processes, use people-to-documents approach.

Tacit knowledge can be converted into explicit knowledge and vice versa and is through this alternation knowledge is created and shared. However, it is easier to capture explicit knowledge than tacit knowledge because it is embedded in human brains (Abu-Nahleh, Hamdan, Abu and Taha 2010). Moreover, converting tacit knowledge to explicit knowledge is often time consuming and problematic (Herschel, Nemati and Steiger 2001). However, once tacit

knowledge is converted to explicit knowledge, the organization is in less danger of losing its “knowledge capital” when employees leave the organization (Stover 2004). The decision to convert knowledge into tacit or explicit will depend on the organization’s knowledge management approach, which could be personalization or codification. Conversion of tacit knowledge may give rise to explicit knowledge and vice versa, the alternation occurs in four processes: socialization, externalization, combination, and internalization (Nonaka 1994; Nonaka and Takeuchi 1995). Socialization occurs when tacit knowledge is shared (Stover 2004), this may take place when as people socialize. Externalization occurs when tacit knowledge is converted into explicit knowledge (Nonaka 2008). It is possible to combine explicit to explicit knowledge (Nonaka and Takeuchi 1995), combination is an important process because through it codified knowledge can be shared and recreated. Moreover, explicit knowledge can be converted to tacit through internalization (Stover 2004). As one reads contents of information carriers explicit knowledge can be converted to tacit.

Both tacit and explicit knowledge can further be categorized into three distinct groups; De Long and Fahey (2000) categorize knowledge into human knowledge, social knowledge and structured knowledge. De long and Fahey (2000) describe human knowledge as what individuals know or know how to do; it is manifested in skill or expertise, and usually combines both explicit and tacit knowledge. The other type of knowledge which is social knowledge exists in relationships between individuals or within groups (Wu, Zubair and Maly 2006). This knowledge is mostly tacit and is shared among members of a particular group or community of practice. Structured knowledge comprises structured and formalized rules procedures and routines ingrained within an organizational setting; it exists in the form of explicit and rule-based (Aktharsha 2010). A key distinction between structured knowledge and the first two types is that structured knowledge is assumed to exist independently of human knowledge (Aktharsha 2010).

Knowledge comes from different sources which can be categorized into (i) experience, (ii) authority, (iii) reasoning, deductive and inductive and (iv) scientific approach (Ary *et al.* 2009). People become experienced when they perform the same task from time to time. As they accumulate experience they become masters of the task and have authority over that task. People with authority are considered to be important sources of knowledge. One consults the authority

after facing challenges and does not know how to accomplish a task. Ary *et al.* (2009) describe reasoning as the other important source of knowledge. Reasoning is the activity of evaluating arguments (Goel, Gold, Kapur and Houle 1997). Reasoning can either be deductive or inductive. Deductive reasoning moves from general principles to specific conclusions while inductive reasoning begins with specifics and then works towards broader generalizations (Rovai, Baker and Pontonm 2013). On the other hand, the scientific approach uses hypothesis to generate new knowledge, this employs research where tentative solutions to a given problem are derived and the best solution is found after testing and verifying for its appropriateness.

3.3 Knowledge management in the agricultural sector

Knowledge management is the deliberate and systematic coordination of an organization's people, technology, processes, and organizational structure in order to add value through reuse and innovation (Dalkir 2013). It involves knowledge gathering, knowledge organizing, knowledge selecting, knowledge sharing and knowledge creating. Littlejohn and Margarayn (2011) point out that knowledge management involves the creation, sharing and using knowledge. These processes constitute the so called knowledge management. Knowledge management formed by the systematic process for creating, acquiring, disseminating, leveraging and using knowledge for the competitive advantage and to achieve organizational objectives (Bhojaraju 2005). Knowledge creation/acquisition is the process of generating knowledge internally and/or acquiring it from external sources (Kahreh 2011). Knowledge sharing refers to the processes of transferring, disseminating and distributing knowledge in order to make it available to those who need it (Kahreh 2011). When knowledge is shared, there are possibilities of creation of new knowledge. On the other hand, managing knowledge involves strategic management processes; it involves formulation stages, implementation stages, and controlling stages (Ahmad and Idris 2008).

Knowledge management results into better exploitation of knowledge assets for business benefits and improves the performance of the business by gaining new understandings (Haslinda and Sarinah 2009). This occurs as people share, create and recreate knowledge. In the knowledge economy, knowledge is an intangible resource which adds value to products (Jelenic 2011). It is

for this reason many organizations are investing in intellectual assets which are used for value addition and inventing new products.

In the agricultural sector, knowledge is created and used by actors. For improving agricultural production, access and use of knowledge is important. For improving agricultural production, the delivery of extension services requires innovative and inter-related approaches of knowledge management (Mekonnen, Sehai and Hoekstra 2012). Knowledge management is concerned with ways of exchanging knowledge among those who can develop it and those who can use it (Hartwich, Pérez, Ramos and Soto 2007). In agricultural settings research institutes are the developers of knowledge while farmers, marketers and processors are users of developed knowledge. However, developing agricultural knowledge requires an understanding of the practical problems being faced by farmers, marketers and processors. For this to happen there must be a strong linkage between agricultural knowledge creators and users. The linkage is important for the two sides to understand each other. This depends much on the effectiveness of agricultural knowledge management system put in place. Knowledge management system is a platform facilitating extraction, storage, retrieval, integration, transformation, visualization, analysis, dissemination, and utilization of knowledge (Sharma and Mehta 2012). Knowledge management is important from creation to dissemination and the ultimate utilization of knowledge. Effective agricultural knowledge management involves people, hardware and software. People are involved in generating, using knowledge and in managing the hardware and software resources needed for knowledge management. These resources are important for storage, retrieval, integration and disseminating of knowledge.

3.3.1 Creating agricultural knowledge

Agricultural knowledge falls into two broad categories namely: indigenous and exogenous knowledge. Local communities possess a wide range of indigenous knowledge that has significantly contributed to the improvement of agricultural systems in relation to production techniques and post-harvest techniques (Koda 2000). Indigenous knowledge can be defined as a body of knowledge built up by a group of people through generations of living in close contact with nature (Johnson 1992). Indigenous knowledge is local, practical and enforced through

learning by doing (Lwoga 2011). Indigenous knowledge is an essential cultural and technological element of human societies, it is unique to a particular culture and acts as the basis for local decision making in agriculture, health, natural resource management and other activities. It is embedded in community practices, institutions, relationships and rituals. This type of knowledge is based on experience of local people, it is shared through interpersonal communication, and it is highly volatile. As owners of indigenous knowledge perish the knowledge is lost with them unless it has been shared to other members of the community.

Exogenous knowledge is a broad base of non-traditional knowledge that local people draw from their interaction with non-local people and institutions, television and other media, formal education, and adoption of western scientific thinking, values, and philosophies (Lwoga, Ngulube and Stilwell 2010b). Exogenous knowledge is explicit in nature thus being easily stored and shared (Lwoga 2011). This type of knowledge can be accessed from multiple sources; Lwoga (2011) mentions some of the sources to include print materials, extension officers, input suppliers, cooperative societies, village meetings, farmer groups and NGOs. It is shared through interpersonal communication, mass media, and observation.

Indigenous knowledge is a form of tacit knowledge because most of it has not been codified. Nonaka and Konno (1998) describe that the creation of tacit knowledge is continuous process. According to Nonaka (1994), knowledge conversion is the engine of knowledge creation; it occurs when there is an interaction between tacit and explicit knowledge. Thus, knowledge conversion occurs through socialization (tacit to tacit), externalization (tacit to explicit), combination (explicit to explicit), and internalization (explicit to tacit). Through socialization, people tell others what they know and may have opportunities of hearing from others. It is here when knowledge from different people is combined to either form new knowledge or add up to what was known before. On the other hand, the creation of exogenous knowledge depends on the availability of public and private extension services, research institutions, laboratories, telecentres, suppliers, libraries, schools and universities, and the mass media (Lwoga 2011). Exogenous knowledge is created when people interact with these institutes. People may interact with these institutions for studying or accessing information. Research institutions and laboratories are there to solve problems thus contributing greatly to knowledge creation. Creation

of exogenous knowledge is more formal, uses agreed standards and methods and is not based on people's experience.

Continuous knowledge creation is important for enhancing agricultural development. According to Nonaka, Toyama and Konno (2001), for knowledge to be created a presence of three elements is needed. The first element is SECI (Socialization, Externalization, Combination and Internalization) process. This element enhances the creation of knowledge through conversion between tacit and explicit knowledge. The second element involves the “*ba*” meaning the space for emerging relationships. Choo and Neto (2010) mention that space for creating the relationship can be physical, virtual, mental or a combination of them all. According to Nonaka and Konno (1998), “*ba*” is considered to be a shared space that serves as a foundation for knowledge creation, it provides the energy, quality and place to perform the individual conversions and to move along the knowledge spiral. Knowledge is created through the interactions amongst individuals or between individuals and their environments; “*ba*” is the place where information is interpreted to become knowledge (Nonaka *et al.* 2001). For knowledge creation to take place, some important assets the “knowledge assets” must be there. These form the third important element in knowledge creation. Knowledge assets are the key elements that facilitate knowledge creation processes; they include the inputs, outputs, and moderator of the knowledge-creating process (Nonaka *et al.* 2001). Knowledge assets are categorized into four different types namely experiential, conceptual, systemic, and routine assets (Chou and He 2003). Knowledge assets affect differently the SECI processes of knowledge creation. Experiential knowledge assets consist of the tacit knowledge that is built through shared hands-on or working experience (Chou and He 2004). Experiential knowledge assets include skills and know-how that are acquired and retained by individuals from their working experiences (Chou and He 2004). Conceptual knowledge assets consist of explicit knowledge articulated through images, symbols and languages; they are based on the concepts held by customers and members of the organization (Nonaka *et al.* 2001). Routine knowledge assets consist of the tacit knowledge that is embedded and regulated in the actions and practices of a firm; they include know-how, organizational routines and cultures as certain patterns of thinking and action that are shared among organizational members and reinforced by daily activities (Umemoto 2002). Systemic knowledge assets consist of systematized and packaged explicit knowledge, such as

explicitly stated technologies, product specifications, manuals, and documented and packaged information about customers and suppliers (Nonaka *et al.* 2001). Conceptual knowledge assets have a greater effect on externalization while routine knowledge assets have a greater effect on socialization (Chou and He 2004). The effect of experiential and systemic knowledge assets on internalization and combination is low respectively.

Agricultural activities require a combination of indigenous and exogenous knowledge which come from indigenous and exogenous sources respectively. It is the social interactions and participations between different actors in the agricultural sector which lead into creation of knowledge. There is a strong link between the creation of exogenous knowledge and agricultural research institutions. Most countries have the National Agricultural Research System (NARS) with the key role of creating new knowledge and developments needed for increasing agricultural productivity. NARS are made up of various national agricultural research institutes (NARI), agricultural universities, private-sector firms, NGOs and farmers' organizations (Food and Agricultural Organization (FAO), 1996). All of the NARS actors enhance efficient and effective research activities. Mamman and Nansoh (2014) define research as a systematic investigation towards increasing the sum of human knowledge to discover new facts or to refurbish old knowledge. Agricultural research builds on the already known knowledge; it combines indigenous and exogenous knowledge together and provides better ways of improving methods of doing things or finding solution to problems of farming (Mamman and Nansoh 2014). The NARS needs the combination of three elements (SECI, “*Ba*” and knowledge assets) for agricultural knowledge creation. SECI processes enhance knowledge creation through interaction; “*Ba*” provides space for knowledge creation, while the knowledge assets provide important inputs and moderators for knowledge creation process.

3.3.2 Factors influencing agricultural knowledge creation

Agricultural knowledge creation is important for optimizing agricultural production. For effective agricultural knowledge creation, it is important to keep into consideration the different factors that influence knowledge creation. The factors influencing knowledge creation include organizational culture, *Ba*, and leadership style (Rollet 2003). Organizational culture is related to

how organizations operate. The dimensions of organizational culture are leadership, trust and care (Wahid, Ismail, Wanarat and Laohavichien 2003). Leadership style is the manner and approach of providing direction, implementing plans, and motivating people (Ojokuku, Odetayo and Sajuyigbe 2012). A leader is person who influences, directs, and motivates others to perform specific tasks and inspires subordinates for efficient performance towards the accomplishment of the stated corporate objectives (Ojokuku *et al.* 2012). Leadership plays a central role in knowledge creation activities. Scholars (Kumar, Jain and Tiwary 2013) describe that leaders should recruit and reward employees committed to knowledge creation processes; render a common platform to employees for sharing experiences; and provide adequate and safe means of expression to employees. Leadership should forge knowledge links between uniquely capable companies; establish knowledge-oriented culture; enhance inter-organizational collaboration; re-enforce and expand knowledge-inventory; and invest in training programs (Kumar *et al.* 2013). Leadership style is a key determinant of the success or failure of any organization because leaders can either motivate or de-motivate creation and usage of edge knowledge.

The other important factor for knowledge creation is the concept of *Ba*, this is related to space and environment for knowledge creation (Nonaka and Konno 1998). Knowledge creation takes place through interactions in *Ba*, interaction is bound by time, space, participants, their different contexts and trust among each other (Von Krogh, Ichijo and Nonaka 2000). Organizations and communities should create a shared space that serves as a foundation for knowledge creation, it should provide energy, quality and place to perform the individual conversions and to move along the knowledge spiral (Nonaka and Konno 1998). Organizations and communities should have culture which motivates knowledge creation. It is culture which facilitates interactions among people and promotes an organization motivational system (Rollet 2003). Well motivated individuals are more likely to be involved in knowledge creation activities.

There is a strong relationship between knowledge sharing culture and knowledge creation and between organization structure and knowledge creation (Yi and Jayasingam 2012). The SECI processes show the relationship existing between knowledge sharing and knowledge creation; when people share knowledge there are possibilities of creating new knowledge. SECI processes enhance knowledge creation through conversion between tacit and explicit knowledge (Nonaka

et al. 2001). Organizations and communities that have invested in knowledge sharing infrastructure are more likely to create new knowledge from time to time. So as to manage knowledge effectively organizations need knowledge based structure which should align with organization strategies, fit existing organizational knowledge and lead to continuous improvement and organizational learning (Gelard, Emamisaleh, Hassanabadi and Rad 2013). Organizational structure affects knowledge creation and organic structure provides good condition for knowledge creation in the organization (Gelard *et al.* 2013). Communication between members of different ranks in organizations should be a lateral interaction and rather than a top down approach.

There is a strong relationship between ICT and knowledge (Yi and Jayasingam 2012). ICTs provide access to information that can create earning opportunities, improve access to basic services, or increase the impact of education and interventions (Kenny, Navas-Sabater and Qiang 2001). ICT has removed the physical constraints of organizations bound to a single location (Toikka 2007; Aker 2011). ICTs reduce communication and information costs and provide new opportunities to access information on agricultural technologies (Aker 2011). Organizations with adequate ICT infrastructure can easily create and share knowledge and collaborate with other organizations in creating knowledge.

The other factor influencing knowledge creation is human capital. The quality of organization human capital influences organizational knowledge creation capacity (Yi and Jayasingam 2012). Human capital is the bundle of capacities and potentials that individuals possess and that facilitate the creation of knowledge and production of economic value (Mitra, Abubakar and Sagagi 2011). Organizations and governments are supposed to have strategies aiming at improving the quality of human capital. This can be done through establishing training programmes for citizens and staff thus improving their quality and capacity to be involved in knowledge creation activities.

Motivation influences the level of knowledge creation in a given organization (Collins, Smith and Stevens 2001). Motivation is a basic need for work and if there is no motivation, there will be no interest (Abbas, Rasheed, Habiba and Shahzad 2013). It provides energy to work and has a

positive impact on knowledge creation (Abbas *et al.* 2013). It can either be positive if it encourages or negative if it discourages. It may result into increased beliefs of knowledge ownership, team work, build individual attitudes towards knowledge creation and increase the perceived usefulness of knowledge (Wang and Noe 2010). To motivate knowledge creation, institutions and communities should provide staff and community members with full cooperation in the process of knowledge creation, and give them autonomy in their own work, decision making, and problem solving (Vanicharoenchai 2007). It is important to create environments that facilitate knowledge creation through enhancing access to informal meetings and providing equipment and facilitation for meetings (Vanicharoenchai 2007). Informal meetings take place through informal gatherings, it is important to have bylaws which allow such types of meetings.

Individual characteristics have a strong impact on individual capabilities to knowledge creation. According to Wang and Noe (2010), individual characteristics influencing knowledge creation are level of education and work experience. Level of education enables one to interpret the environment and create knowledge out of it. It enables one to create knowledge out of observations and through combining ideas. It enables individuals to use technical and organizational infrastructure and multiple channels for knowledge sharing (Davenport and Prusak 1998). Work experience on the other hand creates an individual knowledge base. Through work experience one can be able to identify several sources of knowledge which may be used for creating new knowledge.

Generally, knowledge creation remains to be an important process for socio-economic development. Organizations and communities must determine all of the factors which in one way or the other hinder knowledge creation and look for appropriate solutions to limit their impacts. In the agricultural sector, taking a holistic view in creating agricultural knowledge can enhance improvement of the entire sector. However, this creates a need for keeping into consideration of all factors limiting agricultural knowledge creation and usage.

3.3.3 Disseminating and sharing of agricultural knowledge

Created knowledge must be shared to relevant stakeholders for use. The term “knowledge sharing” means to share one’s knowledge with others and this will be very beneficial for the

organizations (Abbas *et al.* 2013). Knowledge sharing is the behavior to disseminate and share acquired values with other members within an organization (Ryu, Ho and Han 2002). It is the process of mutually exchanging knowledge and jointly creating new knowledge (van den Hooff and de Ridder 2004).

Knowledge sharing process requires knowledge sharing environments. It requires a platform, culture and certain amount of trust between individuals (Aslam 2013). There are different set ups which serve as platforms for knowledge sharing between stakeholders at national and local levels (Moumouni and Labarthe 2012). Knowledge can be shared through formal or informal settings. Knowledge sharing may take place through interpersonal or through mediated communication. Shared knowledge enables organizations and communities exploit and use knowledge potentials.

3.3.4 Formal and informal knowledge sharing practices

Knowledge sharing practices can take place through formal or informal settings (Zahra, Neubaum and Larrañeta 2006). Formal knowledge sharing involves the communication within the formal organizational structure that transmits goals, policies, procedures and directions (Jewels, Underwood & de Pablos 2003). Formal knowledge sharing practices usually center on the routine collection, packaging and distribution of organizational knowledge through formal communication channels (Zarha *et al.* 2006). It involves the use of established standards and procedures in sharing knowledge. Formal knowledge sharing takes place along the formal chain of command (Tyagi and Misra 2010). Official knowledge is shared through formal settings which are considered as top-down approaches (Azudin, Ismail and Taherali 2009).

Informal knowledge sharing is the communication outside the formal organizational structure that fills the organizational gaps, maintains the linkages, and handles the one time situations (Jewels *et al.* 2003). Informal knowledge sharing practices are unstructured and non-routine interactions among actors (Zahra *et al.* 2006). Tacit knowledge which is difficult to define, codify and express is best transmitted through these informal forms. Informal social interactions can increase opportunities to share ideas and knowledge (Zahra *et al.* 2006). Informal knowledge sharing practices are lateral in nature and facilitate the sharing of private non-codified knowledge (Azudin *et al.* 2009).

Knowledge sharing takes place internally and externally. It takes place among members within organizations/communities and with members from other organizations/communities. There are benefits gained from engaging in knowledge sharing with parties external to the organizations (Staplehurst and Ragsdell 2010). When sharing knowledge with external parties, the organization/community becomes aware of what is known by the other party. However, it is possible to lose the organizational/community's competitive edge through sharing knowledge with external parties. Thus, organization/community members should carefully take full advantage of internal and external knowledge sharing through formal and informal knowledge sharing practices for their own betterment and of their organizations and communities.

3.3.5 Knowledge hiding and hoarding

Before understanding factors influencing knowledge sharing it is important to differentiate between knowledge hiding, knowledge hoarding and knowledge sharing. Knowledge hiding is not simply the absence of sharing; rather, knowledge hiding is the intentional attempt to withhold or conceal knowledge that has been requested by another individual (Connelly, Zweig, Webster and Trougakos 2012). There are three ways people can engage in knowledge hiding: playing dumb, rational hiding, and evasive hiding (Pan and Zhang 2014). Playing dumb occurs when people pretend that they are ignorant of the knowledge that others inquired, rational hiding occurs when one tells the knowledge seeker that he or she cannot tell the knowledge because of its confidentiality, while evasive hiding includes providing some other information instead of what the knowledge seeker really wants (Pan and Zhang 2014). Knowledge hiding is not always bad as it is sometimes done to protect the competitive advantage (Husted, Minbaeva and Pedersen 2011).

Knowledge hoarding represents the act of accumulating knowledge that may or may not be shared at a later date; it is essentially the passive accumulation of knowledge which may/may not be shared in the future (Hislop 2003). Knowledge hoarding captures the accumulation of knowledge that has not necessarily been requested by another individual (Webster, Zweig, Connelly, Brodt and Sitkin 2008). Organizations with poor knowledge sharing culture are more

likely to be affected by the knowledge hoarding. In long run, knowledge hoarding has a negative influence on knowledge creation.

Both knowledge hoarding and knowledge hiding discourage knowledge sharing thus creation of new knowledge. These processes have a negative impact on productivity. The problem becomes more serious when it comes to the agricultural sector which involves multiple stakeholders. Knowledge hoarding and knowledge hiding results into dwarfing of the agricultural sector and contributes to poverty among farmers and other stakeholders.

3.3.6 Knowledge sharing, transfer and exchange

There is a difference between knowledge sharing, knowledge transfer and knowledge exchange. Knowledge sharing involves both sharing of knowledge by the knowledge source and the acquisition and application of knowledge by the recipient; it involves the multi-directional movement of knowledge between different units, divisions, or organizations rather than individuals (Wang and Noe 2010). Knowledge exchange includes both knowledge sharing and knowledge seeking (Wang and Noe op. cit) while knowledge sharing involves the dissemination of acquired knowledge to others. On the other hand, knowledge transfer is the process through which one unit is affected by the experience of another (Argote and Ingram 2000). Knowledge transfer is the dissemination of knowledge from one individual or group to another within the organization (Marzanah, Salfarina, Azim and Rusli 2012). Knowledge transfer manifests itself through changes in knowledge or performance of the recipient unit (Inkpen and Tsang 2005). It takes place through formal/informal or personal or impersonal channels.

Knowledge sharing is more effective in environments where the learning process is emphasized and implemented in the organization; it takes place among people (Widen-Wulff and Ginman 2004). Knowledge sharing and knowledge transfer have been used interchangeably by many authors. However, Paulin and Suneson (2012) show a distinction between the two terminologies. Knowledge sharing is an exchange of knowledge between two individuals: one who communicates knowledge and one who assimilates it, the focus of knowledge sharing is on human capital and the interaction of individuals. Knowledge transfer includes a variety of interactions between individuals and groups; within, between, and across groups; and from

groups to the organization. Knowledge sharing, which is the sharing of task-relevant expertise, ideas, and suggestions with one another is multidirectional and takes place between individuals only while knowledge transfer is unidirectional and takes place between individuals, teams, units or organizations (Paulin and Suneson 2012).

In agriculture, knowledge transfer, exchange and sharing are important processes because the sector involves multiple stakeholders who must work closely for enhancing food security and improving livelihoods. In most cases knowledge base among actors in the sector is not the same. Moreover, there may be a specific direction where knowledge is directed. For these reasons, both knowledge transfer, exchange and sharing must be incorporated when one want to disseminate agricultural information.

Agricultural knowledge value chain involves different stakeholders including farmers, researchers, processors, marketers, governmental and non-governmental organizations and consumers. Each stakeholder may use knowledge which may be owned by others. This requires effective settings to enhance agricultural knowledge exchange, sharing or transfer. Communication channels facilitate knowledge dissemination because they act as linkages between owners and seekers of knowledge. Value chain actors in the agricultural sector may be in the same or different physical locations. This calls for a variety of communication channels to facilitate agricultural knowledge dissemination.

3.3.7 Channels for agricultural knowledge sharing

For agricultural knowledge to be shared stakeholders must have access to appropriate communication channels. According to Mtega and Msungu (2013), agricultural knowledge can be shared through electronic and print media and interpersonal communication. Mtega (2012) found that electronic media used for sharing agricultural knowledge include radio, television, mobile phones, and internet while print media include books, posters, newspaper, magazine, leaflets booklets and pamphlets. Notice boards have been common tools used for sharing knowledge (Zeffane 2006). Most offices use notice boards for sharing knowledge to employees and the community around them.

Communication channels can either be formal or informal; Tyagi and Misra (2010) describe that informal communication channels are used for informal knowledge sharing practices. These channels fall out the formal channels used by organizations and communities. Informal communication channels are unofficial channels taking place among staff as face-to-face or telephone interaction (Altınöz 2008). Formal communication channels are used in specified structures within organizations (Altınöz op. cit). They are formal in the sense that organizations and communities use them for sharing knowledge along the chain of command. For effective agricultural knowledge sharing, an integration of formal and informal communication channels is important. This is because informal channels may fasten sharing knowledge previously accessed through formal channels.

Preference of agricultural knowledge sharing channels may differ from one person to the other. There are several factors which influence the choice of agricultural knowledge communication channels among stakeholders in the agricultural sector. Okwu and Daudu (2011) found that availability and accessibility of communication channels led actors in the agricultural sector to use some of the channels more frequently than others. Mtega and Malekani (2009) found that channels which are more accessible have a higher possibility of being used for knowledge sharing than those which are not. When people want to share knowledge they usually use the available and easily accessible communication channels.

Perceived ease of use of a communication channel influences choice of channels for agricultural knowledge sharing. According to Venkatesh and Davis (2000), channels which are simple and do not need more skills for using them are preferred by the majority. This is of greater importance in the agricultural sector which has many actors with different level of expertise and experience in using different communication channels. When sharing or disseminating agricultural knowledge it is important to consider how easily recipients may access knowledge through the channels used. Knowledge shared through ease to use channels is likely to be accessed by more actors than the one shared through complicated communication channels.

Age, sex and literacy level influence individual choices of communication channels for knowledge sharing (Mtega 2012; Okwu and Daudu 2010; Mtega and Malekani 2009). Unlike the

old ones, young people are more willing to use technology based knowledge sharing channels. Individual sex influenced the use of communication channels. Mtega (2012) found that the usage of some communication channels differed between males and females. Mtega states further that gender based division of labor limited females from using some communication channels; for example, more males attended in bars and clubs where alcohol was sold than females. These were important platforms for socialization. Mtega (2012) found that literacy levels influenced the choice of knowledge sharing channels. Internet, newsletter, books and magazines were used more by literate communities while interpersonal face to face knowledge was more common among illiterate communities (Mtega and Malekani 2009).

Preference of communication channels for sharing agricultural knowledge is influenced by the level at which the channels facilitate feedback mechanism. Okwu and Daudu (2010) state that communication channels enhancing immediate feedback are preferred more than those which do not. It is for this reason people prefer mediated or unmediated interpersonal communication because it facilitates instant feedback. Despite enhancing immediate feedback interpersonal communication is known for distortion of messages (Mtega 2012). It is for this case a combination of channels for delivering agricultural knowledge is important. However, it is important to determine the factors influencing knowledge sharing because the effectiveness of knowledge sharing channels may directly be influenced by such factors. The following sub section describes factors which may either hinder or promote knowledge sharing.

3.3.8 Factors influencing agricultural knowledge sharing

There are several factors influencing agricultural knowledge sharing. Norizah, Ibrahim, Mohamed, Yahya and Abdul (2005) categorize factors influencing knowledge sharing into cultural, ICT, communicational and organizational based factors. Organizational factors are related to organizational culture, they are composed of business strategy, people, processes, and structures (Yang and Chen 2007; Sanchez 2004). Organizations are made up of systems which operate through people, structures and processes. For business activities to be conducted, it is important to have access to knowledge. The organizational structure usually determines how knowledge is being shared and the way people behave. Moreover, organizational knowledge

sharing culture can be created. Top managers are responsible with creating organizational knowledge sharing culture. According to Davis, Baggozi and Warshaw (1992), top management can enhance organizational knowledge sharing culture through creating motivational system. Moreover, organizations should have all of the necessary infrastructure and environment for knowledge sharing.

Cultural factors include sociability, solidarity and power distance (Norizah *et al.* 2005; Staplehurst and Ragsdell 2010). Communities with good knowledge sharing culture are known to socialize more and have more social ties. Moreover, the flow of power within organizations and communities affects knowledge sharing culture. This relates to the organizational structure; organizations with very complicated structures are likely to have difficulties in sharing knowledge (Hartini, Normala and Sobry 2006). Moreover, organizations and communities differ with respect to how they support knowledge sharing process, those with some mechanisms to support the process are likely to develop a knowledge sharing culture. Norizah *et al.* (2005) indicate that it is important to establish formal and informal environments for knowledge sharing. Communities and organizations with such environments are known to be more successful.

The other factor influencing knowledge sharing is the communication factor. This factor is explained by trust, communication channel, reputation and altruism (Norizah *et al.* 2005). Trust among members of a community has strong influences on knowledge sharing (Hooff, Elving, Meeuwsen and Dumoulin 2003). For knowledge to be shared well there must be a trust among communicating sides, reputation of the one sharing knowledge is important for the process to be successful. Moreover, people prefer to use different communication channels, choice of channels for sharing knowledge may be influenced by availability and perceived ease of use. Scholars (Mtega and Malekani 2009) show that communication channels which are available and do not require advanced skills in using them are likely to be used more for knowledge sharing.

For knowledge sharing to take place it must involve a set of behaviours that aid the exchange of acquired knowledge (Chow and Chan 2010). Knowledge sharing may be hindered by lack of time and trust and recognition but it can be propagated by experience, transparency and

interpersonal skills (Staplehurst and Ragsdell 2010). Hartini *et al* (2006) describe that individual attitudes determine one's willingness to share knowledge. According to Bakhari *et al.* (2008), individual intention to share knowledge is influenced by awareness, trust, personality and perceived benefits of knowledge sharing.

ICTs form an important channel for knowledge sharing. These technologies have several tools and applications which facilitate knowledge sharing. Among the commonly used ICTs are the mobile phones, computers, internet, radio and television sets (Lwoga 2009). ICTs facilitate communication independent of time and place (Hooff *et al.* 2003). However, for one to use these technologies for knowledge sharing it is important to have adequate infrastructure, having relevant knowledge sharing tools and applications and necessary skills needed for using these technologies (Bakhari and Zawiyah 2008; Norizah *et al.* 2005). Communities differ in terms of ICT infrastructure and type of ICTs for knowledge sharing, people within communities have different skills for using ICTs and own different types of ICTs. TCRA (2013) shows that ICT infrastructure are more developed in urban than in rural areas. This indicates that people living in urban areas have more opportunities of using ICT tools for knowledge sharing than those from rural areas. Studies (Mtega 2012; Mtega and Malekani 2009) indicate that radio and mobile phones are the major ICTs owned by some people in rural areas. On the other hand, CTA (2008) point out that most rural areas in Tanzania have limited coverage of radio frequency and that very few radio stations in the country broadcast agricultural related programmes.

Lee (2010) states that knowledge characteristics, knowledge transfer channels, and knowledge absorptive capacity of receivers influence knowledge sharing. Knowledge can be tacit or explicit, it can be complex or simple, and it can also be specific or general. The type of knowledge influences the way it is going to be shared. Polanyi (1966) describes that tacit knowledge is not easily codified and shared; it is lost when the owner dies. Unlike tacit knowledge, explicit knowledge can be conveyed in documents, email, data bases, as well as through meetings and briefings (Nonaka 1994). It can be described, written down and documented, and is largely acquired in formal educational settings (Hess 2006).

The other factor influencing knowledge sharing is the type of channel to be used for accessing knowledge. Communication channels can either be personal or impersonal, formal or informal. Toumkara (2012) states that informal communication channels may result into loss of certain amounts of knowledge due to lack of formal knowledge coding but may promote knowledge creativity while formal knowledge sharing channels result into greater distribution of knowledge but may inhibit creativity. Toumkara states further that personal channels may be more effective for distributing highly contextual knowledge whereas impersonal channels may be most effective for knowledge that can be readily codified and generalized to other contexts.

Knowledge absorptive capacity is the ability to assimilate and replicate new knowledge gained from external sources (Tsai 2001). According to Chen, Liu and Tsai (2008), knowledge absorptive capacity depends on the individual's literacy level and understanding. Literate individual and communities are more likely to have higher knowledge absorptive capacity and in most cases perceive the importance of knowledge sharing for social and economic development. For effective knowledge sharing, it is important to determine all factors influencing knowledge absorptive capacity and knowledge sharing. This is more important in the agricultural sector because it involves multiple stakeholders whose roles depend upon each other but have different demographic characteristics and occupations.

Knowledge may be indigenous or exogenous and sharing these categories of knowledge requires both tacit and explicit knowledge approaches. Indigenous knowledge is tacit, orally communicated, 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 and it is largely used by local communities for decision-making (Lwoga 2011). Indigenous knowledge is tacit, it is essentially personal in nature and is therefore difficult to extract from the heads of individuals (Sanchez 2005). Like tacit knowledge, indigenous knowledge is shared through oral communication channels. It is accessed when individuals socialize with family members, neighbours, relatives or friends within a community (Mtega, Benard and Dulle 2013). It is shared through informal communication channels because it is difficult to codify it. However, this type of knowledge is very important for agricultural development because it is acquired through firsthand experience of farmers and other actors at

field/farm level. Exogenous knowledge is the information made available to communities from the sources outside their boundaries as part of the information transfer process to support modernization (Mchombu 1995). Exogenous knowledge is shared from outside the community. Mtega *et al.* (2013) describe that exogenous knowledge is mostly contained in formal knowledge sources and it is shared through extension agents, libraries, and through radio and TV broadcasts. However, to enhance agricultural development and improve livelihoods of all actors in the agricultural sector it is important to use strategies which may enhance sharing of both indigenous and exogenous knowledge.

The effectiveness of knowledge sharing process may be influenced by knowledge sources. According to Mtega *et al.* (2013) and Lwoga (2011), knowledge comes from both formal and informal sources. Mtega *et al.* (2013) describe informal sources of knowledge to contain mostly indigenous and tacit knowledge, they are also termed as indigenous knowledge sources. Knowledge from indigenous/informal sources is shared through informal communication channels. On the other hand, formal knowledge sources contain formal knowledge which is mostly explicit in nature and is shared through formal communication channels. Moreover, the distance from the knowledge source to knowledge user influences knowledge sharing. Studies (Mtega 2012; Lwoga 2010; Mtega and Malekani 2009) show that knowledge sources which were close to residential areas were more consulted than those at a distant.

3.4 Critical success factors for agricultural knowledge management

The importance of knowledge management is clear and it is seen as a competitive advantage (Heaidari, Moghimi and Khanifar 2011). Knowledge enables individuals to meet their goals, it facilitates socio-economic development. For enhancing agricultural development, organizations and communities need efficient mechanisms for creation, sharing and usage of agricultural knowledge. Scholars (Heaidani *et al.* 2011; Lehner and Haas 2010; Lin and Lin 2006; Wong 2005) describe efficient mechanisms for creation, sharing and usage of knowledge as the critical success factors for knowledge management. Critical success factors imply that a limited number of factors definitely determine the success of the knowledge management process (Lehner and Haas 2010). They are the crucial factors or parameters required for ensuring the continued

success of an organization and these factors represent those managerial areas that must be given special and continual attention to cause high performance (Ranjan and Bhatnagar 2008). Critical factors for knowledge management explain the degrees of importance in relation to success in knowledge management and attaining competitive edge (Lin and Lin 2006). These factors can be assigned to the dimensions: human beings, organization and technology (Heaidari *et al.* 2011; Lehner and Haas 2010; Wong 2005).

Under the dimension “human being”, individual attitude influences knowledge management processes (Lehner and Haas 2010). Human beings create knowledge, share and use it to attain individual and organizational goals. Individual attitudes are important factors to knowledge management processes because it is through individual decision knowledge is created, shared and used. Ajzen and Fishbein (1980) suggest that the demographic variables, such as socioeconomic status, education and personality trait influence behaviours thus individual attitudes to knowledge management. Top management in organizations can either motivate or demoralize knowledge management process. According to Lin and Lin (2006), top management should take knowledge management seriously; they should provide moral and material support to enhance success in knowledge management. Top management has to devote a higher position to people with better ideas, enhance flexible organizational structures and have a rewarding system for creativity (Eshlaghy and Yusefvand 2011). In an organization, effective performance of knowledge management processes requires a strong support from top management (Brand 1998). To avoid knowledge hoarding, the top management should encourage knowledge sharing and use. As suggested by Wong (2005), all individuals in organizations and communities should exhibit a willingness to share and offer their knowledge freely with others in the organization, to continuously learn, and to search for new knowledge and ideas.

The evolution of Information Communication Technologies (ICTs) has brought a new dimension for supporting knowledge management systems and knowledge management processes (Lehner and Haas 2010). Wong (2005) states that organizations need a well-developed technology infrastructure to support knowledge management. ICTs needed are those which support knowledge creation, sharing and storage. ICTs have potentials of facilitating the creation, sharing, storage and usage of knowledge. ICTs can enhance knowledge sharing by lowering

temporal and spatial barriers between knowledge workers and improving access to information about knowledge (Hendriks 1999). They have either entirely eliminated or considerably reduced the time and geographical distances that influence knowledge sharing (Hendriks 1999). Thus, ICTs remove knowledge sharing barriers brought by time and space; enhance access to information; facilitate knowledge sharing process; store knowledge/information and; locate sources of knowledge (Rao 2005). ICTs are effective at facilitating the sharing of codified knowledge (Cummings and Teng 2003); however, they are very useful and efficient in sharing tacit knowledge through mediated interpersonal communication channels. Emails, databases, text and documents, search engines, groupware, data warehouses and data sharing tools enhance knowledge management (Davis and Riggs 1999). Thus, for effective knowledge management organizations should have a broad ICT infrastructure based on desktop computing and communications, network technology infrastructure such as intranet and internet (Davenport *et al.* 1998).

Although the benefits of ICTs in knowledge management and sharing in particular are indisputable, the downside of technology is that it can be an impediment to knowledge management processes. Scholars (Mtega and Benard 2013; Aker 2010; Sife *et al.* 2010) point out that most developing countries have poor ICT infrastructure and the situation worsens as one moves from urban to rural areas. This has limited most people in developing countries particularly among those living in rural areas from using ICTs in knowledge management. ICTs are not easily acquired or owned by all, Lwoga (2011) shows that ownership and affordability of ICTs among rural communities in most developing countries is low, this has limited usage of ICT tools in knowledge management. Moreover, ICT literacy is very low among most people in developing countries (Ofori-Dwumfuo and Kommey, 2013; Mtega 2012) thus limiting their usage in knowledge management. Furthermore, ICTs can hardly be adopted in sharing both tacit and explicit knowledge as the transfer of tacit knowledge requires controlled interactions (Ofori-Dwumfuo and Kommey 2013) which may be hardly handled with ICTs. When ICTs usage is intensified and traditional channels are substituted, we may expect that sharing implicit knowledge will decrease as ICTs are most suitable for the exchange of explicit knowledge (Wenneker, van Selm and Nelissen 2002). However, Argote and Ingram (2000) point out that making knowledge explicit enough to be embedded in technology eases its internal transfer but

also speeds its spillover to other organizations. Thus; embedding knowledge in technology is an effective way to transfer knowledge within the firm, it is also a way to facilitate knowledge transfer externally, but knowledge can easily leak out to competitors (Argote and Ingram 2000).

The dimension “organization” subsumes the factors which are operated and designed by the organization itself (Lehner and Haas 2010). These factors can be internal or external. Internal factors influencing knowledge management come from within the organization; they may include organizational culture and structure. Organizational culture includes core beliefs, values, norms and social customs that govern the way individuals act and behave in an organization (Wong 2005). Organizations and communities should have a culture supportive to knowledge management, culture that values knowledge and encourages its creation, sharing and usage. Organizations should strengthen self-motivation, form meetings to share knowledge, encourage creativity and innovation, and facilitate informal and internal communication networks (Eshlaghy and Yusefvand 2011). Lehner and Haas (2010) state that organizations should facilitate personnel development, develop stimulation system, and promote a knowledge corporate culture. For effective knowledge management organization must develop organizational knowledge creation culture. Through a knowledge creation culture organizations can easily attain competitive edge; this can be possible when organizations have set mechanisms to stimulate knowledge creation. Organizations should establish platforms for knowledge creation and identify enabling conditions as well as barriers for knowledge creation (Heaidari *et al.* 2011). Moreover, organizational structures must also promote the creation, sharing and usage of knowledge.

Another important internal factor influencing the success of knowledge management is performance measurement. Performance measurement is related to the key areas of the organization such as expansion, innovation and productivity, which is critical to the development of prosperity of an organization (Carneiro 2001). Since knowledge management deals with intangible assets of an organization, non-financial indicators are necessary to be developed to measure and capture the impact of knowledge management (Carneiro 2001). Through performance measurement it is possible to device mechanisms for improving knowledge management processes and attaining competitive edge.

The other organizational factors influencing knowledge management are external factors also referred as environmental factors. Holsapple and Joshi (2000) describe external organizational factors to play important roles to the success of knowledge management in organizations. These factors include fashion; markets; competition; technology; time; governmental; economic; political; social; and educational climate. These factors are important because they let the organization be aware of what takes place outside, they are used to shape the organization and usually help in designing strategies for attaining competitive edge. However; it is important to note that organizations do not have or have little control over environmental factors influencing knowledge management. A clear understanding on how environmental factors influence knowledge management is important for maintaining organizational competitive edge.

It is the dimension “organization” which enhances the efficiency of other critical success factors to knowledge management. Both governmental and non-governmental organizations can set strategies; law and by-laws; frameworks; and procedures to enhance success in knowledge management processes. In the agricultural sector, National Agricultural Research Institutes form an important component of critical success factors for knowledge management. For effective agricultural knowledge management, governments have to strengthen the NARIs in terms of personnel development, material and financial resources and ICT infrastructure development. Organizations and communities should have agricultural knowledge management culture and enhance access and usage of knowledge among actors in the sector.

3.5 Agricultural Knowledge System (AKS) and Agricultural Knowledge and Information System (AKIS)

AKS is a term used to define a set of public and private organizations dedicated to research, education and extension, and their interaction with knowledge users, traditionally farmers (Hermans, Klerkx and Roep 2010). It is a collection of actors in research, extension services, education and training and support systems that act on the knowledge of farmers and generate innovations in response to problems and opportunities, desired outcomes, system drivers and regulatory policies and institutions (Rudman 2010). AKS consist of networks of linked actors, organizations, and objects that perform a number of knowledge-related functions that link

knowledge and know-how with action (McCullough and Matson 2011). McCullough and Matson state further that AKS include institutions, human capital, financial resources, and incentives that give such systems the capacity to function. AKS integrates scientific knowledge with experiential knowledge built through decades of agricultural tradition and they influence the creation, adaptation, and use of knowledge to address challenges facing the agricultural sector (McCullough and Matson 2011).

The term agricultural knowledge system evolved in 1960s when the “Linear/Classical Transfer of Technology” (TOT) model was the practice (Mangombe and Sabiiti 2013; Hermans *et al.* 2010). AKS was driven by an interventionist agricultural policy that sought to coordinate knowledge and innovation transfer in order to accelerate agricultural modernization (EU SCAR 2012). In many countries AKS is reflected in a strong integration of public research, education and extension bodies, often under the control of the Ministry of Agriculture (EU SCAR 2012). AKS has been organized linearly around the transfer of knowledge from scientists to farmers by means of state sponsored extension workers (Hermans *et al.* 2010). Institutions and organizations involved in AKS include ministries, universities, research institutes, and training and advisory services (Röling 2009; Assefa, Waters-Bayer, Fincham and Mudahara 2009). AKS was a government driven initiative to teach farmers new skills, such as how to handle tractors. The original orientation was to diffuse knowledge to farmers and thereby unlock the knowledge embedded in products so as to increase productivity in food sector (EU SCAR 2012). The government is responsible for funding all of these institutions and organizations making up the agricultural knowledge systems. For agricultural development, all institutions and organizations must interact back and forth with farmers that they create and share agricultural knowledge.

AKS must effectively link different actors in the agricultural sector. According to Cash *et al.* (2003), AKS must perform the communication, translation, negotiation and mediation roles, it should be active, iterative and enhance inclusive communication among actors in the sector. AKS should use interactive communication channels that a back and forth communication can be enhanced. There are several communication channels which may be used for knowledge transfer and sharing among actors. Choice of knowledge sharing channels may be influenced by the type of knowledge (whether tacit or implicit), literacy level, ICT infrastructure and individual

preference. For effective knowledge creation and sharing a back and forth communication is inevitable because it is through such a two way communication understanding and knowledge usage is made possible. Linking knowledge to actors in the agricultural sector requires that participants in the resulting conversation understand each other, mutual understanding among actors is often hindered by jargon, language, experiences, and some presumptions (Cash *et al.* 2003).

The linearity nature of AKS has been challenged over the years because of the multiplication of actors contributing to the agricultural knowledge base. Moreover, AKS does not consider the role played by information which is the carrier of knowledge. It was for this reason the concept of Agricultural Knowledge and Information System (AKIS) was introduced in 1970s. According to Rolling (1986) AKIS 'is a set of agricultural organizations and/or persons, and the links and interactions between them, engaged in such processes as the generation; transformation; transmission; storage; retrieval; integration; diffusion; and utilization of knowledge and information, with the purpose of working synergistically to support decision-making, problem solving and innovation in a given country's agriculture. According to EU SCAR (2012), there were four drivers that contributed to the move (in thinking) from AKS to AKIS:

- Research, extension and education have undergone a deep restructuring, transformed by the trend towards liberalization (privatization of service delivery, the multiplication of extension organizations, farmers contributing towards the cost of these services, competitive bidding for research and extension contracts and tighter evaluation procedures);
- Policy agenda: increasing concern over the environmental impact of industrial agriculture, the quality of life of rural populations, rural employment and the need to support the positive externalities linked to agricultural production;
- The linear model of innovation has progressively been replaced by a participatory or 'side by side' network approach, in which innovation is 'co-produced' through interactions between all stakeholders in the food chain (and especially for 2nd order change, so called "system innovation" like the introduction of multifunctional agriculture or organic farming);

- The growing disconnection between farmers' knowledge and research and extension systems.

With time “Information” in AKIS was silently changed into “innovation” (Mangombe and Sabiiti 2012) making AKIS an abbreviation for Agricultural Knowledge and Innovation System. However, information science considers knowledge to be carried by information and that knowledge management enhances new product development (innovation). According to Du and Liu (2011), innovation/new product development is a knowledge intensive process which depends on knowledge sharing among team members. Innovating and the development of new products depend on knowledge accessibility. According to Nakamori (2012) and Chunjuan (2013), knowledge is carried through information from place/person to another. As people access information they filter relevant knowledge needed for solving practical problems and development of new products/innovation. From the knowledge pyramid, knowledge is the information that has been culturally understood such that it explains the how and the why about something or provides insight and understanding into something (Jennex, 2009). From the nature of knowledge, knowledge is also the condition of being able to acquire information (Hemsley and Mason 2012). Thus, from the nature of knowledge and knowledge pyramid knowledge is an outcome of information. Those who filter knowledge from information have to use intelligence that they get relevant explanations for answering the how and why questions. For this case, the AKS concept incorporates both agricultural knowledge and information system and agricultural knowledge and innovation system.

AKS concepts and models have evolved substantially, earlier models focused on forward linkages between the three basic institutional components of the system (research, education and extension services; later backward linkages or feedback mechanisms were built into the AKS model (Lemma and Hoffman 2007). More recently, other entities, such as the media, government, the private sector, support systems and civic society, are recognized as playing an important role in the system, making the system more complex and the need for coordination and integration greater ever (Lemma and Hoffman 2007). AKS must take a broader world than just agriculture as there are other disciplines which influence the food sector. AKS must be able to accommodate new actors who bring in new interests, knowledge, values and expectations. AKS

should accommodate both private and governmental actors and should not consider farmers as only consumers of knowledge but also as generators of knowledge because they contribute a lot to the agricultural knowledge base through indigenous knowledge.

3.6 Positioning agricultural research in AKS

Agricultural research is a key element of the “Agricultural Knowledge System”, together with Education and Innovation to create the “Knowledge Triangle”¹ in the area of agriculture (Zecca 2012). Empirical evidence strongly suggests that agricultural research can improve agricultural productivity output and quality (Spielman and Von Grebmer 2004). Over the years the growth of the agricultural sector has been depending much on how agricultural research supports it. At national level there is NARIs which forms the national level agricultural knowledge base. NARIs have been imperative in the context of Green Revolution (Borthakur and Singh 2012). Growth in agricultural research was very rapid in the 1970s, averaging over six percent annually in the developing world (Byerlee 1998). It is during this time agricultural growth increased in most developing countries (Brüntrup-Seidemann 2011). During this time agricultural research institutes under NARIs were used as centres for production and multiplication of new seeds and developing other inputs and technologies for agricultural development. NARIs were funded by governments (Alston and Pardey, 2008), the private sector was not involved much in research but involved itself in agricultural production. The private sector may invest too little in certain types of research and develop (Alston and Pardey 2008), this is because most actors in the private sector fund activities with immediate results or return to their investment. As stated by Brüntrup-Seidemann (2011), before 1980s there were very few non-governmental organizations and private companies in most developing countries and very few involved themselves in agriculture.

¹ Knowledge triangle refers to the interaction between research, education and innovation (Schuch 2013).

During the 20th century agricultural productivity growth was generated primarily by agricultural research and development financed and conducted by a small group of developed countries (Pardey, Alston and Piggott 2006). With time the agricultural research agenda of these developed countries have changed, this has been influenced much by agricultural production styles and food demands among people from developing and developed world. Pardey *et al.* (2006) point out that people from developed countries demand processed foods while those from developing countries aim at reducing food insecurity.

Experience from different countries has shown that the public sector has reduced the amount of funds set for agricultural research and development (Borthakur and Singh 2012; Brüntrup-Seidemann 2011; Alston and Pardey 2008; Byerlee 1998). Recently, the involvement of the private sector in agricultural research and development has increased (Lemma and Hoffman 2007). There are private companies in both developed and developing countries which conduct agricultural experiments and come up with new and improved seeds, develop other agricultural inputs and sell them for a profit. This has been possible through commercialization of agriculture and the entire food sector. From the 20th century there have been several multinational private companies like Monsanto whose contribution to agricultural research and development is very remarkable. Encouraged by technological and institutional changes, the private sector has become a major actor in agricultural research, with levels of investment grown more rapidly than those of the public sector (Pray 2002). However, the private sector goes only where there is a commercial incentive and farmers too remote or too poor to purchase inputs do not benefit from innovations (Ferroni and Castle 2011).

Public-private partnership in agricultural research development is important in enhancing agricultural growth. Public-private partnerships means any collaborative effort between the public and private sector in which each sector contributes to the planning, resources, and activities needed to accomplish a mutual objective (Spielman and Von Grebmer 2004). Spielman and Von Grebmer state further that these partnerships are a constructive means of enhancing the production of goods, services and technologies that would not otherwise be produced by either sector acting alone. Public-private partnerships are potentially important means of conducting pro-poor agricultural research in many developing countries (Spielman and von Grebmer 2006).

In agricultural research, public-private partnership covers a wide variety of interaction including university-industry research projects, multi-party and multi-sectoral research consortia, local development programs between small businesses and government, or a large-scale global partnership program (Spielman and Von Grebmer 2004). Public-private partnership in agriculture can and must go beyond research and development; be a central ingredient in the creation or stimulation of markets that benefit smallholders, whether on the input or output side (Ferroni and Castle 2011). Public-private partnership must be an engine for improving livelihoods of rural poor who rely on agriculture for a living.

3.7 The role agricultural training institutions in AKS

Agricultural training institutions play a central role in agricultural development (Mangombe and Sabiiti 2013). Through agricultural training institutes it is possible to generate skilled labour for agricultural research, advisory and extension services and farming. Agricultural training institutes aim at scientifically training farmers, extension workers, agricultural teachers and researchers so that agricultural production could continue to be increased on a sustained basis (Johnson 1996). These institutions are formed in the belief that farm production could be increased as a result of the systematic application of current technology and agricultural research findings (Jamaluddin and Alias 1997).

Agricultural training institutions provide different levels of education; they range from early educational institutions, intermediate and higher education. Intermediate and higher education in agriculture continues to play a decisive role in rural development and sustainable agricultural production (Alam, Hoque, Khalifa, Siraj and Ghani 2009). Higher education training in agriculture produces trainers, researchers and policy makers while the other levels can produce extension agents who may work with farmers on a daily basis. The public sector has been offering and funding agricultural trainings for many years resulting into a limited number of trained personnel in agricultural sciences. According to FAO (1996), this is mostly due to the fact that agricultural trainings take many years for one to be competent and they are very costly. The situation is even worse in developing countries whose economy depends on agriculture where

small scale farming is dominant. In developing countries, the level of investment in all levels of agricultural education is low (Zepeda 2001), this is caused by scarceness of resources.

To limit the shortage of agricultural personnel, the private sector has been involved in providing agricultural education. Governments must make sure that the quality of trainings is maintained for agricultural growth. According to FAO (1996), when trained agricultural personnel are properly employed it is possible to increase the multiplier effect thus contributing to agricultural development. Furthermore, it is important to consider agricultural training and education as a sub-system of AKS because it contributes largely to agricultural knowledge creation, sharing and usage. When it is disconnected, it is going to be difficult to develop personnel who can work in the agricultural sector of a given country. FAO (1972) points out that the agricultural education system must be adequately integrated with the larger strategies, plans, and needs of agricultural development.

3.8 Agricultural advisory and extension system in AKS

Agricultural extension and advisory services can be defined as systems and mechanisms designed to build and strengthen the capacity of rural farmers and other stakeholders (Mbo'o-Tchouawou1 and Colverson 2014). The term *extension* was first used to describe adult education programmes in England in the second half of the 19th century; these programmes helped extend the work of universities beyond the campus and into the neighbouring communities (FAO 2008). When the responsibility of extension activities was transferred to the Ministry of Agriculture, the terminology for this new responsibility was changed to *advisory services* in the 20th century (FAO 2008).

Agricultural extension and advisory services play an important role in agricultural development and can contribute to improving the welfare of farmers and other people living in rural areas (Ragasa, Mazunda and Kadzamira 2010). These services enhance access to knowledge which creates awareness among farmers on how to improve agricultural activities. Agricultural knowledge is a determinant of farmers' adoption of new farming practice and agricultural technology, and thus, achieving agricultural development goal (Laoubi, Boudi and Yamao 2010). Agricultural extension and advisory services provide knowledge and technology to improve

agricultural productivity, link farmers to markets and promote sustainable production techniques (Swanson and Rajalahti 2010). They play a critical role in facilitating linkages with farmer-based organizations and other relevant actors (Mbo'o-Tchouawou1 and Colverson 2014). According to USAID (2012), a country with efficient agricultural extension and advisory services is more likely to have attained high agricultural growth. Efficient agricultural extension and advisory services are possible when credible contents are provided and effective delivery mechanisms are put in place.

In developing countries, agricultural extension and advisory services have not been very efficient. The number of personnel involved in provision of extension and advisory services is very limited to *meet all* farmers. According to Mbo'o-Tchouawou1 and Colverson (2014), limited coverage of extension services across rural regions and limited number of personnel involved in provision of agricultural extension advisory services are critical issues in the delivery of extension and advisory services. FAO (2008) points out that during the 20th century, most public extension systems in developing countries were centrally funded and top-down in structure and had primary focus of increasing national food security. These services are supposed to be provided continuously and in all areas including remote rural areas which make it difficult for most governments in developing countries to manage provide extension and advisory services to all farmers. This calls for a public-private partnership in provision of agricultural extension and advisory services. In Tanzania, the public-private partnership is employed by some of the donor funded agricultural projects. These strategies aim at increasing the number of personnel who provide agricultural extension and advisory services for farmers who can hardly get such services through the government agricultural extension and advisory system. However, some private service providers have their own comparative advantages in providing specific services (FAO 2008). It is for this reason, governments must always oversee the provision of agricultural extension and advisory services to farmers.

3.9 Farmers in AKS

Farmers are at a central place in AKS because all strategies being implemented aim at linking them with other actors. According to John (1997), agricultural research aims at solving practical problems being faced by farmers while agricultural extension and advisory services aim at linking other actors to farmers. Agricultural extension and advisory services are designed to build and strengthen the capacity of rural farmers and other stakeholders (Mbo'o-Tchouawou1 and Colverson 2014). Farmers² are involved in generation of knowledge; they are sources of agricultural indigenous knowledge (Lwoga 2011; Lwoga *et al.* 2010a). Thus, AKS can only be effective if they give farmers a central position. Farmers use knowledge created by other actors; they are involved in the actual agricultural production and all strategies set for increasing agricultural growth can only be effective if they start by empowering farmers. Moreover, with commercial farming, cost of agricultural extension and advisory services and research are expected to be covered by farmers themselves (FAO 2008). However, both the public and private sector are working together making sure small scale farmers have access to knowledge needed for decision making, skills for production and markets for selling their produce/products.

Farmers and agricultural researchers must work together to meet the needs of consumers. Moreover, the cooperation between farmers and researchers is important for ensuring sure that good agricultural practices are developed and adopted to meet food quality and increase yields (Bertolini 2004). According to Bertolini (*op. cit.*), involvement of agricultural marketers, consumers and farmers is important for improving the performance of agricultural marketing systems for marketing agricultural produce/products and enhancing effective post-harvest management. This in-turn enhances food accessibility and improves food security and livelihoods of the majority.

² Depending on their level of operation, farmers may be either large scale, medium or small scale.

3.10 Private sector in AKS

The private sector plays a critical and positive role in both building the technical capacities of farmers and give them a voice in setting prices of commodities (Hussein 2001). Private actors in agriculture include input suppliers, purchasers of agricultural products, private trainer-advisers, outreach agencies and private media who participate in activities geared towards agricultural programme (Neuchattel 1999). According to Hussein (2001), the private sector is involved in developing new technologies for agricultural production, in research activities and in disseminating agricultural research outputs to farmers. However, Ferroni and Castle (2011) state that the private sector goes only where there is a commercial incentive, farmers too remote or too poor to purchase inputs do not benefit from innovations through the private sector.

Private sector involvement in agricultural research and development in developing countries has a rich history beginning in the 19th century with research on cash crops produced by colonial farming operations, including research on tea, coffee, rubber, and palm oil cultivated on plantations in Asia and research on wheat and maize (Naseem, Spielman, and Omamo 2010; Kremer and Zwane 2005). The private sector involves itself in agricultural research and development related to plant biology; plant breeding; production of seeds and planting materials; agrochemicals including chemicals for plant protection, fertilizers, and biotechnological applications; buying farm produce/products; food processing; storage and transport; animal and livestock improvement; and agricultural equipment (Naseem *et al.* 2010). When the private sector comes up with new developments, awareness on how to use such technologies is made through multi channels.

The involvement of the private sector in AKS is supported by the willingness of farmers from both developed and developing countries to pay for agricultural extension and advisory services, marketing information services and other knowledge related services (Ulimwengu and Sanyal, 2011; Oladele 2008). ICTs and specifically private mobile phone companies have been involved in agricultural knowledge sharing (Asenso-Okyere and Mekonnen 2012). The usage of these technologies in sharing agricultural knowledge is also supported by individual's willingness to pay for such services. Willingness to pay for agricultural knowledge services may be influenced

by level of income, perceived usefulness of knowledge and affordability (Mwaura, Muwanika, and Okoboi 2010). Thus, before involving in any of the agricultural knowledge services private service providers must determine the need and willingness to pay for such services among actors in the agricultural sector. As stated by Aker (2010), the agricultural sector is very complex because farmers need information on a variety of topics, at a variety of stages before adopting a new technology. Addressing this complexity, the private sector needs to have an intensive understanding of the needs of farmers and other actors within AKS.

3.11 Communities of Practice in AKS

Since the beginning of history, human beings have formed communities that share cultural practices reflecting their collective learning (Wenger 2010). These communities are known as Communities of Practice, they can be defined as informal structures within organizations that bind people together through informal relationships and the sharing of expertise and experience (Wang, Yang and Chou 2008). They are groups of people who share a concern, a set of problems, a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (Wenger, McDermott and Snyder 2002). Participating in these communities of practice is essential for learning; it is at the very core of what makes us human beings capable of meaningful knowing (Wenger 2000).

Disseminating agricultural knowledge services needed by farmers may raise their willingness to pay and help actors in the private sector meet their profit incentives. For meeting farmers' agricultural knowledge needs, involvement of different actors of AKS is inevitable. Agricultural researchers, agricultural extension agents, marketers, consumers, governmental and non-governmental organizations, and farmers play different roles in agricultural knowledge management. Their involvement in AKS ensures that knowledge needs of each member are well known before it is shared.

Communities of practice are voluntarily formed, community members who share most things in common are more likely to learn from each other and share what each one knows from time to time. Those who have most in common are more likely to be within the same community of practice. According to Wenger (2006), a community of practice is not merely a club of friends or

a network of connections between people because it has a shared domain of interest and membership implies a commitment to the domain. Thus, communities of practice represent a voluntary system of creating and sharing knowledge. As Nonaka and Takeuchi (1995) describe, knowledge creation occurs through externalization, socialization, internalization and combination processes. When members of communities of practice *meet all* of these processes take place thus being involved in knowledge management processes. Wenger (2006) points out that those members engage in joint activities and discussions, help each other, and share knowledge; they build relationships that enable them to learn from each other and therefore a shared competence that distinguishes members from other people. Wenger states further that a community of practice is not merely a community of interest, members of a community of practice are practitioners who develop a shared repertoire of resources: experiences, stories, tools and ways of addressing recurring problems. Members of communities of practice must commit their time and other resources in maintaining a shared practice and sustaining interactions.

Communities of practice have several characteristics, according to Wenger (2006) the key characteristics of communities of practice include collaboration, involvement in knowledge management processes, trust among community members, sustained interactions among members, and have shared practices. Members of communities of practice must collaborate in creation of knowledge; they have to voluntarily share what each one knows and use the community of practice as a learning platform. Each member of a community of practice should have an opportunity of being involved in knowledge creation process, this can be possible when members respect and trust what others know. Scholars (Polanyi 1966; Nonaka and Takeuchi 1995) describe that individuals are owners of tacit knowledge which can be shared through socialization, giving opportunities to each community of practice member to share knowledge is important in creation of new knowledge.

The agricultural sector has many actors involved in different activities. It is more likely for actors involved in the same agricultural activity to form communities of practice. This is because through continuous experience and involvement actors within the same type of agricultural activities may have many to share and learn from each other. It is for this reason that farmers, agricultural researchers, marketers, input suppliers, and agricultural extension agents are more

likely to form different agricultural communities of practices related to the type of activities they involve themselves with. However, since the different actors are in the same sector it is important to have some linkage between different communities of practice. This can be made possible through the formal and informal knowledge sharing when they interact while performing interrelated agricultural activities. Thus, an intensive understanding of the needs of the different categories of agricultural communities of practice is important for effective agricultural knowledge management and improving agricultural productivity.

3.12 Governments' interventions in AKS

AKS is made up of agricultural research institutions, universities, extension and advisory services, farmers, and other stakeholders involved in agricultural related activities. NARS is an important component of AKS. NARS is comprised public organizations including the departments of agricultural research and development, agricultural research institutions, and universities (Kapange 2004). Agricultural Research Systems are scientific in nature and have agricultural researchers as actors (Hall, Mytelka and Oyenyika 2005). Before the 21st century, agricultural researchers only came from agricultural research institutes and agricultural universities because the private sector was not involved in agricultural research activities. During the time, NARS received public funding through the Ministry of Agriculture to a centralized research and development departments who then set research priorities and executed research through a network of research centers (Kapange 2004; Byerlee, 1998). Public funds set aside for agricultural research systems have been declining from time to time (Ferroni and Castle 2011).

Likewise, the public sector plays a central role in provision of agricultural extension and advisory services According to Mbo'o-Tchouawou1 and Colverson (2014), public agricultural extension and advisory services were introduced in many developing countries during the post-independence period. The public agricultural extension and advisory system is usually “top-down” in structure (Swanson 2008). Given the number of farm households to be served, the “top-down” structural problems, the lack of well-trained staff, and the inadequate programme resources at the field level, the performance of public extension systems has been inadequate

(Swanson 2008). This has resulted into limited accessibility of agricultural knowledge services among farmers.

The effectiveness of AKS depends on the efficiency of NARS and the agricultural extension and advisory system. Reduced public funding to NARS and the public agricultural extension and advisory system affects the efficiency of AKS. This in turn limits the accessibility of agricultural knowledge services among farmers and other actors in the sector leading into stunted agricultural growth, increased food insecurity and poverty prevalence.

To reform NARS and agricultural extension and advisory systems, several actions including provision of demand-driven agricultural research and information services, decentralized of agricultural extension and advisory services and pluralistic agricultural research and extension approaches have adopted (Mbo'o-Tchouawou1 and Colverson 2014). Moreover, partnership between the public and private sector in agricultural research and provision of agricultural extension and advisory services is inevitable.

To enhance efficiency of AKS under the public-private partnership, the government must provide favourable institutional environment for agricultural development (Ferroni and Castle 2011). The government has to come up with policies which favour access to and usage of knowledge. When governments design policies, it is important to consider agriculture as multidisciplinary sector which is influenced by the performance of other sectors. Weakness and instability of national policies play a part in undermining the effectiveness of the agricultural information delivery (Vidanapathirana 2012). Thus, policies to be designed should take into account the interactions between various sectors while considering farming and rural setups. Laws and regulations made out of policies should also enhance agricultural information delivery; they should be facilitating accessibility of agricultural information services and not hindering it. So, governments should impose policy interventions so as to create favourable environment for agricultural information delivery (Swanson 2008).

Rural infrastructure is crucial in achieving or accelerating agricultural development (Bourguignon and Pleskovic 2008). Investment in infrastructure that facilitates access to agricultural information is important for efficient AKS and agricultural development. Rural

infrastructure that enhances access to agricultural information services are rural roads, ICT infrastructure, power and information resource centres. Governments are responsible for developing rural roads; this is an important intervention towards enhancing access to agricultural information services. Mtega and Malekani (2009) found the most rural areas have limited road infrastructure and most roads are impassable during rain seasons. This limits the delivery of print agricultural information resources transferred by road to rural areas.

Likewise, governments have to invest in information infrastructure in both rural and urban areas. Rural information infrastructure is instrumental in boosting up the rural development initiatives in villages (Das and Dutta 2004). It must enhance the accessibility of speech, transfer of images and mails, multimedia document retrieval, and accessing the radio, television and data (Mtega and Benard 2013). Such rural information infrastructure may include print information resources; rural information centres, radio, television, internet and mobile phone infrastructure for transmitting data and audio-visuals (Struzak 1997). In Tanzania, like in other developing countries, there are disparities between rural and urban areas in terms of information infrastructure, most urban areas have well developed information infrastructure than rural areas (CTA 2008). Such disparities are due to the fact that the private sector is largely involved in developing such infrastructure, usually the private sector is profit oriented and it only invests where there is a prospective good return (Lemma and Hoffman 2007). This has equally limited access to agricultural information services among farmers and other agricultural stakeholders residing in rural areas.

Electricity is important for accessing agricultural information services. ICT tools can only work when connected to sources of power. The International Energy Agency estimates that 1.5 billion people lacked access to electricity in 2008; some 85 percent of those without electricity live in rural areas, mainly in Sub-Saharan Africa and South Asia (Crousillat, Hamilton and Antmann 2014). High connection costs such as meters, wiring, and high recurring costs such as electricity bills have reduced the level of usage and number of users in areas which are electrified (Putti, 2011). This has limited the usage of radio and television sets, mobile phones, internet services, computers and related accessories used for processing, managing and sharing information.

Governments may impose tax interventions that enhance access to agricultural information services. Mtega and Msungu (2013) describe tax interventions can either promote or limit access to agricultural information services. If countries resist the temptation to impose excess taxes on ICT goods and services and eliminate ICT tariffs, they will reap the benefits in broader digital adoption by businesses and consumers, leading to faster economic growth and increased quality of life (Miller and Atkinson 2014). Ssewanyana and Busler (2007) describe high taxes imposed on import and sales of ICT tools to limit the usage of agricultural information. Governments raise ICT costs through two main channels: discriminatory taxes and tariffs; others impose additional and discriminatory taxes on ICT goods and services (Miller and Atkinson 2014). According to Miller and Atkinson (2014), most countries maintain high tariffs on imported ICT goods and on usage of ICT tools. This equally limits access to agricultural information services among actors in the sector including farmers.

Generally, under public-private partnership the government has to establish all the necessary information infrastructure and design appropriate policies to enhance access to agricultural information services. Governments are supposed to play an enabling role rather than hindering access to and usage of agricultural knowledge and information services. Taxes and tariffs imposed should aim at promoting access to agricultural knowledge services and not only consider boosting revenue collections.

3.13 Knowledge seeking behaviour of actors in the agricultural sector

Actors in the agricultural sector need knowledge for making rational decisions regarding agricultural production and marketing hence improving livelihoods. To access and use knowledge, actors must express an intentional behaviour known as knowledge behaviour. According to Wilson (2000), knowledge seeking behaviour is the totality of human behaviour in relation to knowledge sources and channels, including both active and passive information seeking, and information use. Before seeking knowledge one has to express some information needs. Case (2002) describes information needs as the recognition that your knowledge is inadequate to satisfy a goal that you have. Knowledge needs arise when an individual is in a problem situation and cannot manage with the knowledge possessed (Wilson 2000). After

identifying knowledge needs, the knowledge seeker embarks into information seeking. The seeker expresses an intentional behaviour the “knowledge seeking behaviour”. Wilson (2000) describes information seeking behaviour as the purposive seeking for information as a consequence of a need to satisfy some goal.

Knowledge seeking involves identifying types of knowledge needed, possible sources of needed knowledge, and how knowledge can be accessed and used. Understanding of the knowledge needs and knowledge seeking behaviour is crucial for satisfying individual knowledge needs (Mtega and Benard 2013). However, knowledge seeking is influenced by psychological, demographical, role-related, interpersonal, environmental and source-related characteristics of individuals (Heinström 2003). Thus, to access and use relevant knowledge, providers must consider characteristics surrounding knowledge seekers.

The agricultural sector has different actors performing interrelated activities. Farmers, input suppliers, buyers of farm products, processors, consumers, researchers, extension agents and policy makers are some of the key actors in the sector (Sanga, Tumbo, Mlozi and Kilima 2013). However, agricultural extension advisors/agents are the key links between farmers and the relevant agencies/individuals in terms of providing personalized and need-based knowledge for decision making by all parties concerned (Zakaria and Nagata 2010). While thinking of accessing knowledge to satisfy agricultural knowledge needs, seekers must know the knowledge they need, consider all possible sources of knowledge and channels through which knowledge can be accessed. Moreover, it is important to consider the various factors influencing access to agricultural knowledge services.

3.13.1 Agricultural knowledge needs of actors in the agricultural sector

Actors in the agricultural sector have varied knowledge needs; their day to day activities determine what type of knowledge they need to solve practical problems being faced. No one can categorically claim to know all the knowledge needs of actors especially in a knowledge dependent sector like agriculture where there are new and rather complex problems facing the sector every day (Ozowa 1997). Thus, understanding the agricultural knowledge needs of all actors in the agricultural sector is difficult; it requires performing a stakeholders’ agricultural

knowledge needs analysis. According to FAO (2006), stakeholders' agricultural knowledge needs analysis can be used to determine the priority knowledge needs of stakeholders. Through the analysis actors' knowledge needs can be identified.

Actors in the agricultural sectors need various agricultural knowledge needs. Some of the agricultural knowledge needs are overlapping while others are specific to certain groups. However, agricultural knowledge needs mostly relate to three broad categories namely: agricultural production; environmental protection and natural resource management; and agricultural marketing and trade (Tologbonse, Fashola and Obadiah 2008; CTA 2008). Mtega (2012) points out that knowledge needs related to agricultural production include crop and animal production, crop and animal pest and diseases management, and agricultural machinery and equipment. Benard *et al* (2014) mention agricultural knowledge related to environmental protection and natural resources management needed by actors of the agricultural sector include soil and land management, agro-climatology, waste management, forest management, and pollution. According to Tologbonse *et al* (2008), actors' agricultural knowledge needs related to agricultural marketing and trades include: agricultural credit, banking and finance, enterprise and agro-industry development, and trade and marketing of agricultural products. Others include handling, transport, storage, processing of agricultural products, and agricultural prices.

Specific agricultural knowledge needs are determined by agricultural undertakings one is involved in. However, many actors may need the same type of agricultural knowledge for various reasons. For example, Mtega (2012) mentions that farmers need knowledge on crop maintenance that they may be able to manage crops better; agricultural researchers may need the same type of knowledge for testing how crops can be improved. Thus, it is important agricultural knowledge needs before disseminating it.

Knowledge needs may exist in three forms namely dormant knowledge needs, unexpressed and expressed knowledge needs (Fourie 2012; Sridhar 1992). Dormant needs are those that the individual is unaware of, but which may be potentially activated by an knowledge service provider while unexpressed needs are when the people are aware of their needs but do nothing about them, either because they cannot or because they will not (Bitso and Fourie, 2012). Thus, it

is important to consider the three types of knowledge needs before disseminating/sharing agricultural knowledge services to actors in the agricultural sector because some actors never express their knowledge needs.

3.13.2 Sources of agricultural knowledge

Any knowledge seeking process involves a number of further steps including: identifying knowledge sources, consulting the sources and accessing knowledge (Mtega 2012). Knowledge source is an institution or individual that creates or brings about a message (Starasts 2004). The characteristics of a good knowledge source are relevance; timelessness; accuracy; cost effectiveness; reliability; usability; exhaustiveness; and aggregation level (Statrasts 2004).

There are several agricultural knowledge sources used by stakeholders of the agricultural sector. Mtega (2012) mentions the commonly used sources to include radio, television, newspaper and magazines, cell phones, face-to-face encounters, leaflets, libraries and the internet. Benard *et al* (2014) mention other agricultural knowledge sources to include journals, bulletins, community leaders, famers' groups, neighbours, farmers' cooperative societies, extension officers, local government officers, non-government organizations, agricultural libraries, input providers and posters. Mtega and Malekani (2009) point out that actors get agricultural knowledge from books and agricultural research institutes too.

Choice of agricultural knowledge sources among actors in the agricultural sector is influenced by level of income, farm size, age, geographical location, level of education, level of trust on knowledge sources, and sex of knowledge seekers (Mtega and Malekani 2009). Mtega (2012) points out that occupation and the distance from the knowledge seeker's residence to the knowledge sources influence the choice of agricultural knowledge sources. However, choice of agricultural knowledge sources may be influenced by the environment in which the knowledge seeker finds oneself in.

There are some factors which limit the usage of agricultural knowledge sources. According to Daudu, Chado and Igbashal (2009), inadequate fund, inconsistency, improper awareness, poor government management and policies, and feedback problem limit the usage of knowledge

sources. Benard *et al* (2014) describe the irrelevancy of accessed knowledge, complexity of the source of knowledge, uncertainties of knowledge sources, and language barriers to limit the usage of some knowledge sources. Mtega and Malekani (2009) point out that the inaccessibility of knowledge sources limits its usage while Mtega (2012) points out that income, ownership of the knowledge source, the level of education and age of agricultural knowledge seeker influence usage of agricultural knowledge sources. For example, knowledge sources which need some fees so as to access them are used mostly by those who can afford them while sources requiring one to read are only used by literate people. Thus, before deciding to disseminate agricultural one has to consider all factors that may limit the usage of agricultural knowledge sources.

3.13.3 Channels used by actors in the agricultural sector for acquiring knowledge

Communication channels are the media through which organization members interact and share knowledge among them (Chua 2001). The richness of a channel can be examined by its capacity for immediate feedback, its ability to support natural language, the number of cues it provides and the extent to which the channel creates social presence for the receiver (Chua, 2001). Communication channels can either be interpersonal or impersonal (Vishwakarma 2003). Interpersonal communication channels involve face to face contacts while impersonal do not. Communication channels can either be interpersonal or mass media (Okwu, Obinne and Agbulu 2006). Mass media are used for disseminating knowledge to a mass; the audience is usually heterogeneous in character and sometimes knowledge can reach even irrelevant people. On the other hand, interpersonal communication channels involve direct interactions between people who know each other; Okwo *et al.* (2006) describe interpersonal communication channels as face to face communication. Chua (2001) describes communication channels to be either verbal or non-verbal. According to Mtega and Benard (2013), verbal communication tie communities together and they are face to face and involve facial expressions.

There are several communication channels used for accessing agricultural knowledge from the identified sources. Agwu and Adeniran (2009) describe the channels used to be either mediated or professional inter-personal channels. Choice of communication channels depends on a number of factors. Chua (2001) points out that channels with immediate feedback are more likely to be

chosen for sharing agricultural knowledge. Mtega (2012) adds that channels with limited distortion of carried messages are preferred because the original message will reach the receiver. Other factors including perceived ease of use, affordability, infrastructure, literacy level of the knowledge seeker and socio-economic factors influence the choice of communication channels for disseminating and sharing agricultural knowledge (Benard *et al.* 2014; Mtega and Benard 2013; Lwoga 2011; Chilimo 2010; Lwoga *et al.*, 2010A; Mtega and Malekani, 2009; Lwoga, 2009; CTA, 2008).

There are some commonly used communication channels by actors in the agricultural sector. Okwu *et al.* (2006) mention interpersonal communication channels which include extension agents, contact farmers, opinion leaders, friends and relatives to be among the commonly used channel. Okwu *et al.* (2006) mention radio, television, newspapers, film shows, bulletins and handbills as the commonly used mass media communication channels in agriculture. However, different actors in the sector may have different communication channel preference. For example, scholars (Mtega 2012; Agwu and Adeniran 2009; Okwu *et al.* 2006) point out that farmers prefer to access agricultural knowledge through radio, fellow farmers and agricultural extension agents. Thus, for enhancing access to and usage of agricultural knowledge, it is important to know why actors prefer some communication channels to others. This may help agricultural knowledge service providers meet their knowledge provision role thus contributing towards agricultural development and improved livelihoods among actors.

3.13.4 Factors influencing access to and usage of agricultural knowledge

Knowledge seekers access relevant agricultural knowledge from appropriate sources and through appropriate communication channels. However, access to agricultural knowledge is limited in some areas and among some people (Lwoga *et al.* 2011a; CTA 2008). Limited access to agricultural knowledge may be associated with poor access to agricultural knowledge sources (Mtega 2012). Limited access to agricultural knowledge hinders the usage of agricultural knowledge among actors.

There are several factors related to knowledge sources, government policies and interventions, and knowledge seekers themselves which lead to limited access to and usage of agricultural

knowledge among actors in the agricultural sectors. According to Obidike (2011), factors limiting access to and usage of knowledge include: lack or inadequacy of knowledge infrastructure and few agricultural knowledge sources including agricultural knowledge service providers. Inadequate access to knowledge sources, unknown sources of knowledge, lack of simple reading materials, and lack of agricultural demonstrations hinder access to and usage of agricultural knowledge (Mtega 2012; Siyao 2012; Agwu and Adeniran 2009; Daudu *et al.* 2009). Moreover, the type of knowledge channels or sources used to transfer knowledge influences the usage of the knowledge carried (Tsehay 2014). This is associated with ease of use of knowledge channels or source. Knowledge carriers which are ease to use may attract more users than the difficulty ones. Agwu and Adeniran (2009) point out that unavailability of knowledge sources, lack of access to knowledge sources, and inappropriate scheduling of programmes limit accessibility and usage of agricultural knowledge.

There are factors associated with knowledge seekers themselves. Obidike (2011) points out that actors in the agricultural sector have different financial power, those who are well-off can afford to acquire agricultural knowledge from commercial sources while the poor ones cannot. Ulimwengu and Sanyal (2011) point out willingness to pay for agricultural knowledge services differs among actors in the agricultural sector. Actors with more financial power are more likely to be more willing to pay for agricultural knowledge services. Scholars (Benard *et al.* 2014; Mtega 2012; Siyao 2012, Lwoga *et al.* 2011a; Agwu and Adeniran 2009) point out that some actors particularly farmer are illiterate, this has limited their ability to acquire and interpret knowledge thus limiting the level of usage of agricultural knowledge. Mtega (2012) mentions further geographical isolation may also hinder access to agricultural knowledge. CTA (2008) comments that people living in urban areas are more likely to have more access to sources of agricultural knowledge than those from rural areas.

Government interventions including policies, laws, by-laws and procedures can influence access to and usage of agricultural knowledge. Governments have to develop knowledge infrastructure particularly in areas where the private sector cannot be motivated to invest. The private sector goes only where there is a commercial incentive (Ferroni and Castle 2011). Unfortunately, rural areas are exceptional to most private sector investments because of the limited financial power of

most rural people. However, Mtega and Msungu (2013) and Daudu *et al.* (2009) describe that governments have done so little in expanding knowledge infrastructure to rural areas. Mtega and Malekani (2009) found that the library and knowledge centres are limited in urban areas; few rural people have access to such services. Moreover, ICT infrastructure has created a rural-urban digital divide because it is concentrated in urban areas (CTA 2008). This is caused by the fact that in most developing countries ICT infrastructure (radio, telephone and television) are mostly developed by the private sector. Such a divide has equally limited access to agricultural knowledge among actors.

Governments are responsible for designing knowledge policies which are comprised laws, regulations, doctrines and other decision making and practices with society-wide constitutive effects involving knowledge creation, processing, flows, access, and use (Braman 2011). The way knowledge policies are designed may either enhance or limit the access to agricultural knowledge. It is the role of governments to come up with policies which enhance access and usage of agricultural knowledge. Moreover, access to and usage of agricultural knowledge is limited by high tariffs. Miller and Atkinson (2014) describe that governments raise ICT costs through taxes and tariffs and that many nations, particularly lower and lower middle income countries, have imposed additional and discriminatory taxes on ICT goods and services. This has limited ownership of the tools and their usage as sources and channels of agricultural knowledge thus creating a digital gap among those who can and cannot afford. Furthermore, governments have to employ agricultural knowledge service providers/agricultural extension officers. However, CUTS International (2011) shows that the ratio of agricultural extension officers to farmers in most developing countries is very poor that access to and usage of agricultural knowledge has been low.

Generally, governments must take a holistic view in enhancing access to and usage of agricultural knowledge. This involves identifying agricultural knowledge and relevant knowledge sources, and determining appropriate channels. The entire process should take into consideration the knowledge seeker because he/she has agricultural knowledge needs to be satisfied.

3.14 The role of ICTs in AKS

AKS like other information systems involve people and networks of hardware and software used for creating, storing and sharing knowledge (Huang and Lin 2007). The efficiency of information systems depends on a combination of individual, organizational, task, and technological factors (Biygautane and Al-Yahya 2011; Jennex 2007; Desouza 2003; Holsapple and Joshi 2000). A strong link between actors is essential for effective and efficiency communication in the entire agricultural value chain that is from input supply, production, and delivery of outputs to ultimate consumers (Sanga *et al.* 2013; Furuholt and Matotay 2011). ICTs can play a central role in facilitating such interactions.

In socio-economic development, ICTs reduce transaction costs, offer immediate connectivity of voice; data and visuals substitute for other more expensive means of communication and transactions; and channel knowledge and information of all kinds (Kramer, Jenkins and Katz 2007). ICTs are known to be of low-cost and can enhance pervasive connectivity, are adaptable and more affordable tools, and they help in data storage and exchange (Goyal 2011). These technologies enable rural communities to interact with other stakeholders, widen the perspective of local communities in terms of national or global developments, open up new business opportunities and allow easier contact with friends and relatives thus reducing social isolation (Stienen, Bruinsma and Neuman 2007). ICTs reduce the effects brought about by space and time during the communication process.

In agriculture, ICTs enhance timely access to agricultural knowledge services and facilitate reduction of transaction costs associated with agricultural activities. Gelb and Voet (2009) describe some of the benefits of ICTs in agriculture to include: better management, better and timely knowledge access and dissemination, better and integrated production planning, monitoring and follow up, access to the latest results of research and more. ICTs have considerable potential to help even small-scale producers prevent losses after investments have been made by identifying and controlling pests and diseases, receiving timely weather knowledge, and improving resource use (Goyal 2011). According to Goyal (2011), ICTs can

also lead to more optimal use of inputs; these technologies increase producers' knowledge on how to use and manage water, equipment, improved seeds, fertilizer, and pesticide.

The commonly used ICT tools in the agriculture sector are radio, television, mobile phones, internet, and computers (Sife *et al.* 2010; Mtega and Malekani 2009). Emerging ICT applications used in agriculture include: Geographic Information Systems, decision support systems, mobile mapping and hand-held personal computers, precision agriculture, community radio stations, different mobile phone applications, radio frequency identification tags, WorldSpace satellite radio, and web-based applications (Munyua, Adera, and Jensen 2008). ICT applications are designed programs set to serve specific purposes through the use of ICT tools, users have to install such applications in computers or smart phones before being able to use them.

3.14.1 Choice of ICT tools and applications among actors in the agricultural sector

Preference to ICT tools and applications differs among actors in the agricultural sector. Radio is the mostly used ICT tool among actors; Mtega (2012) describes the tool to be used by most farmers. This is because the tool is easily acquired, used, there are various radio stations, and the reach of radio frequencies is in most rural areas. Moreover, radio programmes can be heard through various tools including radio sets and mobile phones. Radio stations may have a national, regional or community coverage. A report from TCRA (2013) indicates that national radio stations have the biggest coverage compared to the other two; Farm Radio International (2011) points out that community radio stations broadcast more local content. Radio programmes can either be direct from radio stations or the playback of on demand web based radio accessed through mobile phones or computers. The other commonly used tool is the mobile phone, Aker (2010) mentions that these tools are widely used because mobile coverage has been rapidly spreading in most countries. Mobile phones significantly reduce communication and information costs (Aker, 2010). Sife *et al.* (2010) point out that mobile phone calls and Short Message Service (SMS) are the commonly used mobile applications. However, smart phone applications are widely being adopted among actors in the agricultural sector. Radio sets are primarily used for knowledge sharing while mobile phones can facilitate both data collection, knowledge storage and sharing.

Television sets are potential in providing audio visual services. These tools require a more expensive investment. Sife *et al.* (2010) point out that most developed countries have well establish rural and urban television infrastructure which is not the case for developing countries. In Tanzania, the number of users of television is less than 30% (TCRA, 2013). Moreover, CTA (2008) mentions that majority of the users of television sets in Tanzania reside in urban areas. TV stations may have several agricultural related programmes providing knowledge related to weather, good agricultural practices, markets, agro-technologies and others more. TV sets are basically used for knowledge sharing.

Other ICT tools and applications used in agriculture include computers and web based applications. Computers have the power of information/data processing, storage and retrieval; they facilitate communication and dissemination; and have reduced the operating costs as one person can be involved in data collection and sharing agricultural information (Al-Shayaa, Al Shenifi and AL Abdu Al Hadi 2011). Tiffin and Tiffin (2005) point out that computers have been widely used among actors in the agricultural sector in managing records and facilitating decision making. Computers are used to develop decision support system for taking strategic decision on the agricultural production and protection research; they facilitate yield prediction and site specific resource allocation of agriculture inputs (Sabesh 2007).

Advancements in web based technologies have made it possible to store agricultural knowledge through cloud computing. Cloud computing have created opportunities for data sharing initiatives that were once prohibitively expensive for most institutions to explore, they have also eased the data collection and aggregation process, which is critical for research, extension, and education (Goyal 2011). For accessing web based applications one needs to use computers or smart phones. Mobile and Internet technology can provide important services cheaply and efficiently, and they offer a particular advantage in developing countries without existing infrastructure (Miller and Atkinson 2014). This is because the wireless infrastructure is used for providing these services.

3.14.2 Factors influencing adoption of ICTs in AKS

Throughout the developing world, ICTs are being integrated into classic rural advisory services, through radio, SMS, television, video, Internet, libraries, the media, and mobile services (Goyal 2011). Advice and knowledge provided via ICTs is becoming more varied, covering specific technologies and practices; climate change mitigation and adaptation; disaster management; early warning of drought, floods, and diseases; price information; political empowerment; natural resource management; production efficiency; and market access (Goyal 2011). Despite the importance of ICTs in agriculture, the level of adoption of these technologies among actors in the agricultural sector in most developing countries is reported to be low (Miller and Atkinson 2014; Mtega and Benard 2013; Mtega 2012; Goyal 2011; Lwoga *et al.* 2010b).

Among the reasons influencing the usage of ICTs is limited infrastructure. Scholars (Mtega and Benard 2013; Mtega 2012; Lwoga *et al.* 2010a) found that in most developing countries the ICT infrastructure is predominant in urban areas while being very limited in most rural areas. Farm Radio International (2011) points out that the level of adoption of ICTs in AKS is limited because of lack of ownership of ICT tools, inadequate power supply, high levels of ICT illiteracy, and limited income. Radio and TV stations cover mainly urban areas, those which can be accessed in rural areas are very few but most of them broadcast urban related content; moreover, limited television viewing is mostly due to limited power supply and few number of TV stations in most developing countries (Sife *et al.* 2010). In most developing countries, only few TV and radio stations broadcast some limited agricultural contents (CTA, 2008).

ICTs have revolutionized life whereby the acquisition and usage of cellular phones by actors in the agricultural sector including farmers is increasing very rapidly (Mtega and Msungu 2013). Taking the Tanzanian case, TCRA (2013) shows that mobile phone infrastructure has increased to a large extent while the number of subscribers has increased by more than 60% for the past two decades. Despite the increased infrastructure and number of subscribers of mobile phone services few farmers are reported to use the tools for accessing and sharing agricultural knowledge. High tariffs have limited most rural people particularly farmers from using mobile phones in accessing and sharing agricultural knowledge (Miller and Atkinson 2014; Mtega, 2012

Sife *et al.* 2010). Moreover, the level of ownership of mobile phones among farmers who are at the centre of AKS is still very low (Nyamba and Mlozi 2012; Sife *et al.* 2010).

Generally, both institutional and individual factors influence the adoption of ICTs in agriculture. Institutional factors are those imposed by the government and other national and international organizations. Individual factors are imposed by individual actors of AKS. For fully adoption of ICTs in AKS, it is important to take a holistic understanding of the factors which hinder or foster the usage of ICTs in agriculture. Therefore, institutions and individuals should support access to agricultural knowledge services through the usage ICTs.

3.15 Chapter summary

This Chapter creates a benchmark against which the researcher can compare and contrast the emerging research results. The literature review also identifies gaps to be further addressed in this study. This Chapter finds that there are number of studies which have addressed issues related to agricultural knowledge creation and sharing. Most of the studies provide useful results for comparison with the current study thus enabling setting appropriate strategies for strengthening agricultural knowledge systems and enhancing access to agricultural knowledge among actors. However, majority of the studies reviewed have considered agricultural knowledge management as a process which involves few actors. Most studies have focused on agricultural researchers, extension agents and farmers as the actors in AKS. They have not taken a holistic view of actors in the agricultural sector. This has made it difficult in setting up strategies for strengthening agricultural knowledge systems and facilitating accessibility of agricultural knowledge services among actors in the sector. It has been found that limited access to agricultural knowledge is predominant a developing countries phenomenon. Developed countries have managed to optimize ICTs in enhancing access to agricultural knowledge services which has not been the case in developing countries. Reports and studies acknowledge that there is a fast growing ICT infrastructure in most African countries and Tanzania in particular. However, adoption of ICTs in agriculture is still reported to be low. Thus, the fact that most reports and studies reviewed have shown that knowledge infrastructure has been developed to a reasonable extent, there is a need to conduct specific in country studies in order to understand

how agricultural knowledge systems can be strengthened and enhance access to agricultural knowledge among actors in the sector. The following chapter discusses the research methodologies adopted by current study.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

The previous Chapter discussed the literature review related to the topic under study. This chapter discusses the research methodology employed by this study. Research methodology is a systematic way to solve a problem, it is the study of methods by which knowledge is gained, it aims at giving the work plan of research, it is a science of studying how research is to be carried out, and it involves procedures by which researchers go about describing, explaining and predicting phenomena (Rajasekar, Philominathan and Chinnathambi 2006). Research methodology encompasses research methods. Bhattacharyya (2009:17) defines research methods as the techniques employed by researchers in conducting research operations. Research methodology deals with the research methods and takes into consideration the logic behind the methods used (op. cit).

Research methodology gives the work plan of research, it takes into consideration the research design, gathering of data and its analysis, as well as theorizing the social, ethical and political interests that affect the researcher (Burgess 1984). It takes a broader view as it includes all the methods by which knowledge is gained and gives the work plan of the research (Rajasekar *et al.* 2006). According to Bhattacharyya (2009:17), research methodology may differ from one research problem to the other. However, research methodologies are set to answer several questions. According to Kothari (2004:8), research methodologies seek to answer the following questions: why a research study is being undertaken, how the research problem has been defined, in what way and why the hypothesis has been formulated, and what data is to be collected. They also answer the following questions: what particular method has been adopted and why particular technique of analyzing data has been used.

The current chapter starts by giving details of research methodology; it describes the different types of research methodologies. The chapter discusses the research purpose by describing why the current was conducted. The chapter then describes the research design (study population,

sampling techniques and data collection methods). Further, the chapter describes the measurements used in measuring variables, reliability and validity, and description of data analysis techniques. Furthermore, the chapter discusses ethical considerations and originality of the current study. It finally discusses the scope of the study and ends by giving a chapter summary.

4.2 The research process

After defining and stating the research problem, the researcher has to undergo a series of steps collectively known as research process. According to Kothari (2004), the research process shows the steps necessary to effectively carry out research and the desired sequencing of these steps. Figure 4.1 shows the series of actions or steps involved in a research process.

Research methodology is shown on the top of Figure 4.1 as it gives the overall plan of the study. Burgess (1984) describes research methodology as a work plan of the entire research process and to give details on how each step has to be undertaken. Among others, the research methodology involves the preparation of research design, data collection and data analysis. In the current study the research methodology and its constituting sections is discussed in this chapter.

The research methodology is followed by the research purpose. This section describes why the research is being conducted. It gives a summary of different purposes of research activities and ends by giving the purpose of the current study. Details of the research purpose are given in Section 4.3.

The other step for the current research process is the research paradigm. Research paradigms are important in research process because they help to determine what should be studied, how it should be studied, how it should be done, and how the attained findings and meaning are assigned. The current study used the pragmatic paradigm whose details are given Section 4.4. The research approach follows after the research paradigms. The two research approaches: “quantitative and qualitative” are given and described in details. The section tells how each approach facilitated collection of data for the current the current study. Details of research approaches are given in Section 4.5 of this chapter.

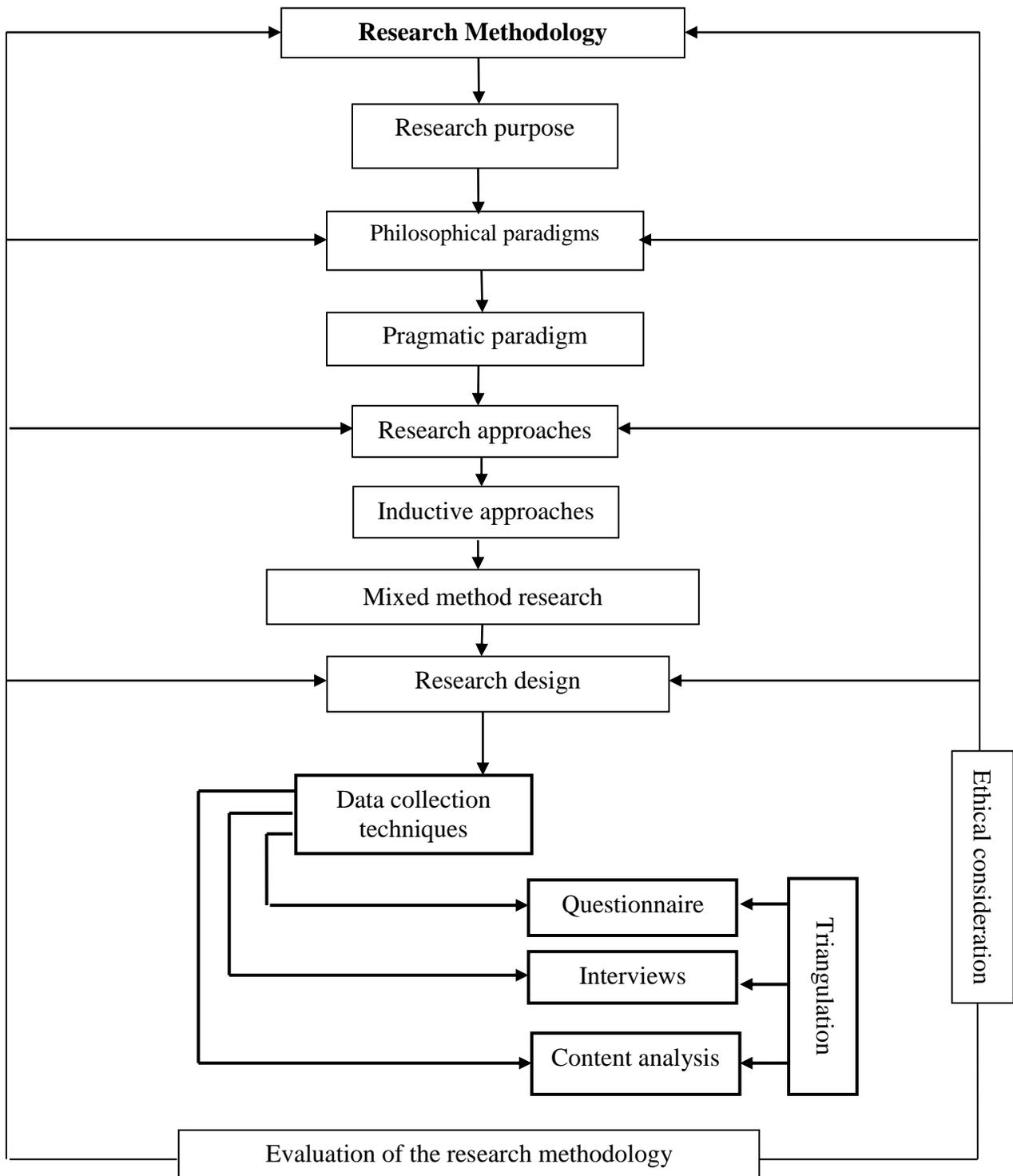


Figure 4.1: The research process

Source: Bhattacharjee (2012) and Kothari (2004)

The research design follows after the research approaches. The research design gives details of the arrangement of conditions for collection and analysis of data. It gives details on data collection techniques and tools to be used for data collection.

The research process ends up by evaluating the research methodology. The evaluation is meant to identify challenges faced and how the researcher managed to collect data in such conditions. It assesses whether ethical issues were maintained throughout the study. The research evaluation is given in section 4.17 of this chapter.

4.3 Research purpose

There are three basic purposes of inquiry: exploratory, descriptive and explanatory (Kothari 2004; Mwanje 2001). Exploratory research aims at generating new ideas and gathering information for clarifying concepts (Krishnaswami 2002). Descriptive research is a fact finding investigation with adequate interpretation (Krishnaswami op. cit). Descriptive research collects information that can be used in predicting behavior. When a research is conducted for diagnostic purpose, it aims at discovering what is happening. Krishnaswami (op.cit) points out that diagnostic research aims at discovering what is happening, why it happens and what can be done about it. Finally, research is for experimentation purposes. Experimentation is the most sophisticated, exacting and powerful method for discovering and developing an organized body of knowledge and it aims at generalizing the variable relationships so that they may be applied outside the laboratory to a wider population of interest (Kothari 2004).

The overall purpose of this study as given in Section 1.6 was to investigate how agricultural knowledge systems can be strengthened for improving rural livelihoods in Tanzania so as to recommend a model for enhancing access to agricultural knowledge among actors. Chapter Two proposed a number of constructs and moderators which influence the efficiency of agricultural knowledge systems. Thus, the purpose of the current study is to describe how the proposed constructs and moderators can enhance access to agricultural knowledge among actors. Basing on the objectives of the study, this study is both descriptive and explanatory in nature.

4.4 Philosophical paradigms

The term paradigm is derived from the history of science and can be traced back to the work of Thomas Kuhn in 1962 through his work entitled “*The Structure of Scientific Revolutions*” which examined the history of the natural sciences to identify patterns of activities that shape the progress of science. In his book, Kuhn (1962) defined paradigm as a set of beliefs, rules and standards, procedures and practices that guide the world view of a group of researchers. It is a philosophical template or framework that guides the production of knowledge (Kuhn op. cit). Weaver and Olson (2006) describe paradigms as patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished. Paradigms guide the researcher in philosophical assumptions about the research and in the selection of tools, instruments, participants, and methods used in the study (Lincoln and Guba 2000). According to Ponterotto (2005) paradigms help to determine what should be studied, how it should be studied, how it should be done, and how the attained findings and meaning are assigned to them.

4.4.1 Types of philosophical paradigms

There are various paradigms used to guide research. Paradigms can be categorized into positivism, post-positivism, constructivism–interpretivism, critical theory and pragmatic paradigm (Mackenzie and Knipe 2006; Ponterotto 2005; Lincoln and Guba 2000). Paradigms differ in terms of ontology, epistemology and methodology. Ontology addresses the nature of reality (Klenke 2008) which influences the way research is conducted. The other paradigmatic element is epistemology, Klenke (2008) states that it deals with the origin, nature and limits of human knowledge it also addresses how we come to know reality. Further, it focuses on the nature and sources of knowledge and how it can be acquired. Paradigms also differ with respect to research methodologies. Within each paradigm, several research methodologies are possible, each drawing on a number of methods or techniques for data collection and interpretation (Lincoln and Guba 2000). According to Klenke (2008), methodology identifies the particular practices used to attain knowledge. It describes how knowledge is created; different paradigms

use different practices to create knowledge. Nature of knowledge and knowledge accumulation paradigmatic elements describe the how knowledge is created.

Positivism paradigm was introduced by Kuhn (1962). According to Kuhn (op. cit), the positivism research paradigm adheres to the view that only “factual” knowledge gained through observation, including measurement, is trustworthy. According to Krauss (2005), in positivism studies the role of the researcher is limited to data collection and interpretation through objective approach and the research findings are usually observable and quantifiable. The current study employs both qualitative and quantitative approaches; this makes positivism paradigm not suitable for the study.

Post-positivism is similar to positivism in relation to the goal of predicting phenomena within the approach of realism, the correlation of assessing causative factors to that of consequences, and the implementation of an objective role of research (Ponterotto 2005). Positivism and post-positivism are quite diverse in relation to overall ideology (Ponterotto op. cit). In post-positivism there is an increased use of qualitative techniques in order to ‘check’ the validity of findings (Denzin and Lincoln 2000). Post-positivism is flexible in nature and aims at providing an alternative perspective to the realm of conducting research (Crossan 2003). Post-positivism holds the theory that there is indeed an objective reality, but this reality is not obtained without interjecting a multifaceted perspective into the scope of measurement (Ponterotto 2005). Post-positivism focuses on the importance of utilizing multiple measurements in addition to observations for both methods assist in the identification of bias prevalent within interpretations (Trochim 2006). In general, positivism aims at verifying a theory while post-positivism promotes theory falsification (Lincoln and Guba 2000). The current study intended to build a model rather than falsify existing models. This makes post-positivism not suitable for the the study.

The other philosophical paradigm employed in research is the interpretivism. This paradigm is associated with the philosophical position of idealism, and is used to group together diverse approaches, including social constructionism, phenomenology and hermeneutics; approaches that reject the objectivist view that meaning resides within the world independently of consciousness (Collins 2010). Interpretive researchers assume that access to reality (given or socially

constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments (Myers 2013). Interpretive researchers do not predefine dependent and independent variables but focus on the complexity of human sense making as the situation emerges, they attempt to understand phenomena through meanings that people assign to them (Myers 2013). According to (Creswell 2009), interpretive researcher tends to rely upon the participants views of the situation being studied and recognizes the impact on the research of their own background and experiences. Interpretivism, by its nature promotes the value of qualitative data in pursuit of knowledge suggesting that reality is socially constructed (Chowdhury 2014). Thomas, Nelson and Silverman (2010) point out that interpretivist epistemology is based on the fact that events are understood through the mental processes of interpretation. The current employs both quantitative and qualitative research approaches. This makes interpretivism not suitable for this study.

Constructivist paradigm is closely related to interpretivism which addresses essential features of shared meaning and understanding whereas constructivism extends this concern with knowledge as produced and interpreted (Thomas *et al.* 2010). With constructivism, individuals construct their own knowledge within the social-cultural context influenced by their prior knowledge and understanding (Thomas *et al.* 2010). Under constructivist paradigm the researcher has to maintain the parameters of a constructivist epistemological discourse. The current study has not adopted constructivism because it relies on qualitative approaches only.

Researchers can be led by a participatory/transformational research paradigm. This paradigm arose during the 1980s and 1990s from individuals who felt that the post-positivist assumptions imposed structural laws and theories that did not fit marginalized individuals in our society or issues of social justice that needed to be addressed (Creswell 2009). The participatory worldview holds that research inquiry needs to be intertwined with politics and a political agenda (Creswell 2009). The paradigm allows the researcher to have negotiations with participants in creating knowledge. Participatory research paradigms are more collaborative and involve an action research methodology that is not applicable for the current study.

Researchers may use a pragmatic lens in conducting research. According to Creswell (2009), pragmatism as a worldview arises out of actions, situations, and consequences rather than antecedent conditions. Creswell states further that pragmatism conveys its importance for focusing attention on the research problem in social science research and then using pluralistic approaches to derive knowledge about the problem. According to Goldkuhl (2004), pragmatic researchers seek to answer the following questions:

- What action is performed?
- Who is the actor?
- What is the result of the action?
- What is the time-context of the action?
- What is the place-context of the action?
- Who is the receiver of the action/result?
- What are the intended effects - purposes of the action?
- What unintended effects are arisen from the action?

Pragmatism employs both qualitative and quantitative approaches in deriving knowledge about the problem and responding to these questions. This gives researchers freedom to decide on what techniques to adopt during data collection basing on the research problem in question.

4.4.2 Philosophical paradigm for the study

The current study adopted a pragmatic paradigm. The paradigm was adopted because it provides an opportunity for different worldviews, and different assumptions, as well as different forms of data collection and analysis in the mixed methods study (Creswell 2009). When using pragmatic lens to research, methods are matched to specific questions and purpose of the research (Mackenzie and Knipe 2006). Pragmatic lens uses qualitative and quantitative methods as complementary strategies to different types of research questions or issues; it is more suitable when neither quantitative nor qualitative research alone can provide adequate findings for the research (Ritchie and Lewis 2003). The current study could hardly employ a single research approach and it was for this reason pragmatism was adopted.

4.5 Research approaches

Research approaches are plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation (Creswell 2009). Selection of a research approach is based on the nature of the research problem or issue being addressed, the researchers' personal experiences, and the audiences for the study (Creswell 2009). Kothari (2004) categorizes research approaches into quantitative, qualitative methods and mixed method research. Quantitative methods involve generation of data in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigid fashion and it is sub-classified into inferential, experimental and simulation approaches to research (Kothari 2004). The purpose of inferential approach to research is to form a data base from which to infer characteristics or relationships of population (Nallaperumal 2014). On the other hand, experimental approach to research seeks to determine if a specific treatment influences an outcome (Creswell 2009). Lastly, simulation approach to research involves the construction of an artificial environment within which relevant information and data can be generated (Kothari 2004).

Qualitative approach to research is concerned with subjective assessment of attitudes, opinions and behaviour (Kothari 2004). Qualitative research is concerned with qualitative phenomenon; it aims at discovering the underlying motives of human behaviour (Nallaperumal 2014). Such an approach to research generates results either in non-quantitative form or in the form which are not subjected to rigorous quantitative analysis (Nallaperumal 2014). Qualitative research approaches use focus group discussions and key informant interviews to collect information and usually pose open-ended questions to interviewees.

Most social science research employs mixed research approaches. This approach to inquiry involves collection of both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks (Creswell 2009). Mixed research approaches provide a more complete understanding of a research problem than either approach alone and strengthen the validity and reliability of research results (Creswell 2009; Jewels and Ford 2006;).

This study employed mixed method research. The approach was selected because neither quantitative nor qualitative approach could provide a more complete understanding of a research problem. As stated by Ritchie and Lewis (2003), many of the research questions require both qualitative and quantitative approaches for better understanding of the nature of issues to be studied. This study examined both number and nature of the phenomenon. Creswell (2009) points out that when the study has to examine numbers and nature of phenomena mixed approaches become more appropriate. The current study evaluated the performance of AKS and determined factors influencing performance before proposing for a suitable model to enhance access to agricultural knowledge among actors. Ritchie and Lewis (2003) point out that it is not possible to carry out comprehensive evaluation without employing mixed research approaches. It is for these reasons mixed research approaches were adopted for the current study.

According to Driscoll, Appiah-Yeboah, Salib and Rupert (2007), in mixed method research can be implemented sequentially or concurrently. It is sequentially when data is collected in iterative process that data collected in one phase contribute to that collected in the other. In sequential designs, either the qualitative or quantitative data are collected in an initial stage, followed by the collection of the other data type during a second stage (Castro, Kellison, Boyd, and Kopak 2010). The sequential design to mixed method research integrates data during interpretation with a primary focus of explaining quantitative results (Terrell 2012). Concurrent designs are characterized by the collection of both types of data during the same stage (Castro *et al.* 2010). The purpose of concurrent designs is to use both qualitative and quantitative data to define relationships among variables of interest (Castro *et al.* 2010). The current study employed both sequential and concurrent designs. Mixed method research was employed through concurrent design by involving both open and closed ended questions in the survey questionnaire. It involved sequential designs through conducting the survey with closed and open ended questions at the first phase followed by in-depth interviews and focus group discussions in the second phase. Results from the main survey, in-depth interviews and focus group discussions were mixed together during presentation of findings and when results were interpreted while those from secondary data were merged with other results during interpretation and discussion of findings in Chapter Six.

4.6 Research design

Research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (Kothari 2004). It is a logical and systematic plan prepared for directing the collection, measurement and analysis of data in objective and economical procedures (Krishnaswami 2002). It is a program that guides the investigator in the process of collecting, analyzing and interpreting observations (Krishnaswami op. cit). According to Durrheim (2006), a research design is a plan of action that steers the manner in which data is collected and analyzed. It includes an outline of what the researcher will do from writing the hypothesis and its operational implications to the final analysis of data (Kothari 2004). Kothari states further that the research design offers several critical decision making options on how data can be efficiently collected and analyzed to reach a solution while focusing on the research purpose. A research design provides answers to the research questions and helps to control variance (Dwivedi 1997). According to Kothari (2004), the research design helps answer the following questions: what the study is about, why the study is being done, where will the study be carried out, what type of data is required, where can the required data be found, and what periods of time will the study include. Other questions answered by research designs are: what will be the sample design, what techniques of data collection will be used, how the data will be analyzed, and in what style will the report be prepared. Research designs are not precise and specific plans but rather a series of guidelines to keep one going in the right direction, a tentative plan which undergoes modifications as circumstances demand (Krishnaswami 2002). The quality of research designs can be defined in terms of four key design attributes: internal validity, external validity, construct validity, and statistical conclusion validity (Bhattacharjee, 2012). Details on validity are given from section 4.14.2.1 to 4.14.2.7.

There are various categories of research designs. Bhattacharjee (2012) and Kothari (2004) broadly categorize research designs into positivist and interpretive. Bhattacharjee (op cit) describes that positivist designs seek generalized patterns based on an objective view of reality, while interpretive designs seek subjective interpretations of social phenomena from the perspectives of the subjects involved. Bhattacharjee (2012) and Kothari (2004) give examples of

positivist designs to include laboratory experiments, field experiments, field surveys, secondary data analysis, and case research while examples of interpretive designs include case research, phenomenology, descriptive/diagnostic research and ethnography. Sometimes, joint use of qualitative and quantitative data may help generate unique insight into a complex social phenomenon that are not available from either types of data alone, and hence, mixed-method designs that combine qualitative and quantitative data are often highly desirable (Labaree 2013; Bhattacharjee 2012). Durrheim (2006) and Kothari (2004) point out that a research design should not only be guided by the research purpose; but also by the theoretical paradigm informing the research; desired standard of accuracy; the situation within which the research is being carried out; and the data collection and analysis techniques. Choice of the research design for this study took into consideration all conditions for good research designs. Thus, a mixed-method design was chosen for this study.

Research design includes selecting a research method, operationalising constructs of interest, and devising an appropriate sampling strategy (Bhattacharjee 2012). Operational definitions have been discussed in Section 1.8 of Chapter One while details on research methods have been discussed in Section 4.9 of this chapter. Bhattacharjee (op cit) states further that researchers must also carefully choose the target population from which they wish to collect data, and a sampling strategy to select a sample from that population. Details of the study area were given in Section 1.2 of Chapter One and further details have been given in section 4.7 of this chapter. Details of the target population and sampling procedures are presented in section 4.7 of this chapter.

4.7 Selection of the study area

Kilosa, Kilombero and Mvomero districts of Morogoro Region were purposively selected and involved in the study. Decision to select these districts was based on the availability of agricultural research institute in the district, basic ICT infrastructure (mobile phone, radio and TV infrastructure) and average yield of staple food crops. According to URT (2012), Kilosa, Kilombero and Mvomero have a higher average yield of staple food crops. Moreover, each of these districts had an agricultural research centre/institute. Furthermore, TCRA (2015a) showed that Kilosa, Kilombero and Mvomero districts had a better access to radio and TV broadcasts

than other districts in the region. Detailed descriptions for each of the three districts have been given under Section 1.2 of Chapter One.

Administratively, each district had divisions with several wards. Each ward had several villages as shown in Table 4.1.

Table 4.1: Administrative units of districts under study

District	Number of divisions	Number of wards	Number of villages	Population		
				Male	Female	Total
Kilombero	5	19	81	202,789	205,091	407,880
Kilosa	9	37	161	218,378	219,797	438,175
Mvomero	4	17	101	154,843	157,266	312,109

Source: NBS (2012) and URT (2007)

Wards to be included in the study area were purposely selected based on the availability of ICT infrastructure and other communication channels. Basing on the above criteria nine wards (three from each district) were selected for the study. Wards involved were Kibaoni, Mang'ula, and Lumemo from Kilombero District; Rudewa, Chanzulu and Kimamba B from Kilosa District; and Wami Dakawa, Mvomero and Hembeti from Mvomero District. A sampling frame of all villages from each of the nine wards was prepared. One village from each of the three wards of each district was randomly selected for the study. Villages selected for the study and their respective wards and districts are shown in Table 4.2.

Table 4.2 Study villages

S/N	Village	Ward	District
1	Rudewa Mabatini	Rudewa	Kilosa
	Chanzulu	Chanzulu	
	Kimamba B	Kimamba B	
2	Michenga	Lumemo	Kilombero
	Mgudeni	Mang'ula	
	Mlimba A	Mlimba	
3	Hembeti	Hembeti	Mvomero
	Mvomero	Mvomero	
	Wami Dakawa	Dakawa	

4.8 Study population and sampling

This section describes the study population and sample, and outlines the sampling strategy, sampling frame, sample size and sampling techniques used.

4.8.1 Population

Population is the total of all individuals who have certain characteristics and are of interest to a researcher (Salkind 2012). The population is an entire group about which some information is required to be ascertained (Banerjee and Chaudhury 2010). Castillo (2009) defines research population generally as a large collection of individuals or objects that is the main focus of a scientific query. The population for the study does not necessarily include people; it may include other items which may be of interest to the researcher. It consists of all the subjects you want to study (Yount 2006). According to Bhattacharjee (2012), the population may consist of well-defined collection of individuals or objects known to have similar characteristics. Jha (2014) adds that population may comprise people, objects, materials or even documents as per the requirement of the study.

When selecting the population for the study it is important to consider the characteristics the researcher intends to study. The relevancy of the population to a study depends upon the research problem, parameters of interest, the objectives of the study, geographical area selected for the survey, and the operational definition of the unit of study (Krishnaswami 2002). According to Yount (2006), the research question or purpose of the study will suggest a suitable definition of the population to be studied in terms of location and restriction to a particular age group, sex or occupation. The population must be fully defined so that those to be included and excluded are clearly spelt out (Banerjee and Chaudhury 2010). It should be defined by geographic location, age and sex with additional definitions of attributes and variables such as occupation, religion and ethnic group (Banerjee and Chaudhury 2010). When selecting the research population it is important to determine whether to use finite or infinite population. The population of the study is finite when the number of items is certain and infinite when the number of items is infinite (Kothari 2004). The population is used as a unit of analysis. The unit of analysis may be a

person, group, organization, country, object, or any other entity that you wish to draw scientific inferences about (Bhattacharjee 2012).

The current study involved infinite population which included actors in AKS. These people included farmers, researchers from agricultural research institutes, agricultural extension staff, agricultural input suppliers, and information service providers. The study also involved policy makers, village executives and governmental and non-governmental departments directly involved in agriculture and related activities.

4.8.2 Sampling

Sampling is the statistical process of selecting a subset of a population of interest for purposes of making observations and statistical inferences about that population (Bhattacharjee 2012). Sampling is a scientific way of selecting study subjects (Dongre, Deshmuk, Kalaiselvan, and Upadhyaya 2009). Yount (2006) defines sampling as the process of selecting a group of subjects for a study in such a way that the individuals represent the larger group from which they were selected (Yount 2006). Yount describes a sample as the representative portion of a population. During sampling the researcher makes decisions concerning the relevance of the population; sampling strategies; the sampling frame; and sample size to be drawn (Krishnashwami 2002).

The main aim of sampling is to make an inference about an unknown parameter from a measurable sample statistic and testing statistical hypothesis relating to the population (Krishnashwami 2002). According to Creswell (2009), sampling reduces the time and cost, reduces labor; it provides much quicker results; sampling is only possible when the population is infinite. Well selected samples may reflect fairly accurately the characteristics of the population (Krishnashwami 2002). A sample for a specific study is only well selected if appropriate sampling strategies are employed.

4.8.3 Sampling strategies

Sampling strategies involve all techniques used in selecting the items for the sample (Kothari 2004). A well-defined sampling strategy that utilizes an unbiased and robust frame can provide

unbiased and robust results (Wilmot 2005). There are two broad categories of sampling techniques employed in research namely probability (random) sampling and non-probability sampling (Creswell 2009). Kothari (2004) describes probability sampling to be ideal if generalisability of results is important for the study, when there are unique circumstances then non-probability sampling can be used.

Probability sampling is a technique in which every unit in the population has a chance (non-zero probability) of being selected in the sample, and this chance can be accurately determined (Bhattacharjee 2012). In a probability sample, elements in the population are chosen at random and have a known probability of selection (Ritchie and Lewis 2003). According to Bhattacharjee (2012), all probability sampling have two attributes in common: every unit in the population has a known non-zero probability of being sampled, and the sampling procedure involves random selection at some point. Probability sampling technique is categorized into simple random sampling, systematic random sampling, stratified random sampling and multi-stage sampling (Ritchie and Lewis 2003). Simple random sampling gives all possible subsets of a population an equal probability of being selected (Bhattacharjee 2012). If the population has “N” items then each item has $1/N$ chances of being included in the sample. Krishnashwami (2002) describes simple random sampling to be suitable when the population is homogenous. According to Kothari (2004), when selecting items for the study through simple random sampling each item is assigned with a number and then a lottery method can be used to select items from the population. Through this procedure each item of the population is given an equal chance of being selected.

The other type of probability sampling is systematic sampling. Krishnaswami (2002) describes it as an alternative to simple random sampling. In this technique, the sampling frame is ordered according to some criteria; it involves a random start and then proceeds with the selection of every k th element from that point onwards (Bhattacharjee 2012). For making it work better, it is important that the starting point is not automatically the first in the list, but is instead randomly chosen from within the first k elements on the list (Bhattacharjee op. cit).

Stratified random sampling is another form of probability sampling employed in social and scientific research. This method is employed when the population from which a sample is to be drawn does not constitute a homogeneous group (Kothari 2004). In stratified sampling, the sampling frame is divided into homogeneous and non-overlapping subgroups called strata, and a simple random sample is drawn within each subgroup (Bhattacharjee 2012). Through this procedure each item of the population is given a non-zero probability or chance of being included in the sample.

Another form of probability sampling technique is the cluster sampling. Cluster sampling involves grouping the population and then selecting the groups or the clusters rather than individual elements for inclusion in the sample (Kothari 2004). Cluster sampling is employed when the population is dispersed over a wide geographic region that it may not be feasible to conduct a simple random sampling of the entire population; in such case, it may be reasonable to divide the population into “clusters” (usually along geographic boundaries), randomly sample a few clusters, and measure all units within that cluster (Bhattacharjee 2012). The clustering approach can, however, make the sampling procedure relatively easier and increase the efficiency of field work but the results are less generalisable to the population than those obtained from simple random samples (Bhattacharjee op. cit; Kothari 2004).

All of the previously described sampling methods involve single-stage sampling techniques; however, sampling procedures may involve multi-stages. Under multi-stage sampling the first stage may be to select large primary sampling units such as states, then districts, then towns and finally certain families within towns (Kothari 2004). If this technique of random-sampling is applied at all stages, the sampling procedure is known as multi-stage random sampling (Kothari 2004).

Researchers may intend to include some items of the population in the study because of the characteristics they have. In such circumstances non-probability sampling techniques are employed. Non-probability sampling is a sampling technique in which some units of the population have zero chance of selection or where the probability of selection cannot be accurately determined (Bhattacharjee 2012). Non-probability sampling technique does not aim to

produce a statistically representative sample or draw statistical inference (Wilmot 2005). Because selection is non-random, non-probability sampling does not allow the estimation of sampling errors, and may be subjected to a sampling bias and therefore, information from a sample cannot be generalized back to the population (Bhattacharjee 2012). Non-probability sampling technique is categorized into purposive sampling, where sample units are selected with definite purpose in view and convenient sampling, where the conveniently available respondents are selected (Dongre *et al.* 2009). The other is quota sampling which is a restricted type of convenient or purposive sampling which draws sample from different strata. The other category is snow ball sampling. Snow-ball sampling involves asking respondents to identify other potential participant with specific set of characteristics and then asking the next respondent (Krishnaswami 2002). Snow-ball is used when the target population is unknown or difficult to approach (Dongre *et al.* 2009).

The current study used both probability and non-probability sampling techniques where simple random sampling and purposive sampling techniques were adopted in selecting respondents from the population. Purposive sampling technique enables the selection of participants basing on set criteria (Ritchie and Lewis 2003). The study involved some role actors who were chosen basing on their characteristics, experiences and key roles they played in AKS (see sections 4.8.7 for details).

The study involved simple random sampling technique for drawing respondents among farmers for the main survey. The technique was selected because it can enhance generalization of results. Bhattacharjee (2012) describes simple random sampling as the simplest of all probability sampling techniques, the sample is unbiased and the inferences are most generalisable amongst all probability sampling techniques. Before selecting the sample for the study, a sampling frame containing all farmers from each village was made (see section 4.8.4 for details). Basing on their farming experience, some farmers were purposively selected for the focus group discussions (see section 4.11.3 for details).

4.8.4 Sampling frame

Before selecting units to be studied the researcher has to prepare a sampling frame. According to scholars (Weathington, Cunningham and Pitternger 2010), a sampling frame is the set of individuals within a population who can actually be reached for a specific research purpose. A sampling frame is developed by creating a list of all units of the population which can be reached by the study; these units may include areas, people, materials or other objects the researcher intends to study.

The current study was conducted in rural and semi-urban setting where agriculture is the main economic activity. URT (2013d) indicates that majority of rural people (89%) are farmers. The sampling frame for this study was a list of people relying totally on farming for earning a living in the study area. The researcher created a list of all farmers and other AKS actors from each village. In the list, each name of the farmer was assigned a unique number which was used as an identifier distinguishing one from the other. The sampling frame was used when the sample for the study was selected.

4.8.5 Sample size

Before drawing a sample it is important to determine the sample size. Powell (1997) mentions that it is better to use a larger sample size for more precision but there is no point of utilizing a sample that is larger than necessary. There are several criteria used in determining sample sizes: the degree of precision required determines the sample size needed, the larger the sample size the more precise is the results (Powell 1997; Federer 1991). The second criterion is the variability of the population (Powell 1997), the more the population varies the larger the sample size needed to achieve a given level of accuracy and representativeness. Federer (1991) points out that the available resources including personnel and equipment must be considered when determining the sample size. Moreover, the size and shape of the sampling units determine the sample size needed (Federer 1991). Lastly, Powell (1997) points out that the way results will be analyzed influences the sample size.

Table 4.3 Sample size³ for the study

S/N	Village	Population size	Working age population	Number of farmers	Anticipated sample size	Response rate
1	Rudewa Mabatini	4,876	2,389	2,126	32	32 (100%)
2	Chanzulu	3,617	1,772	1,578	23	23 (100%)
3	Kimamba B	5,967	2,924	2,602	39	38 (97%)
4	Michenga	4,120	2,019	1,797	28	28 (100%)
5	Mgudeni	8,775	4,300	3,827	57	50 (88%)
6	Mlimba A	7,449	3,650	3,249	49	31 (63%)
7	Hembeti	4,010	1965	1,749	26	26 (100%)
8	Wami Dakawa	7,209	3,532	3,144	47	39 (83%)
9	Mvomero	9,321	4,567	4,065	61	47 (77%)
Total		55,344	27,118	24,117	362	314 (87%)

One can use formulas in determining the sample size. Krejcie and Morgan (1970) proposed a Table for determining the sample size for research activities. The Table estimates the sample size for each population size. Estimates are based on the formula for calculating the sample size expressed as:

$$\text{Sample size} = X^2NP(1 - P)/d^2(N - 1) + X^2P(1 - P)$$

Where: X² = Table Value of Chi-Square at d.f = 1, N = Population size, P = Population proportion (assumed to be 0.50), d = degree of accuracy.

Basing on the table for determining sample size developed by Krejcie and Morgan (1970); the working age population; and the number of people relying on agriculture from each village; the sample size for each of the selected villages is as shown in Table 4.3. The total number of farmers to be randomly selected from the nine villages and included in the sample was 362.

³ The total population includes people of all age groups (children, youth, adults and elders). According to TBS (2013), the working age population ranges from 15 to 64 years of age which is 54.7% of the entire population. In Tanzania, 89% of rural dwellers are farmers (URT, 2013d). Thus, the sample shown in Table 4.5 has been computed basing on these facts.

However, 314 respondents turned up among the 362 farmers included in the sample making a response rate of 87%. The other, 48 respondents did not manage to participate in the study due several reasons. The study also involved other 81 respondents as described in sections 4.8.6 to 4.8.9. Thus, the total number of AKS actors involved in this study was 395 respondents.

4.8.6 Selecting sampling techniques

The current study employed mixed sampling techniques were both simple random and purposive random sampling techniques were employed. Mixed sampling techniques are designed to generate a sample that addresses research questions; it involves sampling decisions which are made before the study starts; and employs both probability and purposive sampling (Teddlie and Yu, 2007). Sections 4.8.6.1 to 4.8.6.9 describe how the sample for the current study was drawn from the population.

4.8.6.1 Selection of respondents among farmers

A numbered list of all farmers from each of the selected village formed the sampling frame. The nine villages had a homogenous population of 25,193 farmers. Using random number generators a set of numbers associated with the names of farmers was randomly selected from each village depending on the pre-determined sample size (see Section 4.8.5 and Table 4.3 for details). Selected farmers from each village formed the sample to which the survey questionnaire was administered. Thus, a total of 362 respondents were selected among farmers from the study area.

4.8.6.2 Selection of respondents among agricultural researchers

The heads of departments or sections/units concerned with research-extension-farmer linkage from Cholima Research Centre in Mvomero district, Kilombero Agricultural Training and Research Institute from Kilombero district and Ilonga Agricultural Research Institute from Kilosa district were purposively selected and involved in the study. The three heads of departments were selected because they led units whose primary role was to share research outputs to intended audience.

4.8.6.3 Selection of respondents among agricultural extension workers

District Agriculture Irrigation and Cooperative Officers from the three districts and village /ward agricultural extension officers from the nine villages involved in the study were purposively selected and included in the study. Thus, the study involved a total of 12 agricultural extension officers.

4.8.6.4 Selection of respondents among providers of agricultural information services

Through the District Agriculture Irrigation and Cooperative Office of the three districts, a sampling frame of all organizations involved in providing agricultural information services were created. Two large agricultural information service providers were purposively selected basing on the geographical coverage of their services. Radio Pambazuko FM and the Rural Urban Development Initiatives were purposively selected in Kilombero district; Mtandao wa Vikundi vya Wakulima (MVIWATA) and Kilosa Community Radio for Kilosa district and; Radio Abood and NAFKA in Mvomero district. This made a total of six agricultural information services providers.

4.8.6.5 Selection of respondents among input suppliers

Sampling frames of input suppliers operating in study villages were created through district agro-dealer networks which are: Kilosa Input suppliers Network (KADNET) for Kilosa District, Kilombero Agro-dealer Network (UWAPEKI) for Kilombero District and the Mvomero Agro-dealer Network for Mvomero District. From the sampling frame, it was found that each village included in the study had less than five input suppliers. Due to their small number, all input suppliers found in the study villages were purposively selected for the study. Thus, nine input suppliers (one from each village) were selected from the nine villages involved in the study.

4.8.6.6 Selection of respondents among village executives

Each of the nine villages involved in the study have village executive officers responsible for all matters related to the village government. Due to their involvement in all village issues including

agricultural related ones, each village executive officer from the study villages was purposively selected and included in the sample.

4.8.6.7 Selection of respondents among policy makers

Each of the nine wards included in the study had councilors who were involved in making policies. Councilors were representatives of people and for the case of rural areas they represented farmers in the district council. Due to the nature of their daily activities, councilors had a lot of information which was believed vital for the current study. It was due to this reason a total of nine councilors from the nine wards were included in the sample.

4.8.6.8 Selection of respondents among buyers of agricultural produce/products

By help of the village executive officers, sampling frames of buyers of agricultural produce/products were created in each village. One buyer was purposively selected from each village included in the study basing on the size of volumes of agricultural produce bought from farmers (making a total of nine buyers).

4.8.6.9 Selection of participants for the focus group discussions

The study involved 24 participants (eight from one village for each district) from the three districts for focus group discussions. For progressive junior and senior farmers were purposively selected for focus group discussions from one village from each district (see Section 4.11.3 for details).

4.9 Research strategy

There are different research strategies or methods that can be used in conducting research. According to Kothari (2004), primary data is collected during the course of doing experiments in an experimental research and through surveys for descriptive studies. Survey is a research method involving the use of standardized questionnaires or interviews to collect data about people and their preferences, thoughts, and behaviours in a systematic manner (Bhattacharjee 2012). Surveys capture snapshots of practices, beliefs, or situations from a random sample of

subjects in field settings through a survey questionnaire or less frequently, through a structured interview (Bhattacharjee 2012). The survey method can be used for descriptive, exploratory, or explanatory research; the method is best suited for studies that have individual people as the unit of analysis (Bhattacharjee 2012). On the other hand, experimental methods seek to determine if a specific treatment influences an outcome (Creswell 2009). In experiments the impact is assessed by providing a specific treatment to one group and withholding it from another and then determining how both groups scored on an outcome (Creswell 2009).

Other research strategies which may be adopted by researchers to collect primary data are case studies and interpretive or qualitative research. Case study is a method of intensively studying a phenomenon over time within its natural setting in one or a few sites (Bhattacharjee 2012). On the other hand, interpretive/qualitative research is a form of interpretive inquiry in which researchers make an interpretation of what they see, hear, and understand (Creswell 2009). Interpretive research is a research paradigm that is based on the assumption that social reality is not singular or objective, but is rather shaped by human experiences and social contexts, and is therefore best studied within its socio-historic context by reconciling the subjective interpretations of its various participants (Bhattacharjee 2012).

The other commonly used research strategy is using the already existing data known as secondary data. According to Kothari (2004), secondary data means data that are already available, or data which have already been collected and analyzed by someone else. Secondary data is accessed through content analysis. Krishnaswami (2002) defines content analysis as a research technique for making inferences by objectively and systematically identifying specified characteristics of contents of documents. Documentary review is a method of data collection and data analysis technique. Secondary data is found in reports, books, articles, government publications and technical and trade journals.

When selecting research strategies, the researcher has to consider a number of factors. Kothari (2004) points out that nature of the study, availability of funds, time factor and level of precision required can help determine an appropriate research strategy. However, depending on the type of study more than one research strategies may be employed. It is for these reasons the current

study adopted survey and documentary reviews strategies. The survey strategy has been cited as the most reliable way of determining attitudes and knowledge of a particular group through directing interrogation by gathering facts and describing the current situation (Allan 2005; Pelizzari 2003). As described in section 4.4, this study employed a combination of qualitative and quantitative approaches so as to provide a more complete understanding of a research problem. This made a survey research strategy more appropriate for this study. Documentary review was used to supplement the survey methodology for data gathering. It does not involve interviews as it uses the already existing data. Documentary review acts as benchmarks for comparing the current and documented performance. Using the two research strategies made it important for the study to employ a number of data collection methods and instruments as detailed in Section 4.11 of this chapter.

4.10 Pilot study

Before embarking into the main study a pilot study was conducted. Pilot studies or pre-testing are conducted so as to develop and test adequacy of research instruments, assess the feasibility of the study, assess whether the research protocol is realistic and workable, and establish whether the sampling frame and technique are effective (Van Teijlingen and Hundley 2002). A pilot study also assesses the likely success of proposed recruitment approaches, identifies logistical problems which might occur using proposed methods, estimates variability in outcomes to help determining sample size, and helps in collecting preliminary data (Van Teijlingen and Hundley 2002). Furthermore, it is through pilot studies researchers can determine what resources they need for a study, assess the efficiency of the proposed data analysis techniques, and refine research instruments. For this reason, a pilot study which involved 30 respondents was undertaken at Sangasanga Village which is in Mzumbe ward of Mvomero district. Data collected during pre-test was not included in the study but helped in improving the data collection instruments.

4.11 Data Collection Tools

The study collected both primary and secondary data. Primary data was collected through questionnaire-based surveys, key informant interviews and focus group discussions. Secondary

data was obtained through review of documents from agricultural research institutions, libraries and information centres.

4.11.1 Questionnaire

A questionnaire is a research instrument consisting of a set of questions (items) intended to capture responses from respondents in a standardized manner (Bhattacharjee 2012). According to Kothari (2004), questions may be unstructured or structured. Unstructured questions ask respondents to provide a response in their own words, while structured questions ask respondents to select an answer from a given set of choices (Bhattacharjee 2012). Structured questionnaires are simple to administer and relatively inexpensive to analyze, they enable the provision of alternative replies, at times, helps to understand the meaning of the question clearly (Kothari 2004).

Structured questionnaires formed the main data collection tool and were administered to farmers. The questionnaires had a mixture of both closed and open-ended questions. Open and closed ended questions were about “roles played by each actor in an agricultural knowledge systems; factors influencing knowledge sharing; the use of ICTs in knowledge sharing; how different interventions influence agricultural knowledge management; and the relationship existing between institutes and individuals in AKS”. Face to face interviews were conducted for filling structured questionnaires for farmers.

4.11.2 Interviews

A key informant is generally a person with a special expertise selected to provide information (Dvorak 1992). Key informants must be purposively selected for the study basing on pre-set criteria. Data is collected from key informants through key informant interviews. Dvorak (1992) defines key informant interview as a structured conversation with people who have been selected to speak about a specific topic due to their deep knowledge and understanding of the topic. Key informant interviews provide an opportunity for detailed investigation of each person's personal perspective, it is used where delicate or complex issues need to be explored at a detailed level (Ritchie and Lewis 2003). Key informant interviews use a checklist as a data collection tool.

With a check-list approach, the researcher lists the topics to be covered in the interview, which takes the form of a discussion (Dvorak 1992). Dvorak describes the check-list as an essentially reminder to the researcher of the topics that need to be covered in the conversation.

In the current study key informants were purposively selected among village executive officers, agricultural extension officers, agricultural researchers, agricultural information providers, input suppliers, councillors and buyers. Key informant interviews were held at each district agricultural irrigation and cooperatives office, agricultural research institute and in each village. Key informant interviews were guided by a key informant interview checklist which was structured around “roles played by each actor in AKS; factors influencing agricultural knowledge sharing; the use of ICTs in knowledge sharing; how interventions influence agricultural knowledge management; and the relationship existing between institutes and individuals in an agricultural knowledge system”. Information collected through key informant interviews supplemented data gathered through questionnaire.

An unstructured questionnaire was administered among village executive officers, agricultural extension officers, agricultural researchers, agricultural information providers, input suppliers, councillors and buyers not involved in key informant interviews. Face to face interviews were scheduled to facilitate data collection.

4.11.3 Focus group discussions

Focus group discussions are a form of group interview that capitalizes on communication between research participants in order to generate data (Kitzinger 1995). The method is particularly useful for exploring people's knowledge and experiences and can be used to examine not only what people think but how they think and why they think that way (Kitzinger 1994).

Focus group discussions involve about 6 - 12 persons guided by a facilitator, talk freely and spontaneously about a certain topic (Krishnashwami 2002). In this technique, a small group of respondents (usually 6-10 respondents) are interviewed together in a common location (Bhattacharjee 2012). When conducting focus group discussions the interviewer is a facilitator who leads the discussion, and ensures all respondents participate in the discussion. Focus groups

allow deeper examination of complex issues than other forms of survey research, because when people hear others talk, it often triggers responses or ideas that they did not think about before (Bhattacharjee 2012). This data collection technique was adopted because it is more useful in conducting exploratory research.

Three focus group discussions (one from each district) were conducted. Focus group discussions involved farmers with varied farming experience. Farmers to be involved in focus group discussions were purposively chosen among those who were not involved in the questionnaire survey. The main criteria were experience in farming and level of yield.

A total of three focus group discussions were held. One Focus group discussion involving eight farmers was held in each district to augment the data gathered through questionnaire, content analysis and key informant interviews. Focus group discussions were held at Kimamba B village in Kilosa district, Mgudeni in Kilombero and Wami Dakawa in Mvomero district. A focus group discussion guide was prepared and used in leading discussions. The focus group discussion guide was structured around: roles played by each actor in an agricultural knowledge systems; factors influencing knowledge sharing; the use of ICTs in knowledge sharing; how different interventions influence agricultural knowledge management; and the relationship existing between institutes and individuals in an agricultural knowledge system.

4.11.4 Secondary data collection methods

Secondary data means data that are already available, it refers to the data which have already been collected and analyzed by someone else (Kothari 2004). Secondary data can embrace a whole spectrum of empirical forms; they can include data generated through systematic reviews, through documentary analysis as well as the results from large-scale datasets (Smith and Smith 2008). Secondary data can be numeric or non-numeric (Smith and Smith 2008). Kothari (2004) points out that secondary data may either be published data or unpublished data; published data may be available in publications; technical and trade journals; books, magazines and newspapers; and reports (Kothari 2004).

The current study collected secondary data for complementing the collected primary data. Secondary data were collected from agricultural production reports, articles on agricultural knowledge management, and agricultural policies. They were accessed from libraries, villages, wards and district council offices. Secondary data were also accessed in research institutions, NBS, TCRA, NGOs dealing with agricultural development, and from the Ministry of Agriculture, Livestock and Fisheries. Secondary data were collected through documentary reviews.

4.12 Measurement of variables

A variable is a concept which can take on different quantitative values (Bhattacharjee 2012:11; Kothari 2004:34). Variables bear differing or varying values from time to time. Depending on their intended use, variables may be mainly classified as independent and dependent (Kothari 2004:34). Independent variables explain other variables while dependent variables are explained by independent variables (Bhattacharjee 2012:12). In other words, independent variables influence the dependent variables.

According to Hubbard (2010), if a thing can be observed in any way at all, it lends itself to some type of measurement method. Measurement is the process of observing and recording the observations that are collected as part of a research effort (Trochim, Donnelly and Arora 2015). It is the process of assigning numbers to objects, events or observations according to set rules and standards (Kimberlin and Winterstein 2008; Fife-Schaw 2006).

Kothari (2004:71) categorizes measurement into four levels namely nominal, ordinal, interval and ratio. Nominal scale is simply a system of assigning number symbols to events in order to label them (Kothari 2004:71). Nominal scales, also called categorical scales, measure categorical data. These scales are used for variables or indicators that have mutually exclusive attributes (Bhattacharjee 2012:45). Nominal measurements are simply a set of membership statements, such as whether a fetus is male or female, or whether you have a particular medical condition, with these scales, there is no implicit order or sense of relative size (Hubbard 2010). This scale is also known as dummy coding, it place variables/items into categories based on some shared traits.

Researchers use other higher measurements including the ordinal scale. According to Bhattacharjee (2012), ordinal scales are those that measure rank-ordered data, such as the ranking of students in a class as first, second, third, and so forth, based on their grade point average or test scores. The scale places events in order, but there is no attempt to make the intervals of the scale equal in terms of some rule (Kothari 2004). Ordinal scales allow us to say one value is more than another, but not by how much (Hubbard 2010). Thus, the central tendency measure of an ordinal scale can be its median or mode (Bhattacharjee 2012). Rank orders represent ordinal scales and are frequently used in research relating to qualitative phenomena (Kothari 2004).

The other measurement used to measure variables is the interval scale. Bhattacharjee (2012) describes interval scales as those where the values measured are not only rank-ordered, but are also equidistant from adjacent attributes. Interval scales can have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero or the unique origin (Kothari 2004). Interval scale allows us to examine “how much more” is one attribute when compared to another, which is not possible with nominal or ordinal scales (Bhattacharjee 2012). The primary limitation of the interval scale is the lack of a true zero; it does not have the capacity to measure the complete absence of a trait or characteristic (Kothari 2004). Allowed measures of central tendency include mean, median, or mode, as are measures of dispersion, such as range and standard deviation, other permissible statistical analyses include correlation, regression, analysis of variance, and so on (Bhattacharjee 2012).

The highest measurement used by researchers is ratio scale. Bhattacharjee (2012) describes ratio scales as those that have all the qualities of nominal, ordinal, and interval scales, and in addition, also have a “true zero” point (where the value zero implies lack or non-availability of the underlying construct). Kothari (2004) describes ratio scale to represent the actual amounts of variables. Age, height and weight are examples of ratio scales. All statistical techniques are usable with ratio scales and all manipulations that one can carry out with real numbers can also be carried out with ratio scale values, multiplication and division can be used with this scale but not with other scales mentioned above (Kothari 2004). Measurement starts with conceptualization where concepts and constructs to be measured are described (refer Section 2.3

of Chapter Two). After conceptualization meaning has to be made out of concepts and constructs through operationalization. Bhattacharjee (2012) defines operationalisation as the process of designing precise measures for abstract theoretical constructs. According to Creswell (2009), operationalisation starts with specifying an operational definition of the constructs of interest, then searching for literature for existing measures matching the operational definition that can be used directly or modified to measure the constructs of interest. When there is no measure or if any of the existing measures are poor or reflect a different conceptualization than that intended by the researcher, new instruments may have to be designed for measuring those constructs (Bhattacharjee 2012). When these stages are followed properly appropriate measures for constructs of interest are designed. However, it is important to consider the reliability and validity of the scales of measurement.

In the current study, AKS usage was the primary dependent variable. Demographic characteristics surrounding actors in AKS; their agricultural information needs; different factors influencing AKS usage; and agricultural knowledge sharing processes among actors were the independent variables. Other independent variables included role of ICTs in agriculture and government interventions. Constructs were then derived from these variables. Nominal scales were used to measure nominal data collected. Ordinal scales were used to measure AKS usage, agricultural information needs and measure the influence of different factors on AKS usage. Ordinal scales were also used to measure how agricultural knowledge sharing processes took place among actors, the impact of ICTs and government interventions on AKS usage. Likert scales were used for data intervals. Ratio scales were used to measure the influence of some quantitative information on AKS usage. Data analysis techniques used depended on the measurement scale used.

4.13 Data analysis

After data collection the processing and analysis of data followed. Kothari (2004) describes data processing to include editing, coding, classification and tabulation of collected data so that they are amenable to analysis. Analysis of data is a process of inspecting, cleaning, transforming, and modelling data with the goal of discovering useful information, suggesting conclusions, and

supporting decision making (Bihani and Patil 2014). The term analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data-groups (Kothari 2004). There are five stages of data analysis which are narrative, coding, interpretation, confirmation, and presentation (Bihani and Patil 2014). Data analysis helps in providing the critical link between good decision making and success; it is used for prediction and identification and for the rules of evidence for guiding the analysis by falsifiability, validity and parsimony (Bihani and Patil 2014). As described from sections 4.13.1 to 4.13.3, the current study employed various techniques in analyzing data.

4.13.1 Qualitative data analysis

Qualitative data consist of words and observations, not numbers and just like other types of data they require analysis and interpretation so as to bring order and understanding (Taylor-Powell and Renner 2003). Qualitative data analysis is the analysis of qualitative data such as text data from interview transcripts, the process is heavily dependent on the researcher's analytic and integrative skills and personal knowledge of the social context where the data is collected (Bhattacharjee 2012:113). Bhattacharjee describes further that the emphasis in qualitative analysis is "sense making" or understanding a phenomenon, rather than predicting or explaining.

Qualitative data in this study were analyzed by content analysis. This data analysis technique was selected because it was used for qualitative primary and secondary data. Content analysis involves counting the total number of (key) words used or the number of times a particular word is used either during a within-study or between-study literature analysis (Leech and Onwuegbuzie 2008). It involves a systematic analysis of the content of a text (e.g., who says what, to whom, why, and to what extent and with what effect) in a quantitative or qualitative manner (Bhattacharjee 2012:115).

4.13.2 Quantitative data analysis

Quantitative data involve numerical counts (Bhattacharjee 2012:119). They are data based on numbers. Quantitative data result from the quantification of information. The quantification of information involves no more than agreeing on techniques for mapping observations onto

numeric scales (Miller, Strang and Miller 2010). Krishnaswami (2002) categorizes quantitative data into ordinal, interval, ratio and as discrete and continuous data. Nominal data carry no quantitative information except that each possible value can be distinguished from the others (Miller *et al.* 2010). Among the data carrying quantitative information ordinal data is the lowest. Kothari (2004:70) describes ordinal data as the lowest level of the ordered data which places events in order, but have no attempt to make the intervals of the scale equal in terms of some rule. Interval data follows in order of rank; Bhattacharjee (2012:45) describes interval data as the one where the value measured is not only rank-ordered, but is also equidistant from adjacent attributes. Once they have a true zero, quantitative data are ratio data. Kothari (2004:72) describes ratio data to represent the actual amounts of variables. Numeric data collected in a research project can be analyzed quantitatively using statistical tools in two different ways namely descriptive and inferential analysis (Bhattacharjee 2012:119). Statistics is a set of procedures for gathering, measuring, classifying, computing, describing, synthesizing, analyzing and interpreting systematically acquired quantitative data (Jaggi 2003). Descriptive analysis refers to statistically describing, aggregating, and presenting the constructs of interest or associations between constructs (Bhattacharjee 2012:119). It helps to summarize large amount of data in a sensible way and reduces lot of data into a simpler summary (Jaggi 2003). Descriptive statistics deal with the measures of different aspects of population or distribution of the population values (Bickel and Lehmann 2012). Descriptive statistics employ numerical and graphic methods in presenting data (Jaggi 2003). Jaggi points further that numerical methods help to compute statistics such as the mean and standard deviation, the methods look at distribution, central tendency and dispersion.

The other statistical method employed in quantitative analysis is inferential analysis. Inferential analysis is concerned with the various tests of significance for testing hypotheses in order to determine with what validity data can be said to indicate some conclusion or conclusions (Kothari 2004:131). According to Byrne (2007), inferential statistics determine probability of characteristics of population based on the characteristics of the sample and help assess strength of the relationship between independent (causal) and dependent (effect) variables. Bhattacharjee (2012) describes this type of techniques to be used when drawing conclusions about associations between variables. Byrne (2007) describes that inferential statistics are used when the sample

size is large enough, there is complete list of the members of the population, and a random sample from this population has been drawn from the population. The technique is supported by statistical software such as Statistical Package for Social Sciences (SPSS Version 21.0).

Quantitative data collected through structured questionnaires were edited, classified, coded and tabulated to make them amenable to analysis. Coded data was then cleaned and analyzed using the Statistical Package for Social Sciences (SPSS). In this study, SPSS facilitated the generation of frequencies, percentages, forms and tables, which were used to present data statistically and graphically. Descriptive and inferential statistics drew generalizations, conclusions and identifying relationships existing between dependent and independent variables. It also facilitated the generation of associations and relationships between variables.

4.13.3 Secondary data analysis

The study collected data from existing documents (secondary data). These data may be found in reports, documentaries or other publications, they can be numeric or non-numeric (Smith and Smith 2008), and they may be censuses and organizational records. The major advantage of working with secondary data is economy: because someone else has already collected the data, the researcher does not have to devote resources to this phase of research (Vartanian 2010).

After identifying sources with secondary data it is important to collect and analyze it. Vartanian (2010) describes secondary data analysis as the process of re-analyzing data collected by others. According to Boslaugh (2007), when analyzing secondary data it is important to consider the purpose for which data was previously collected; to determine when, who and how data were collected; and assess how consistent is the data with other sources of information. Through content analysis data suitable for the current study were identified from pre-existing from publications.

4.14 Reliability and validity

Reliability and validity are used in connection with measurement of data (Bhattacharjee 2012). Sound measurement must meet the tests of validity and reliability; one has to consider them

when evaluating a measurement tool (Kothari 2004). A measure can be reliable but not valid, if it is measuring something very consistently but is consistently measuring the wrong construct; likewise, a measure can be valid but not reliable if it is measuring the right construct, but not doing so in a consistent manner (Bhattacharjee 2012). Kimberlin and Winterstein, (2008) describe the two as the key indicators of the quality of a measuring instrument are the reliability and validity of the measures. The following sections describe the two tests in details and how they were used in the current research.

4.14.1 Reliability in quantitative and qualitative research

Reliability is the degree to which the measure of a construct is consistent or dependable (Bhattacharjee 2012). It is the degree to which a measurement technique can be depended upon to secure consistent results upon repeated application (Weiner 2007). According to Kimberlin and Winterstein (2008), reliability estimates are used to evaluate the stability of measures administered at different times to the same individuals. Neuman (2006) categorizes reliability into representative, equivalence and stability reliability. Representative reliability deals with whether the indicator provides a similar response when applied to different groups or sub populations, equivalence reliability assesses whether the measure yields similar results across multiple indicators while stability reliability dwells on whether the measure present a uniform answer when applied in different time periods (Neuman 2006). Stability of measurement is determined by administering a test at two different points in time to the same individuals and determining the correlation or strength of association of the two sets of scores while interrater reliability establishes the equivalence of ratings obtained with an instrument when used by different observers (Kimberlin and Winterstein 2008). Kothari (2004) describes that internal consistency gives an estimate of the equivalence of sets of items from the same test. Reliability implies consistency but not accuracy (Bhattacharjee 2012).

Reliability in quantitative research differs from that in qualitative research (Cohen, Manion and Morrison 2007). In quantitative research reliability is evaluated through the degree to which a measurement, given repeatedly, remains the same; the stability of a measurement over time; and the similarity of measurements within a given time period (Golafshani 2003). According to

Cohen *et al.* (2007), reliability in quantitative research is concerned with replica-ability, demonstrability, objectivity, stability and consistency of measurements. It shows the accuracy and precision and equivalence. On the other hand, reliability in qualitative research is concerned with dependability, trustworthiness, stability and replica-ability (Cohen *et al.* 2007). Moreover, reliability in qualitative research is concerned with authenticity and conformability, comprehensiveness of situation, honesty and candour depth of response, credibility transferability, and consistency (Cohen *et al.* 2007).

In the current study, reliability of quantitative research was enhanced by having clearly defined constructs, using precise levels of measurement and using multiple indicators. Moreover, data collection tools developed were pre-tested to ensure accuracy and consistency. Zohrabi (2013) describes that pre-testing data collection tools is important for ensuring reliability. The study also ensured reliability through asking the same questions to all respondents, in the same way they are worded for ensuring consistency. The current study also involved a large sample size to maximize reliability. Reliability of qualitative research was improved by using credible sources of data; triangulation; familiarity with the culture of participating organizations and actors; and employing purposive and random sampling of individuals to serve as informants.

4.14.2 Validity in quantitative and qualitative research

Validity refers to the extent to which a test measures what is actually intended to be measured (Kothari 2004). Validity is often defined as the extent to which an instrument measures what it purports to measure (Kimberlin and Winterstein 2008). It determines whether the research truly measures that which it was intended to measure or how truthful the research results are Golafshani (2003). Validity requires that an instrument is reliable, but an instrument can be reliable without being valid (Kimberlin and Winterstein 2008). It is concerned with the meaningfulness of research components; when researchers measure behaviours, they are concerned with whether they are measuring what they intended to measure (Drost 2011). Validity can be assessed using theoretical or empirical approaches, and should ideally be measured using both approaches. Theoretical assessment of validity focuses on how well the idea of a theoretical construct is translated into an operational measure while empirical assessment of

validity examines how well a given measure relates to one or more external criterion, based on empirical observations (Bhattacharjee 2012).

There are several ways of categorizing validity but the best way is to categorize them according to their role in research. Scholars (Bhattacharjee 2012; Drost 2011; Kimberlin and Winterstein 2008; Kothari 2004; Golafshani 2003) categorize validity into construct validity, criterion-related validity, internal and external validity, face validity, content validity and statistical validity. Details of each and how each type of validity was used in the current study are described in subsections 4.14.2.1 to 4.14.2.7.

4.14.2.1 Construct validity

Construct validity refers to the extent to which a measure adequately represents the underlying construct that it is supposed to measure (Bhattacharjee 2012). Kothari (2004) defines it as the degree to which scores on a test can be accounted for by the explanatory constructs of a sound theory. This type of validity is a judgment based on the accumulation of evidence from numerous studies using a specific measuring instrument (Kimberlin and Winterstein 2008). Westen and Rosenthal (2003) describe construct validity as an estimate of the extent to which variance in the measure reflects variance in the underlying construct. Construct validity pertains to the accuracy of the instruments for data collection and how well the results measured fit the theories being tested (Cohen *et al.* 2007). Evaluation of construct validity requires examining the relationship of the measure being evaluated with variables known to be related or theoretically related to the construct measured by the instrument (Kimberlin and Winterstein 2008).

In the current study, construct validity was addressed by presenting the operational definitions of variables and keywords under Section 1.8 of Chapter One. Construct validity was also addressed by constructing unambiguous and smart questions while preparing data collection tools. According to Westen and Rosenthal (2003), such questions can easily predict the magnitude of correlations between a single predictor variable and multiple criterion variables. Furthermore, construct validity was enhanced through increasing the coverage of questions in the measuring instruments. This enabled the researcher to measure each variable that it was easy to determine the correlation existing between variables. Moreover, the study used different sources of

evidence; this also helped in validating the construct. Triangulation was also used to address construct validity. According to Kothari (2004), triangulation involves the use of different research approaches and techniques. Construct validity was also addressed through pre-testing data collection tools. Lastly, the use of multiple theories/models was also used in order to address construct validity.

4.14.2.2 Criterion-related validity

Criterion-related validity relates to the ability to predict some outcome or estimate the existence of some current condition, it reflects the success of measures used for some empirical estimating purpose (Kothari 2004). This type of validity provides evidence about how well scores on the new measure correlate with other measures of the same construct or very similar underlying constructs that theoretically should be related (Kimberlin and Winterstein 2008). Through this type of validity there are some criteria which are adopted to assess of success of the measure. Kothari (2004) validity is assessed through relevance (a criterion is relevant if it is defined in the terms judged to be the proper measure); freedom from bias (freedom from bias is attained when the criterion gives each subject an equal opportunity to score well); reliability (a reliable criterion is stable or reproducible); and availability (the information specified by the criterion must be available). The current study addressed criterion-related validity through triangulation of data collection tools and data collection methods. The study employed structured questionnaire, key informant interview checklist, focus group discussion guide and documentary review guide in collecting both primary and secondary data.

4.14.2.3 Internal validity

Internal validity examines whether the observed change in a dependent variable is indeed caused by a corresponding change in hypothesized independent variable, and not by variables extraneous to the research context (Bhattacharjee 2012). Internal validity determines whether the dependent variable is really influenced by a change in the independent variable. Bhattacharjee (2012) points out that causality requires three conditions namely the co-variation of cause and effect (that is if cause happens, then effect also happens; and if cause does not happen, effect

does not happen), temporal precedence (cause must precede effect in time) and no plausible alternative explanation (or spurious correlation).

There are different threats to internal validity, Bergh, Hanke, Balkundi, Brown and Chen (2004) mention history, maturation, testing, instrumentation, statistical regression, selection, and ambiguity about the direction of the causal influence to be the main threats to internal validity. History threat is the possibility that the observed effects (dependent variables) are caused by extraneous or historical events rather than by the experimental treatment (Bhattacharjee 2012). The other threat is maturation, Bergh *et al.* (2004) describe maturation threat to be the possibility that observed effects are caused by natural maturation of subjects rather than the experimental treatment.

The other threat to internal validity, testing validity is about how familiarity with a test can sometimes affect responses to subsequent administration of the test; it is a threat to internal validity when an effect might be due to the number of times particular responses are measured (Bergh *et al.* 2004). To limit the threat, researchers must control the gain or loss associated with testing. The fourth testing to internal validity is the instrumentation threat. Bhattacharjee (2012) describes that instrumentation threat is created when either a measuring instrument is changed or when the observers or scorers change over the course of the study. Instrumentation threat can be ruled out by employing mixed instruments and adopting more structured data collection tools. The other threat to internal validity is the mortality threat; Bergh *et al.* (2004) describe it to occur when some subjects drop out of the study. Bergh *et al.* (2004) point out further that due to such drop outs artifacts may be selected to replace. The other threat to internal validity is the statistical regression threat. According to Bergh *et al.* (2004) and Bhattacharjee (2012), statistical regression is a threat to internal validity when changes in values are associated with a regression toward the mean effect, this occurs when study subjects are chosen on the basis of extreme scores. Statistical regression threat can be ruled out by applying randomization techniques during sampling.

Validity can also be threatened by the selection of the sample. Selection threat to validity can arise when study subjects are selected because they possess a characteristic that is related to the

independent or dependent variables (Bergh *et al.* 2004). Selection threat to validity can be ruled out through employing random sampling techniques during data collection. The other type of threat to validity is the ambiguity about direction of causal inference. Bhattacharjee (2012) describes this threat to arise when the temporal precedence or antecedence among relationships is unclear that it prevents researchers from knowing which variable causes which effects and can lead to tautologies in the interpretation of the findings. Through this threat the researcher cannot tell which variable affects the other. Ambiguity about the direction of influence may be more common in natural science studies.

In this study, internal validity for quantitative data was improved by employing random sampling techniques and through pre-testing data collection tools and research methods. For qualitative data, internal validity was improved by asking the same questions to all informants involved in interviews; using different sources of data to get similar information; and employing purposive sampling for selecting key informants.

4.14.2.4 External validity

External validity refers to whether the observed associations can be generalized from the sample to the population (population validity), or to other people, organizations, contexts, or time (Bergh *et al.* 2004). It describes whether causal relationships can be generalized to different measures, persons, settings, and times (Bhattacharjee 2012). Kothari (2004) describes external validity of research findings as the generalisability to populations, settings, treatment variables and measurement variables. It describes the degree to which results of empirical investigation can be generalized to the population. Generalizing to well-explained target populations should be clearly differentiated from generalizing across populations (Drost 2011). Survey research, where data is sourced from a wide variety of individuals, firms, or other units of analysis, tends to have broader generalisability than laboratory experiments (Bhattacharjee 2012).

There are two types of external validity namely population validity and ecological validity (Bracht and Glass 1968). Under population validity there are two types of population, the total population and the target population. Bracht and Glass (1968) describe total population as the population of subjects that are available to the researcher for the study while the target

population is the total group of subjects about whom the researcher is empirically attempting to learn something. Bracht and Glass state further that the process of generalizing the results from the sample of subjects to a population is known as statistical inference. Under population validity, external validity is improved by employing random sampling while selecting the sample. With regards to ecological validity, Bracht and Glass (1968) describe it as to whether the generalized results in a particular environment can be generalized under another environment. Ecological validity examines whether a causal relationship obtained in one setting can be generalized to another (Drost 2011).

In the current study, external validity was improved through involving a large sample size of respondents from the selected study area. This was done so as to make sure that the sample was a really representation of the entire population. Moreover, random selection of respondents was employed so as to increase external validity. Random sampling technique was the major sampling technique employed.

4.14.2.5 Face validity

Face validity refers to whether an indicator seems to be a reasonable measure of its underlying construct (Bhattacharjee 2012). Face validity is a subjective judgment on the operationalisation of a construct (Drost 2011). Even though subjective judgment is needed throughout the research process, the aforementioned method of validation is not very convincing to others as a valid judgment (Drost op. cit). The current study employed a pre-tested structured questionnaire as the main data collection tool. This aimed at increasing face validity. Moreover, face validity was improved by selecting respondents according to pre-set criteria.

4.14.2.6 Content validity

Content validity is the qualitative type of validity where the domain of the concept is made clear and the analyst judges whether the measures fully represent the domain (Drost 2011). It is an assessment of how well a set of scale items matches with the relevant content domain of the construct that it is trying to measure (Bhattacharjee 2012). Content validity is a qualitative means of ensuring that indicators tap the meaning of a concept as defined by the researcher (Drost

2011). There are basically two ways of assessing content validity: (i) ask a number of questions about the instrument or test; and/or (ii) ask the opinion of expert judges in the field (Drost 2011). The current study addressed content validity by defining all key concepts used in the study, developing detailed research questions, selecting appropriate respondents with adequate knowledge to respond to questions, and using appropriate techniques to selected respondents.

4.14.2.7 Statistical validity

Statistical validity is the type of validity that is quantitatively determined (Berg and Latin 2008). It is the degree to which the experiment's results rest on appropriate and thorough use of statistical analysis (Stausberg and Engler 2013). It examines the extent to which conclusions derived using a statistical procedure is valid (Bhattacharjee 2012). It examines whether the right statistical method was used for hypotheses testing, whether the variables used meet the assumptions of that statistical test (such as sample size or distributional requirements), and so forth (Bhattacharjee 2012). Statistical validity was improved through involving a large sample size and employing appropriate statistical tests and procedures in analyzing data.

4.15 Ethical considerations

Research ethics are codes or guidelines that help reconcile value conflicts (Gillespie 1995). Ethical consideration in research is important so as to avoid harm to any part involved in the research activity. In the current study the following were considered: adherence to standards set by the Commission of Science and Technology in Tanzania; protecting confidentiality of participants; obtaining informed consent from the respondents; giving credit to research associates who provided direct evidence; and placing a high value on intellectual honesty. The study also observed the ethical issues stipulated in the Policy on Research Ethics of the University of South Africa of the year 2007. As stipulated by UNISA (2007); ethical considerations must apply to all stages of a research activity. It was for this reason the current study had to be cleared by the university before embarking into data collection. Moreover, ethical considerations were maintained from data collection, data coding and interpretation, report writing and final dissemination of the report.

4.16 Research evaluation

The research activities for the current study involved different phases including: pre-testing the data collection tools, refining data collection tools, field data collection, data coding, data cleaning and analysis. These activities were conducted after granting a clearance approval for the study as required by the UNISA's Policy on Research Ethics of the year 2007. In Tanzania one has to access a research permit before embarking into the actual field work. The permit was granted and actual data collection activities started in September through November 2015. It was the same time several activities for the year 2015 general election took place. Due to general election campaigns it was difficult to reach some villages as ward executives who were to host the research team were preoccupied with activities related to general elections. It was for this reason data collection in some villages was to be postponed for some weeks. Moreover, due to general election campaigns, there might be few chances of political or ideological inclination among some respondents thus affecting the responses expected.

Data collection in rural areas required translating the research instruments from English to the Swahili language. This might have led to unintended errors as a result of the translation process or due to inadequate technical terms in Swahili. Despite this challenge the level cooperation from different authorities and respondents was very good throughout the data collection phase that adequate data for the study were collected. The response rate from respondents was high as it was more than 87%. Involving a larger sample for this study was important for increasing the validity and reliability of the findings of the study. Generally, the entire research was very successful.

4.17 Chapter summary

The Chapter presents research methodology adopted by the study. It starts by introducing the importance of research methodology and describes the various stages of the research process. The Chapter elaborates the research approaches adopted by the current study and reasons for adoption. It then discusses reasons for conducting the current study. The Chapter also discusses research design and sample design adopted by the current study. This is followed by introducing the selection of the study area, population for the study and sampling strategies. The Chapter also

describes the research strategy used in gathering information. It gives reasons for adopting surveys and document reviews for gathering information. The Chapter discusses why a pilot study is conducted, where and how it was done. The Chapter gives details of data collection methods, it describes about the tools adopted in data collection and the measurement scales used. It gives details of how collected data was analyzed. The chapter describes the reliability and validity, the ethical considerations, and lastly the scope of the study. It ends by evaluating the entire research activity. The following chapter presents the key research findings of the study.

CHAPTER FIVE

PRESENTATION OF RESEARCH FINDINGS

5.1 Introduction

Having applied the research methodology, this Chapter presents the results generated from the survey, interviews, focus group discussions and structured records review as described in the previous chapter. Presentation of the research findings is important because it shows what has been found after collecting and analyzing data. It also shows how the knowledge gaps identified through literature review can be filled. Presented research findings form an important ground for assessing similarities and differences of the current results with those from previous related studies. Moreover, presenting research findings is necessary as it helps to give the meaning of the data collected through creating associations among variables of interest. When presenting findings, results from different research approaches are integrated to ease the interpretation process. In this chapter, the results are presented according to themes based on the research questions listed below:

- i. Which types of AKS are used in the study area?
- ii. What categories of knowledge do actors in AKS need?
- iii. Which factors hinder access to agricultural knowledge among actors in AKS?
- iv. How is agricultural knowledge shared among actors forming the AKS?
- v. How ICTs support agricultural knowledge management and AKS?
- vi. What roles are played by the Government in enhancing access to and use of AKS?
- vii. What are the significant variables that influence AKS usage among actors?

The current chapter starts by presenting the profile of respondents in section 5.1; it is followed by the presentation of findings which is guided by the research questions listed above. The Chapter presents both quantitative and qualitative findings. Since not all respondents responded

to all questions, in certain circumstances the reported results are based on responded cases only. Thus, in such cases results indicate the percentage of the actual respondents to a particular question rather than the percentage of the total sample.

The study employed a structured questionnaire, interview guide, focus group discussion guide and a structured document review for collecting data. When both tools were used, the findings from the questionnaire are reported first followed by those from other tools. Findings from review of documents are presented last. In a few cases and only when necessary results from both or some of the tools are presented together. After presenting the findings, a summary of the whole chapter is given.

5.2 Profile of the respondents

The study targeted 362 farmers, 12 agricultural extension agents, nine ward councillors and nine village executives. It also targeted three agricultural researchers, nine buyers, nine input suppliers and six other agricultural information providers. The study also involved 24 other participants for focus group discussions selected among farmers. Among the 362 farmers selected for the study 314 (87%) of them were involved in the surveys. Due to several reasons, 48 (13%) farmers included in the sample did not participate in the surveys. The distribution of the 314 farmers by their demographic characteristics is summarized in Tables 5.2.1 to 5.2.6.

5.2.1 Distribution of farmers by age

Both male and female farmers were selected for the study. Findings in Table 5.1 indicate that 161(51.3%) of the farmers were female and 153 (48.7%) were male making a total of 314 farmers (which is 87% of the target sample size).

Table 5.1: Frequency distribution of farmers by sex and age group (N=314)

Age group of the respondent	Sex of the respondent		Total
	Male	Female	
15 to 25	10	12	22 (7.0%)
26 to 35	39	40	79 (25.2%)
36 to 45	40	40	80 (25.5%)
46 to 55	24	18	42 (13.4%)
56 to 65	40	51	91 (28.9%)
Total	153 (48.7%)	161 (51.3%)	314 (100%)

The distribution by age shows that 22 (7.0%) of the respondents were aged between 15–25 years; 79 (25.2%) were between 26-35 years; 80 (25.5%) were between 36-45 years; 42 (13.4%) were between 46-55 years; and 91 (28.9%) were between 56-65 years. Findings in Table 5.1 show that more farmers (28.9%) were between 56-65 years while fewer (7.0%) were between 15-25 years.

5.2.2 Level of education of farmers

Findings in Table 5.2 show that farmers involved in the study had informal to secondary level of education. Majority of the farmers (220, 70.1%) had primary education; others (42, 13.4%) had secondary education; others (38, 12.1%) had informal education; few (14, 4.5%) had adult education; while none had tertiary education.

Table 5.2: Level of education of farmers by sex (N=314)

Sex of the respondent	Level of education of the respondent				Total
	Informal education	Adult education	Primary education	Secondary education	
Male	7 (4.6%)	7 (4.6%)	112 (73.2%)	27 (17.6%)	153 (48.7%)
Female	31 (19.3%)	7 (4.3%)	108 (67.1%)	15 (9.3%)	161 (51.3%)
Total	38 (12.1%)	14 (4.5%)	220 (70.1%)	42 (13.4%)	314 (100%)

With respect to level of education by sex of respondent, findings indicate that 112 (73.2%) male farmers as opposed to 108 (67.1%) female farmers had primary education; and 27 (17.6%) male farmers as opposed to 15 (9.3%) female farmers had secondary education. Findings also indicate that seven (4.6%) of the male farmers as opposed to seven (4.3%) of the female farmers had

adult education; and the other seven (4.6%) male farmers as opposed to 31 (19.3%) female farmers had informal education.

5.2.3 Household size of farmers by their marital status

The study involved farmers from households with different household sizes. Farmers also differed in terms of marital status. Some were single (with and without children and dependants), others were either married, divorced or widows. Table 5.3 shows the household size of farmers involved in the study. Findings indicate that 95 (30.3%) farmers were from households with one to three members; 151(48.1%) were from households with four to six members; 53 (16.9%) were from households with seven to nine members; and 15 (4.8%) farmers from households with 10 or more members.

Table 5.3: Household size by marital status of farmer (N=314)

Household size	Marital status				Total
	Single	Married	Widow	Divorced	
1 to 3	32 (51.6%)	58 (26.1%)	4 (17.4%)	1 (14.3%)	95 (30.3%)
4 to 6	23 (37.1%)	110 (49.5%)	13 (56.5%)	5 (71.4%)	151 (48.1%)
7 to 9	5 (8.1%)	42 (18.9%)	5 (21.7%)	1 (14.3%)	53 (16.9%)
≥10	2 (3.2%)	12 (5.4%)	1 (4.3%)	0 (0.0%)	15 (4.8%)
Total	62 (19.8%)	222 (70.7%)	23 (7.3%)	7 (2.2%)	314 (100%)

Table 5.3 indicates further that 62 (19.8%) farmers were from single parent households, 222 (70.7%) from married couples; 23 (7.3%) from widowed; and seven (2.2%) from divorced households. Findings reveal that most farmers were from married couples. Since communities in the three districts followed a patriarch system then most of the households involved in the study were headed by males.

5.2.4 Experience of farmers in agricultural activities

Experience in agricultural activities differed from one farmer to the other. Farmers differed also in terms of years one has involved himself or herself in agricultural activities. Table 5.4

summarizes the frequency distribution of farmers against years one has been involved in agricultural activities.

Table 5.4: Years farmers involved in agricultural activities (N=314)

Years in agricultural activities	Frequency
1 to 5	60 (19.1%)
6 to 10	60 (19.1%)
11 to 15	40 (12.7%)
16 to 20	40 (12.7%)
21 to 25	27 (8.6%)
26 to 30	30 (9.6%)
> 30	57 (18.2%)
Total	314 (100%)

Findings in Table 5.4 show that 60 (19.1%) of the farmers had 1-5 years in agriculture; 60 (19.1%) had 6-10 years; 40 (12.7%) had 11-15 years; and 40 (12.7%) had 16-20 years. Findings also indicate that 27 (8.6%) of the farmers had 21-25 years in agriculture; 30 (9.6%) had 26-30 years; and 57 (18.2%) had more than thirty years in agriculture.

5.2.5 Major crops grown and average yield per acre

Farmers in the study area grew different crops; major crops grown were maize and paddy. They grew one of the two or both. Findings in Table 5.5 give a summary of the frequency of farmers against each crop and farm size. It was found that paddy was mainly grown in Kilombero District as among 109 farmers, 93 (85.3%) grew paddy while 40 (36.7%) grew maize. Maize was found to be a dominant crop in Kilosa District as 80 (86.0%) farmers grew maize while 53 (57.3%) grew paddy. In Mvomero District majority of the farmers grew both crops, it was found that 98 (87.5%) of the farmers grew maize while others (82, 73.2%) grew paddy.

Table 5.5: Crops cultivated and average acreage by frequency of farmers for each crop

District	Crop type	
	Maize	Paddy
Kilombero	40 (36.7%)	93 (85.3%)
Kilosa	80 (86.0%)	53 (57%)
Mvomero	98 (87.5%)	82 (73.2%)
Farm size	Frequency of farmers per farm size per crop grown	
	Maize	Paddy
<1	7 (3.2%)	7 (3.1%)
1 to 2	85 (39%)	98 (43%)
3 to 5	85 (39%)	86 (37.7%)
6 to 9	20 (9.2%)	18 (7.9%)
≥10	21 (9.6%)	19 (8.3%)
Total	218 (100%)	228 (100%)

Results indicate that 228 farmers cultivated paddy as one of their major crops while 218 cultivated maize as one of the major crops. It is found from Table 5.5 that seven (3.2%) farmers cultivated less than an acre of maize; 85 (39%) farmers had 1-2 acres of maize; 85 (39%) had 3-5 acres of maize; 20 (9.2%) had 6-9 acres of maize; and 21 (9.6%) had more than ten acres of maize. Moreover, seven (3.1%) of the farmers cultivated less than one acre of paddy; 98 (43%) had 1-2 acres of paddy; 86 (37.7%) had 3-5 acres; 18 (7.9%) had 6-9; and 19 (8.3%) had more than ten acres of paddy.

5.2.6 Yield of major crops cultivated

Yield of the two major crops varied from one farmer to the other. Table 5.6 summarizes the average yield of the two major crops cultivated in the study area. The yield of both maize and paddy ranged from one to 30 bags of 100kg per acre. Among maize growers, 171 (78.4%) of the farmers harvested between one and 10 bags of maize per acre; 38 (17.4%) harvested between 11 and 20 bags; and nine (4.1%) farmers harvested between 21 and 30 bags of maize per acre.

Table 5.6: Average yield of major crops grown (N=314)

Average yield per acre (in 100 kg bags)	Frequency of farmers at each level of yield per acre	
	Maize	Paddy
1 to 10	171 (78.4%)	131 (57.5%)
11 to 20	38 (17.4%)	54 (23.7%)
21 to 30	9 (4.1%)	43 (18.9%)
Total	218 (100%)	228 (100%)

Among paddy growers, 131 (57.5%) of the farmers harvested between one and 10 bags of paddy per acre; 54 (23.7%) harvested between 11 and 20 bags; and 43 (19.9%) harvested between 21 and 30 bags. Generally, the yield of both maize and paddy ranged from one to 10 bags of 100kgs per acre.

5.3 Types of AKS used in the study area

It was found that actors in the agricultural sector used multiple AKS in their agricultural activities. Among the farmers, findings indicate that 310 (98.7%) farmers used human based system (see Table 5.28 on page 185 for details). With human based system, farmers acquired agricultural knowledge through experience, stored it through human memory and shared acquired knowledge through face to face oral communication. Results indicate that 231 (73.6%) farmers used ICT based system (see Table 5.28 on page 185 for details). ICTs used were mainly radio and TV sets, and mobile phones. Moreover, 39 (12.4%) farmers used paper based system (see Table 5.28 on page 185 for details). It was found that very few farmers mentioned to use one type of AKS, those using only one mentioned to use human based systems.

Among actors other than farmers, findings reveal that both human based, paper based and ICT based system were used. Choice of the AKS to be used was influenced by type and location of the recipient.

5.3.1 Major actors in AKS

Findings from focus group discussions and interviews indicate that there were three broad categories of actors in AKS; these were the farmers, government and the private sector. In the government sub-category there were: village and ward agricultural extension officers; village executives; ward executives; and councillors. Others were agricultural research institutes and the DAICO office. The private sector sub-category had more actors including: input suppliers; buyers of agricultural produce; and media (radio TV stations). There were also mobile phone operators; local and international NGOs; and several private companies implementing several agricultural interventions. Other actors under the private sector sub-category were warehouse operators and millers. Farmers were either found as individual farmers, in farmers' groups or in farmers' associations. Some villages had farmers who received intensive trainings that they may train fellow farmers.

5.3.2 Roles played by actors in AKS

The Government is the main actor in agricultural development in the study area. It was found that through village and ward executives the government managed all issues related to socio, cultural, economic and security issues in villages. Village executives were responsible for the distribution of subsidized agricultural inputs to farmers. Findings indicate that village and ward agricultural extension officers provided agricultural extension services to farmers. Councillors represented farmers and other villagers to district councils where all developmental issues were discussed and decided before being implemented. The DAICO office coordinated all issues related to agriculture (crops), irrigation and cooperatives in the district, the office also maintain good public private partnership with the private sector involved in agriculture in the district. Agricultural research institutes created new knowledge, developments and technologies farmers could need for increasing productivity. The Government established agricultural research institutes in different areas specializing in crops cultivated in relevant areas. This aimed at making it easier for solving area/zone specific problems being faced by farmers.

Roles played by actors from the private sector differed from one actor to the other. Findings indicate that input suppliers run agro-shops selling agricultural inputs to farmers. Almost each

village had an agro-shop and some villages had more than two. Agro-shops had standby attendants selling agricultural inputs to farmers. It was found that few of them had agriculture related backgrounds. Findings indicate further that in each district there was an umbrella organization for managing input suppliers' rights and making sure that each operated in the defined geographical areas. The other actors were buyers of agricultural produce/products whose only role was realized after harvest. They bought harvests and were the source of income to farmers. Warehouse operators stored harvest before or after sale, few village governments had such facilities but in most case private operators owned them. In most cases most warehouses had milling machines for processing farm produce. Farmers decided to either process harvest before selling or sell unprocessed produce. Radio and TV stations broadcasted some agricultural programmes to farmers. These stations had either district or national coverage, farmers mentioned to access broadcasts from their villages. Moreover, there were mobile phone operators providing mobile phone services to farmers. Few of the operators had some specific value added agriculture services provided together with the general mobile phone services.

NGOs were among actors in the private sector. It was found that there were many NGOs operating in the study area. Findings indicate that NGOs provided several services including agricultural extension and education services to farmers; mobilizing farmers into groups; and post-harvest handling through agricultural processing. Findings indicate that other NGOs worked with agricultural research institutes in conducting agricultural research activities while others mobilized farmers to form savings and credits associations. Private companies on the other hand were mainly concerned with seed multiplication and distribution.

Farmers were the main aim of most of the implemented interventions. They formed farmers' groups that they could easily access agricultural extension and education services from providers. Farmers also formed farmers' associations so that they could easily get services, increase bargaining power and sometimes be able to sell their produce/products directly to markets in major towns or abroad. They were also mobilized to form savings and credit associations so that they could easily get capital for their agricultural activities. The Government and NGOs conducted training of trainers among farmers, those trained had to train other farmers (trained farmers who trained others were named as village based agricultural advisors).

5.3.3 Linkages among actors in AKS

Findings indicate that actors in AKS were poorly linked together. It was found that most of the villages involved in the study were found near research institutes but very few farmers mentioned to have acquired agricultural knowledge directly from agricultural research institutes (see Table 5.11 on page 160, 5.12 on page 162 and 5.19 on page 175 for details). Agricultural extension officers involved in the study also mentioned to have limited linkages with agricultural research institutes. It was found that each agricultural zone in Tanzania was linked to agricultural research institutes through a selected zone agricultural extension officer whose main role was to share agricultural research needs to research institutes and research outputs to farmers and other actors. Each district had an officer linking the district and the zonal agricultural extension office. This agricultural research outputs were shared to farmers through village/ward agricultural extension officers. Due to the very low agricultural extension officer to farmers ratio, very few farmers had opportunities to present agricultural related problems or access agricultural research outputs from agricultural research institutes through agricultural extension officers. Thus, this strategy left actors from the two ends not linked together.

It was found that there were no structured agricultural markets or agricultural market information systems used by farmers or other actors. Buyers visited farmers' households so as to buy harvests. It was found that villages had meetings involving all villagers scheduled at certain intervals. Findings on Table 5.15 on page 169 indicate that villages meetings did not put much consideration in agricultural related issues. Moreover, there were several agricultural programmes broadcasted through radio and TV sets. However, most of these programmes were aired during odd hours. Furthermore, farmers mentioned that they failed to put into use some of the acquired agricultural knowledge because agricultural inputs were either not available or lately delivered.

5.4 Categories of agricultural knowledge acquired by actors in AKS

AKS actors acquired agricultural knowledge for agricultural activities they involved themselves in. Findings in Table 5.7 show that farmers acquired agricultural knowledge related to weather, farm preparation, seed selection techniques, seed sowing techniques and crop maintenance. They

also acquired agricultural knowledge related to post-harvest practices, agricultural marketing and agricultural credits.

Table 5.7: Categories of agricultural knowledge acquired by farmers (N=314)

Category of agricultural knowledge acquired	Frequency distribution
Weather	213 (67.8%)
Farm preparation	83 (26.4%)
Seed selection techniques	281 (89.5%)
Seed sowing techniques	83 (26.4%)
Crop maintenance	211 (67.2%)
Post-harvest practices	112 (35.7%)
Agricultural marketing	109 (34.7%)
Agricultural credits	38 (12.1%)

It is shown in Table 5.7 that 213 (67.8%) of the farmers acquired knowledge about weather; 83 (26.4%) acquired knowledge about farm preparation; 281 (89.5%) acquired knowledge about seed selection techniques; 83 (26.4%) acquired knowledge about seed sowing techniques; and 211 (67.2%) acquired knowledge about crop maintenance. Findings show further that 112 (35.7%) of the farmers acquired knowledge about post-harvest practices; 109 (34.7%) acquired knowledge about agricultural marketing; and 38 (12.1%) farmers acquired agricultural knowledge about agricultural credits. This indicates that knowledge about seed selection, weather and crop maintenance was acquired by most farmers because more than two thirds of the respondents acquired these categories of knowledge. On the other hand, knowledge about agricultural credits was least acquired by respondents.

Findings from focus group discussions were similar to those from the main survey. Those involved in key informant interviews revealed that they acquired agricultural knowledge related to their key roles. Agricultural extension officers acquired all categories of agricultural knowledge because farmers had varied agricultural knowledge needs. Village executives were mainly concerned with the distribution of subsidized inputs so they had more information on subsidized inputs. Input suppliers acquired knowledge on agricultural inputs; buyers acquired knowledge on quality of produce, storage and handling. Employees of NGOs mentioned to

acquire different categories of agricultural knowledge related to their core functions in agriculture. The core role of radio and TV stations was communicating, so they worked closely with other actors in performing their roles. Despite performing a communication role, some mobile phone operators provided agricultural value added services to farmers and other actors. In order to provide such services it was important for them to acquire all categories of agricultural knowledge.

5.4.1 Frequency of acquiring of different categories of agricultural knowledge

Respondents were asked about the frequency of acquiring different categories of agricultural knowledge mentioned in section 5.4. As shown in Table 5.8, some categories of agricultural knowledge were acquired “*very frequently*”, others “*frequently*”, some “*infrequently*” and others “*not acquired at all*”. It was found that 211 (67.2%) of the farmers acquired knowledge about weather. Among them, 147 (46.8%) mentioned to have been acquiring it very frequently; 44 (14%) acquired it frequently; and 20 (6.4%) farmers mentioned to have been acquiring it infrequently. Findings indicate further that 103 (32.8%) of all farmers involved in the study did not acquire knowledge on weather at all. Findings indicate further that 83 (26.4%) acquired knowledge on farm preparation techniques. However, none of the farmers mentioned to have been acquiring this category of agricultural knowledge very frequently; 35 (11.1%) farmers acquired this category of agricultural knowledge frequently; 48 acquired it infrequently; and 231 (73.6%) did not acquire it at all.

As shown in Table 5.8, most farmers acquired knowledge on seed selection techniques as only 30 (9.6%) did not acquire knowledge from this category. Among those who acquired, 131 (41.7%) of the farmers acquired it very frequently; 137 (43.6%) acquired it frequently; and 16 (5.1%) acquired it infrequently. Among those who acquired knowledge on seed sowing techniques, it was found that none acquired it very frequently; 38 (12.1%) farmers acquired it frequently; 45 (45.3%) acquired it infrequently while 231 (73.6%) of the farmers did not acquire it at all.

Table 5.8: Frequency of acquiring different categories of agricultural knowledge (N=314)

Agricultural knowledge category	Frequency of acquiring knowledge			
	Very frequently	Frequently	Infrequently	Not at all
Weather	147 (46.8%)	44 (14%)	20 (6.4%)	103 (32.8%)
Farm preparation	0.0 (0.0%)	35 (11.15%)	48 (15.3%)	231 (73.6%)
Seed selection techniques	131 (41.7%)	137 (43.6%)	16 (5.1%)	30 (9.6%)
Seed sowing techniques	0.0 (0.0%)	38 (12.1%)	45 (14.3%)	231 (73.6%)
Crop maintenance	105 (33.4%)	83 (26.4)	27 (8.6%)	99 (31.5%)
Post-harvest practices	18 (5.7%)	49 (15.6%)	47 (15%)	200 (63.7%)
Agricultural marketing	26 (8.3%)	36 (11.5%)	51 (16.2%)	201 (64%)
Agricultural credits	3 (1.0%)	11 (3.5%)	29 (9.2%)	271 (86.3%)

Findings in Table 5.8 indicate that 215 (68.5%) of the farmers acquired knowledge about crop maintenance. Among them, 105 (33.4%) acquired it very frequently; 83 (26.4%) acquired it frequently; and 27 (8.6%) acquired it infrequently. Table 5.8 indicates that 99 (31.5%) of the farmers did not acquire knowledge about crop maintenance at all.

Knowledge about post-harvest practices was acquired by 114 (36.3%) of the farmers, among them 18 (5.7%) acquired such knowledge very frequently; 49 (15.6%) acquired it frequently; and 47 (15%) acquired it infrequently. It was found that 200 (63.7%) of the farmers did not acquire knowledge about post-harvest practices at all. Table 5.8 indicates further that 113 (36%) farmers acquired knowledge on agricultural marketing. Among those acquiring knowledge on agricultural marketing, 26 (8.3%) acquired it very frequently; 36 (11.5%) acquired it frequently; and 51 (16.2%) farmers acquired it infrequently. Findings show that 201 (64%) of farmers did not acquire it at all. The last category of agricultural knowledge acquired by farmers was agricultural credits. However, few farmers acquired this category of knowledge as only three (1.0%) farmers acquired it very frequently; others (11, 3.5%) acquired it frequently; and 29 (9.2%) acquired it infrequently while majority (271, 86.3%) of farmers did not acquire it at all.

Findings from focus group discussions indicate that the level of acquisition of different categories of agricultural knowledge related to findings from the main survey. It was found that farmers mentioned to have been acquiring frequently agricultural knowledge related to weather

and seeds. It was found that majority of farmers did not acquire knowledge related to farm preparation, seed sowing techniques, post-harvest practices, agricultural marketing and agricultural credits.

Results from key informant interviews indicate that different AKS actors acquired agricultural knowledge at different levels. It was found that agricultural extension officers frequently acquired different categories of agricultural knowledge because farmers had different agricultural knowledge needs. Agricultural input-suppliers acquired knowledge on agricultural inputs and on techniques for marketing agricultural inputs. It was also found that buyers acquired knowledge related to post-harvest handling, marketing and processing of agricultural produce. NGOs involved in the study provided different agricultural services to agricultural value chain actors. It was for this reason employees from NGOs mentioned to frequently acquire knowledge on weather, land preparation, agricultural inputs, crop maintenance, post-harvest practices, agricultural marketing systems, agricultural processing, and savings and credits. Councillors and village executives mentioned to frequently acquire knowledge on subsidies of agricultural inputs. Mobile phone operators provided agricultural information services, for this case they frequently acquired different categories of agricultural knowledge. Warehouse operators stored harvests and some owned millers. They needed knowledge related to post-harvest handling, and processing of agricultural produce. Lastly, agricultural researchers reported to frequently acquire agricultural knowledge related crop maintenance, agricultural inputs and weather.

5.4.2 Time preferred to acquire different categories of agricultural knowledge

Respondents were asked to mention when they preferred to acquire each category of agricultural knowledge. Among the farmers, majority preferred to acquire each category of agricultural knowledge during a particular period of time of the cropping calendar. It can be seen from Table 5.9 that knowledge on weather was acquired almost throughout the year. However, most farmers (208, 66.2%) acquired it during land preparation. Other farmers (117, 37.3%) acquired it during sowing; 56 (17.8%) acquired it during fertilizer/insecticide/pesticide application; 47 (15%) during weeding; 30 (9.6%) during harvest time; and nine (2.9%) acquired it after harvest. Findings indicate further that all farmers (83, 26.4%) who acquired knowledge on land preparation acquired it during land/farm preparation.

Table 5.9: Time when agricultural knowledge is accessed (N=314)

Agricultural knowledge category	Cropping calendar				
	Farm preparation	Sowing	Crop maintenance	Harvest time	Post-harvest time
Weather	208 (66.2%)	117 (37.3%)	150 (47.8%)	30(9.6%)	09(2.9%)
Farm preparation	83 (26.4%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
Seed selection techniques	195 (62.1%)	194 (61.8%)	0.0 (0.0%)	23 (7.3%)	13 (4.1%)
Seed sowing techniques	0.0 (0.0%)	83 (26.4%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
Crop maintenance	0.0 (0.0%)	0.0 (0.0%)	211 (67.2%)	0.0 (0.0%)	0.0 (0.0%)
Post-harvest practices	04 (1.3%)	01 (0.3%)	0.0 (0.0%)	75 (2.9%)	112 (35.7%)
Agricultural marketing	03 (1.0%)	0.0 (0.0%)	02 (0.6%)	71 (22.6%)	109 (34.7%)
Agricultural credits	29 (9.2%)	4 (1.3%)	03 (0.9%)	08 (2.5%)	03 (1.0%)

Among the farmers, majority mentioned to have been accessing knowledge on seed selection techniques. It was found that 195 (62.1%) of the farmers acquired this category of agricultural knowledge during land preparation; 194 (61.8%) acquired it during sowing; and none of the farmers acquired it during fertilizer/insecticide/pesticide application or weeding. Findings indicate further that 23 (7.3%) of the farmers acquired knowledge about seed selection techniques during harvest while 13 (4.1%) acquired it during post-harvest practices. Findings indicate that 83 (26.4%) of the farmers acquired knowledge about seed sowing techniques during sowing time only.

Findings in Table 5.9 indicate that 211 (67.2%) of the farmers acquired knowledge on crop maintenance. Among those who acquired it, 112 (35.7%) acquired it during fertilizer/insecticide/pesticide application while 99 (31.5%) acquired it during weeding.

It was found that majority (112, 35.7%) of those who acquired knowledge on post-harvest practices mentioned to have acquired it after harvesting their farms while 75 (2.9%) acquired it

during harvest time. Findings in Table 5.9 indicate that none of the farmers acquired knowledge on post-harvest practices during weeding and fertilizer/insecticide/pesticide application, only one (0.3%) farmer mentioned to have acquired it during sowing while four (1.3%) during land preparation.

Knowledge on agricultural marketing was acquired by farmers mostly after harvest. Findings indicate that 109 (34.7%) of the farmers acquired this category of knowledge after harvest; 71 (22.6%) acquired it during harvest time; and two (0.6%) farmers acquired it during weeding/fertilizer/insecticide/pesticide application while three (1.0%) acquired it during land preparation. None of the farmers acquired it during sowing.

5.4.3 Factors limiting usage of acquired categories of agricultural knowledge

It was found that not all of the acquired agricultural knowledge was used. Findings on Figure 5.1 show that only 61 (19.43%) farmers used all of acquired agricultural knowledge while majority (253, 80.57%) did not put into practice all of what they acquired.

Figure 5.1: Usage of acquired agricultural knowledge (N=314)

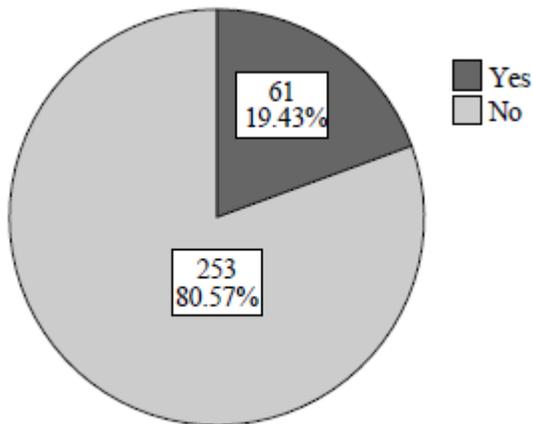


Table 5.10: Factors limiting usage of acquired agricultural knowledge (N=314)

Reason why knowledge was not put into use	Frequency distribution
Did not afford to acquire some of the inputs	21 (6.7%)
Found some knowledge to be useless	30 (9.6%)
Acquired some agricultural knowledge lately	145 (46.2%)
Some of the inputs were not available/delivered lately	56 (17.8%)
Time consuming to use some knowledge	35 (11.1%)

Farmers were asked to mention reasons which limited them from using acquired agricultural knowledge. Findings in Table 5.10 indicate that 21 (6.7%) of the farmers did not use acquired knowledge because they did not afford to buy some of the inputs while 30 (9.6%) perceived some categories of agricultural knowledge to be useless. Table 5.10 indicates further that 145 (46.2%) of the farmers did not use some agricultural knowledge because they acquired it late. It was also found that 56 (17.8%) of the farmers did not put into use acquired agricultural knowledge because some of the inputs were not available or delivered late. Finally, 35 (11.1) of them farmers did not use some of the acquired agricultural knowledge because it was time consuming to put into use the acquired skills.

Results acquired through focus group discussions also indicate that not all of the acquired agricultural knowledge was used. Participants mentioned not to use acquired knowledge because they later found it to be irrelevant. They also failed to put into use some of the acquired knowledge because some of the procedures were tedious or difficult to implement. It was found that acquired knowledge was not used when inputs were unavailable or very expensive. Farmers acquired a lot of knowledge from demonstration plots. Unfortunately most demonstration plots were not established on time thus limiting farmers from using acquired knowledge.

Findings from key informant interviews indicate that most key informants involved provided agricultural and related services to farmers. They provided/created agricultural knowledge, inputs, storage space for agricultural produce, bought or processed agricultural produce. As they provided their services agricultural knowledge was provided too. Thus, most key informants were custodians of agricultural knowledge. However, late delivery of some of agricultural

knowledge was mentioned to limit usage of some categories of agricultural knowledge among most actors.

5.4.4 Sources of agricultural knowledge used by actors in AKS

Respondents were asked to mention sources from which they acquired agricultural knowledge. Findings in Table 5.11 summarize the sources used by farmers for acquiring agricultural knowledge. It was found that majority of the farmers (305, 97.1%) acquired agricultural knowledge from fellow farmers. Others, 193 (61.5%) acquired agricultural knowledge from radio sets, 152 (48.4%) through mobile phones, 120 (38.2%) from village based agricultural advisor and 105 (33.4%) farmers from input suppliers. Findings indicate that 102 (32.5%) of the farmers acquired agricultural knowledge from agricultural extension agents, 80 (25.5%) from TV sets, 66 (21%) from demonstration plots while 63 (20.1%) from farmers' groups.

Findings in Table 5.11 indicate that most sources of agricultural knowledge were not used by most respondents. Churches and mosques were used by only one percent of the respondents while newspapers, books/booklets and agricultural researchers were used by less than three percent of the farmers. Findings indicate further that leaflets/brochures and agricultural shows/farmers' field day were mentioned to be used by less than four percent of the farmers. Findings also indicate that 27 (8.6%) of farmers acquired agricultural knowledge from village executives; 33 (10.5%) acquired it through posters and buyers; while 50 (15.9%) acquired from buyers.

Table 5.11: Sources of agricultural knowledge (N=314)

Source of agricultural knowledge	Frequency distribution	
	Yes	No
Agricultural extension officer	102 (32.5%)	212 (67.5%)
Fellow farmers	305 (97.1%)	9 (2.9%)
Radio set	193 (61.5%)	120 (38.2%)
TV set	80 (25.5%)	234 (74.5%)
Mobile phones	152 (48.4%)	162 (51.6%)
Newspaper	07 (2.2%)	307 (97.8%)
Posters	33 (10.5%)	281 (89.5%)
Books and booklets	05 (1.6%)	309 (98.4%)
Agricultural researchers	07 (2.2%)	307 (97.8%)
Leaflets and brochures	10 (3.2%)	304 (96.8%)
Village executives	27 (8.6%)	287 (91.4%)
Trainings and seminars	50 (15.9%)	264 (84.1%)
Input supplier	105 (33.4%)	209 (66.6%)
Buyers	33 (10.5%)	281 (89.5%)
Demonstration plots	66 (21%)	248 (79%)
Agricultural shows/farmers' field day	12 (3.8%)	302 (96.2%)
Churches/mosques	03 (1.0%)	310 (99.7%)
Farmers' group	63 (20.1%)	251 (79.9%)
Village based agricultural advisor	120 (38.2%)	194 (61.8%)

Findings from focus group discussions also show that actors used different sources of agricultural knowledge. It was found from focus group discussions that most farmers used fellows as their main source of agricultural knowledge. Among other actors, ICT and paper based sources were mentioned to be used for acquiring knowledge. Human based sources of agricultural knowledge reported to be used among farmers were fellow farmers, agricultural extension officers, input suppliers and village based agricultural advisors. Mobile phones, radio and TV sets were mentioned to be used mostly among ICT based agricultural knowledge sources. Among paper based agricultural knowledge sources, participants reported to use leaflets, booklets and newspapers.

Findings from key informant interviews revealed that human based agricultural knowledge sources were used most. Among the non-farmers respondents, it was found that agricultural extension officers, councillors, employees from NGOS, researchers and village executives used colleagues and supervisors as human based sources. Human based agricultural knowledge sources (mainly colleagues and fellows) were used most among buyers, input-suppliers, warehouse operators and millers. ICT based agricultural knowledge sources used by agricultural extension officers, researchers and NGOs were computers, internet, mobile phones, radio and TV sets. Other actors mentioned to use mobile phones, radio and TV sets only. Letters, newspapers, books, leaflets and booklets were the paper based agricultural knowledge sources used by agricultural extension officers, councillors, employees from NGOS, researchers and village executives. Other AKS actors mentioned to use newspapers and leaflets.

5.4.4.1 Frequency of using agricultural knowledge sources among actors in AKS

Respondents were asked about the frequency at which each of the sources of agricultural knowledge was used. As shown in Table 5.12, the frequency of usage of agricultural knowledge sources was different as sources were either used “very frequently”, “frequently”, “infrequently” or “not used at all”. Majority of the farmers (241, 76.8%) mentioned to very frequently use fellow farmers as an agricultural knowledge source. Findings show that 128 (40.8%) of the farmers very frequently used mobile phones for acquiring agricultural knowledge; radio sets were also mentioned to be very frequently used by 125 (39.8%) farmers. Findings from Table 5.12 also reveal that village based agricultural advisors were very frequently used by 77 (24.5%) of the farmers. Other sources of agricultural knowledge were mentioned to be very frequently used by less than 20% of farmers.

As indicated in Table 5.12, some agricultural knowledge sources were frequently used by farmers. It was found that fellow farmers as an agricultural knowledge source were frequently used by 66 (21%) of the farmers, agricultural extension officers and input suppliers by 59 (18.8%) and radio sets by 57 (18.2%). Findings indicate further that 46 (14.6%) of the farmers used frequently mobile phones while other sources were frequently used by less than 10% of farmers involved in the survey.

As shown in Table 5.12, some sources were infrequently used for acquiring agricultural knowledge. It was found that less than 10% of the farmers infrequently used all agricultural knowledge sources.

Table 5.12: Frequency of usage of sources of agricultural knowledge (N=314)

Sources of agricultural knowledge	Frequency			
	Very frequently	Frequently	Infrequently	Not used at all
Agricultural extension agents	26 (8.3%)	59 (18.8%)	17(5.4%)	212 (67.5%)
Fellow farmer	241(76.8%)	66 (21%)	01(0.3%)	06 (1.9%)
Radio set	125 (39.8%)	57 (18.2%)	22 (07%)	52 (16.6%)
TV set	39 (12.4%)	29 (9.2%)	10 (3.2%)	175 (55.7%)
Mobile phones	128 (40.8%)	46 (14.6%)	04 (1.3%)	75 (23.9%)
Newspapers	01 (0.3%)	04 (1.3%)	05 (1.6%)	303 (96.8%)
Posters	03 (1.0%)	17 (5.4%)	15 (4.8%)	278 (88.8%)
Books and booklets	04 (1.3%)	04 (1.3%)	00 (00%)	305 (99.7%)
Agricultural researchers	04 (1.3%)	06 (1.9%)	00 (00%)	302 (96.2%)
Leaflets and brochures	01 (0.3%)	04 (1.3%)	07 (2.2%)	301 (96.2%)
Village executives	03 (1.0%)	16 (5.1%)	11 (3.5%)	283 (90.1%)
Trainings and seminars	07 (2.2%)	21 (6.7%)	23 (7.3%)	263 (83.4%)
Input supplier	33 (10.5%)	59 (18.8%)	15 (4.8%)	207 (65.9%)
Buyers	01 (0.3%)	13 (4.1%)	21 (6.7%)	279 (88.9%)
Demonstration plots	19 (6.1%)	34 (10.8%)	13 (4.1%)	248 (79%)
Agricultural shows	02 (0.6%)	05 (1.6%)	07 (2.2%)	299 (95.2%)
Churches/ mosques	03 (1.0%)	00 (00%)	02 (0.63%)	309 (98.4%)
Farmers' groups	22 (7.0%)	13 (4.1%)	25 (8.0%)	254 (80.9%)
Village Based Agricultural Advisor	77 (24.5%)	24 (7.6%)	21 (6.1%)	192 (1.1%)

There were some farmers who did not use some of the agricultural knowledge sources at all. As shown in Table 5.12, only few sources were mentioned to be not used at all by few farmers. Only six (1.9%) of the farmers did not used fellow farmers as an agricultural knowledge source. Others, 52 (16.6%) did not used radio sets as agricultural knowledge sources while mobile

phones were not used by 75 (23.9%). It was found that other agricultural knowledge sources were mentioned to be not used by more than 60% of the farmers involved in the study.

5.4.4.2 Factors influencing usage of agricultural knowledge sources among actors in AKS

It was found that respondents' sex, age, level of education, farming experience, and yield influenced usage of agricultural knowledge sources. A cross tabulation relating farmers' sex and agricultural knowledge sources was run to determine the relationship existing between them. Cross tabulation analysis results are found in Table 5.13 and presented in sub-section 5.4.4.2.1. Moreover, Kendall's tau correlation analysis was probed to find out the relationship existing between demographic characteristics and usage of agricultural knowledge sources (see Table 5.16) as presented in sub-section 5.4.4.2.2.

5.4.4.2.1 Influence of sex of farmers on usage of sources of agricultural knowledge

The study assessed how sex of the farmer influenced usage of agricultural knowledge sources. As shown in Table 5.13, 62 (40.5%) of the male and 40 (24.8%) of the female farmers used agricultural extension officer as an agricultural knowledge source; 149 (97.4%) male and 156 (96.9%) female farmers used fellow farmers as an agricultural knowledge source; while 112 (73.2%) male and 81 (56.1%) female farmers used radio sets as an agricultural knowledge source. Findings indicate also that 46 (30.1%) of the male and 34 (21.1%) of the female farmers used TV sets while 84 (34.9%) male and 68 (42.2%) female farmers used mobile phones as agricultural knowledge sources. It was also found that 33 (21.6%) of the male and 30 (18.6%) female farmers used farmers' groups as agricultural knowledge sources while 58 (37.9%) male and 62 (38.5%) female farmers used village based agricultural advisors as agricultural knowledge sources.

Findings in Table 5.13 indicate that posters were used as agricultural knowledge sources by 22 (14.4%) of the male and 11 (6.8%) of the female farmers, village executives by 15 (9.8%) male and 12 (7.5%) female farmers and trainings and seminars by 30 (19.6%) male and 20 (12.4%)

female farmers. Others, 52 (34%) of the male and 53 (32.9%) of the female farmers used input suppliers; 21 (13.7%) male and 12 (7.5%) female farmers used buyers of agricultural produce; and 43 (28.1%) male and 23 (14.3%) female farmers used demonstration plots as a source of agricultural knowledge.

Table 5.13: Usage of sources of agricultural knowledge by sex of farmers (N=314)

Source of agricultural knowledge	Sex of the respondent (frequency within sex of respondent)	
	Male	Female
Agricultural extension officer	62 (40.5%)	40 (24.8%)
Fellow farmers	149 (97.4%)	156 (96.9%)
Radio set	112 (73.2%)	81 (56.1%)
TV sets	46 (30.1%)	34 (21.1%)
Mobile phones	84 (34.9%)	68 (42.2%)
Newspaper	06 (3.9%)	01 (0.6%)
Posters	22 (14.4%)	11 (6.8%)
Books and booklets	04 (2.6%)	01 (0.6%)
Agricultural researchers	07 (4.6%)	00 (00%)
Leaflets and brochures	08 (5.2%)	02 (1.2%)
Village executives	15 (9.8%)	12 (7.5%)
Trainings and seminars	30 (19.6%)	20 (12.4%)
Input suppliers	52 (34%)	53 (32.9%)
Buyers	21 (13.7%)	12 (7.5%)
Demonstration plots	43 (28.1%)	23 (14.3%)
Agricultural shows	08 (5.2%)	04 (2.5%)
Churches and mosques	03 (2.0%)	00 (00%)
Farmers' group	33 (21.6%)	30 (18.6%)
Village based agricultural advisor	58 (37.9%)	62 (38.5%)

Among agricultural knowledge sources found to be least used, comparatively more male than female farmers mentioned to use them. Findings indicate that newspapers were used by six (3.9%) male farmers while only one (0.6%) of the female farmer mentioned to use them. Findings indicate further that four male farmers (2.6%) used books and booklets as opposed to one (0.6%) of the female farmer; seven male farmers (4.6%) used agricultural researchers as source of agricultural knowledge while none of the female farmers did. Findings also indicate that leaflets and brochures were used by eight male farmers (5.2%) as opposed to only two

female farmers (1.2%) used the sources. Furthermore, eight (5.2%) of the male farmers acquired agricultural knowledge through agricultural shows as opposed to only four (2.5%) of the female farmers. Lastly, it was found that three (2.0%) of the male farmers acquired agricultural knowledge from churches and mosques while none among female farmers did.

Findings from focus group discussions revealed a very limited influence of sex of farmers on usage of fellows and colleagues as agricultural knowledge sources. These findings are similar to those of the main survey. However, it was reported that sources found away from residential areas were mostly used by male rather than female farmers.

5.4.4.2.2 Influence of other demographic characteristics on usage of agricultural knowledge sources

Individual characteristics other than sex of actors in AKS are known to influence usage of agricultural knowledge sources. A Spearman's Correlation analysis was run to assess the relationship existing between farmer's individual characteristics and usage of agricultural knowledge sources. Findings in Table 5.14 indicate that there was either a positive or negative relationship existing between individual characteristics and usage of agricultural knowledge sources. Age of farmers was found to influence usage of agricultural knowledge sources. The relationship existing between age and usage of agricultural knowledge sources was found to be either weak positive or negative. Results in Table 5.14 indicate that there was a weak positive relationship (Spearman Correlation Coefficient = 0.098) between age of the farmer and usage of fellow farmers as an agricultural knowledge source. It was also found that a weak negative relationship (Spearman Correlation Coefficients ranging from -0.019 to -0.157) existed between age and usage of other agricultural knowledge sources. Results in Table 5.14 indicate that there was a weak negative relationship existing between farmers' level of education and usage of agricultural knowledge sources (Spearman Correlation Coefficients ranging from -0.002 to -0.195).

It was further found that there was a weak relationship existing between farmers' farming experience and usage of agricultural knowledge sources. The Spearman Correlation Coefficient of $r=0.111$ (between fellow farmers and farming experience); $r=0.016$ (between radio sets and

farming experience); $r=0.036$ (for TV sets and farming experience); $r=0.017$ (between mobile phones and farming experience); and $r=0.014$ (between demonstration plots and farming experience) indicate that there was a weak positive relationship existing between farmer's farming experience and usage of some agricultural knowledge sources. However, the Spearman Correlation Coefficient of $r= -0.051$ (between posters and farming experience); $r= -0.109$ (between trainings and farming experience); and $r= -0.129$ (between input suppliers and farming experience) show that there was a weak negative relationship existing between usage of other agricultural knowledge sources and farmer's farming experience. Likewise, the Spearman Correlation Coefficient of $r= -0.046$ (between buyers of agricultural produce and farming experience); $r= -0.085$ (between farmer's group and farming experience); and $r= -0.064$ (between village based agricultural advisors and farming experience) also indicate that there was a weak negative relationship existing between usage of other agricultural knowledge sources and farmer's farming experience.

As indicated Table in 5.14, there was no relationship existing between farm size and using agricultural extension officers as a source for agricultural knowledge. However, there was a weak positive relationship existing between farm size and acquiring agricultural knowledge from fellow farmers (Spearman Correlation Coefficient = 0.057). The relationship between farm size and using other sources of agricultural knowledge was found to be weak and negative with Spearman Correlation Coefficients ranging from -0.011 to -0.213 (see Table 5.14 for details).

The other variable influencing usage of agricultural knowledge sources was yield. Farmers' related yield to income generated through farming activities. Findings from Table 5.14 indicate a weak positive relationship existing between yield and accessing agricultural knowledge from agricultural extension officers (Spearman Correlation Coefficient = 0.018); fellow farmers (0.062); mobile phones (0.039); farmer's group (0.034) and village based agricultural advisors (0.147). The relationship existing between yield and usage of other sources of agricultural knowledge was weak and negative with Spearman Correlation Coefficients ranging from -0.017 to -0.127.

Table 5.14: Influence of farmer's demographic characteristics on usage of agricultural knowledge sources (N=314)

Source of agricultural knowledge	Spearman's rho	Individual farmer's characteristics				
		Age group	Level of education	Farming experience	Farm size	Yield in 100 kg bags
Agricultural extension officer	Correlation Coefficient	-.019	-.195**	.030	.000	.018
	Sig. (2-tailed)	.744	.001	.599	.998	.754
Fellow farmers	Correlation Coefficient	.098	-.019	.111*	.057	.062
	Sig. (2-tailed)	.082	.740	.049	.317	.273
Radio sets	Correlation Coefficient	-.019	-.191**	.016	-.167**	-.017
	Sig. (2-tailed)	.739	.001	.784	.003	.763
TV set	Correlation Coefficient	-.050	-.162**	.036	-.213**	-.049
	Sig. (2-tailed)	.379	.004	.527	.000	.382
Mobile phones	Correlation Coefficient	-.022	-.156**	.017	-.010	.039
	Sig. (2-tailed)	.696	.006	.760	.860	.493
Posters	Correlation Coefficient	-.063	-.061	-.051	-.011	-.037
	Sig. (2-tailed)	.267	.280	.368	.846	.515
Trainings/ seminars	Correlation Coefficient	-.157**	-.169**	-.109	-.013	-.127*
	Sig. (2-tailed)	.005	.003	.055	.812	.024
Input supplier	Correlation Coefficient	-.128*	-.005	-.129*	-.172**	-.046
	Sig. (2-tailed)	.023	.925	.023	.002	.417
Buyers	Correlation Coefficient	-.072	-.065	-.046	-.127*	-.069
	Sig. (2-tailed)	.205	.252	.412	.024	.225
Demonstration plots a	Correlation Coefficient	-.030	-.148**	.014	-.070	-.026
	Sig. (2-tailed)	.600	.009	.801	.216	.647
Farmers' group	Correlation Coefficient	-.092	-.002	-.085	-.065	.034
	Sig. (2-tailed)	.104	.965	.134	.253	.546
Village Based Agricultural Advisor	Correlation Coefficient	-.136*	-.082	-.064	-.044	.147**
	Sig. (2-tailed)	.016	.145	.256	.434	.009

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Results from focus group discussions indicate that age and farming experience influenced choice of agricultural knowledge. It was found that younger farmers acquired agricultural knowledge from parents and other experienced farmers. Moreover, it was found that farmers with better yields got reasonable income and were able to consult different agricultural knowledge sources which were around or far away from their residences. Level of education was mentioned to have limited influence as most farmers were literate (knew how to read and write) but they lacked access to relevant print resources. They also mentioned that farm size did not have any influence on choice of agricultural knowledge.

5.4.4.2.3 Other factors influencing usage of agricultural knowledge sources

There were other factors influencing usage of agricultural knowledge sources. As shown in Table 5.15, majority of the farmers (219, 69.7%) did not use some agricultural knowledge sources because it was difficult to access them. Others (88, 28%) did not use some of the agricultural knowledge sources because they were located far away from their residential areas. Moreover, 176 (56.1%) of the farmers did not afford to consult some agricultural knowledge sources because they did not have money needed to be paid as fees for accessing and using knowledge sources. Other farmers (114, 36.3%) failed to use some of the agricultural knowledge sources because they did not own some communication tools needed to consult some sources.

Findings in Table 5.15 indicate that 262 (83.4%) of the farmers did not acquire agricultural knowledge from farmers' group because they were not members of any group. Others (26, 8.3%) did not use mobile phones, radio and TV sets due to poor signals and limited network coverage. Moreover, 125 (39.8%) of the farmers did not use some agricultural knowledge sources due to lack of power needed to run ICT tools. Findings indicate further that 93 (29.6%) of the farmers did not use some of the agricultural knowledge sources due to high tariffs. Furthermore, 123 (39.2%) did not acquire some valuable agricultural knowledge through radio and TV sets because agricultural programmes were broadcasted during odd hours.

Table 5.15: Other factors hindering acquisition of agricultural knowledge (N=314)

Factors hindering access to agricultural knowledge	Frequency
Sources not easily accessed	219 (69.7%)
Sources found far away from residential areas	88 (28%)
Difficult language used	67 (21.3%)
Feedback not easily made	10 (3.2%)
Expensive to access and use source	176 (56.1%)
Do not own communication tools	114 (36.3%)
Not a member of a farmers' group	262 (83.4%)
Poor network/signal of some ICTs	26 (8.3%)
Poor/lack power supply	125 (39.8%)
Too high mobile phone tariffs	93 (29.6%)
TV and radio programmes aired during odd hours	123 (39.2%)
Illiteracy among farmers on how to use some knowledge sources	52 (16.6%)
Limited agricultural related issues discussed during village meetings	126 (40.1%)
Irrelevant content disseminated by some sources	05 (1.6%)
Agricultural extension services not provided frequently	205 (65.3%)

Findings in Table 5.15 indicate that 52 (40.1%) of the farmers did not use some agricultural knowledge sources because of illiteracy and lack of skills needed to consult some sources. Others (67, 21.3%) did not use some of the agricultural knowledge sources because of difficult and unknown languages used to present information. Moreover, 26 (40.1%) did not use some of the sources because such sources were believed to have limited agricultural knowledge contents. Furthermore, five (1.6%) mentioned to have not used some of the agricultural knowledge sources because they had irrelevant contents. Finally, 205 (65.3%) of the farmers mentioned that they did not have access to agricultural extension services due to limited number of agricultural extension officers in their areas.

Most of the factors mentioned to limit usage of some agricultural knowledge sources among farmers involved in the main survey were also mentioned during focus group discussions. It was found that some agricultural knowledge sources were not used because they had irrelevant knowledge or had limited agricultural knowledge while other sources were too expensive to access. Other sources were not used because of lack of or unreliable power sources. It was also found that radio and TV sets were not used much because most agricultural programmes were

broadcasted during irrelevant time. Finally, it was mentioned that low ownership of channels/tools also limited usage of some agricultural knowledge sources.

Findings from key informant interviews indicate that limited ICT infrastructure, unreliable power supply, high mobile phone tariffs, and lack of awareness on agricultural knowledge sources limited usage of some agricultural knowledge sources. Limited ICT skills hindered the usage of computers, internet and some ICT applications among warehouse operators, millers, buyers, input suppliers, councillors and village executives. Moreover, limited number of computers and other ICTs in agricultural extension offices and research institutes was also mentioned to hinder usage of ICT based agricultural knowledge sources. Finally, impassable roads during rainy season limited usage of paper based agricultural knowledge sources in most rural areas.

5.5 Factors hindering and stimulating the accessibility of agricultural knowledge

Results indicate that all actors in AKS involved in the study accessed agricultural knowledge for their agricultural activities. As shown in Table 5.16, several factors were found to influence the accessibility of agricultural knowledge among actors in AKS. Such factors were either based on actors themselves or sources from which agricultural knowledge was accessed.

5.5.1 Factors based on AKS actors hindering agricultural knowledge accessibility

Findings on Table 5.16 indicate that there were several farmers' based factors which hindered agricultural knowledge accessibility. It was found that 54 (17.2%) of the farmers did not access some knowledge because they did not know where to access it. It was also found that some 58 (18.5%) of the farmers did not access some agricultural knowledge categories because they did not know where knowledge was stored while 40 (12.7%) failed to access agricultural knowledge because it was expensive to acquire it. Moreover, 176 (56.1%) farmers did not afford to consult some agricultural knowledge sources due to limited income. Others (114, 36.3%) did not access some categories of agricultural knowledge because they did not own communication tools used for accessing knowledge. Finally, 52 (40.1%) did not access some agricultural knowledge because of illiteracy and lack of skills.

Table 5.16: Farmers’ based factors hindering accessibility of agricultural knowledge (N=314)

Reason hindering knowledge acquisition	Frequency distribution
Did not know where to acquire knowledge	54 (17.2%)
Did not know that there is new knowledge	58 (18.5%)
It is expensive to acquire it	40 (12.7%)
Illiteracy	52 (16.6%)
Low income	176 (56.1%)
Do not own communication tools	114 (36.3%)

Findings from focus group discussions were found to be similar to those from the main survey. Participants in focus group discussions mentioned illiteracy, poverty, and low ownership of communication tools to limit the level of accessibility of agricultural knowledge. It was reported that distance from residential areas to agricultural knowledge sources limited mostly female farmers from accessing agricultural knowledge because they were involved in both farm and domestic activities.

Findings from key informant interviews revealed that ICT illiteracy among some buyers, input suppliers, councillors, village executives, warehouse operators and millers limited them from accessing agricultural knowledge. Moreover, limited income among agricultural extension officers and village executives hindered them from acquiring some categories of agricultural knowledge.

5.5.2 Factors hindering accessibility of agricultural knowledge based on knowledge sources

Other factors hindering accessibility of agricultural knowledge were based on agricultural knowledge sources. Findings in Table 5.17 indicate that 219 (69.7%) of the farmers did not access some of the agricultural knowledge because sources were not easily accessible. Others (88, 28%) did not access agricultural knowledge because sources were located far away from residential areas. Findings indicate that 67 (21.3%) failed to access agricultural knowledge from some sources due to language barriers.

Table 5.17: Factors hindering accessibility of agricultural knowledge based on knowledge sources (N=314)

Reason limiting agricultural knowledge usage	Frequency distribution
Sources not easily accessed	219 (69.7%)
Sources found far away from residential areas	88 (28%)
Difficult language used/language barriers	67 (21.3%)
Feedback not easily made	10 (3.2%)
Do not own communication tools	114 (36.3%)
Not a member of a farmers' group	262 (83.4%)
Poor network/signal of some ICTs	26 (8.3%)
Poor/lack power supply	125 (39.8%)
TV and radio programmes aired during odd hours	123 (39.2%)
Limited agricultural related issues during village meetings	126 (40.1%)
Irrelevant content disseminated by some sources	05 (1.6%)
Agricultural extension services not provided frequently	205 (65.3%)

It was found that 262 (83.4%) of the farmers mentioned that being not members of farmers' groups hindered them from accessing agricultural knowledge from farmers' groups. Others (26, 8.3%), did not access some categories of agricultural knowledge because of poor signals and limited network coverage of some ICTs while 125 (39.8%) did not acquire knowledge due to lack of sources of power to run ICT tools. Findings show that 93 (29.6%) of the farmers failed to access some agricultural knowledge due to high tariffs. It was found that 123 (39.2%) of the farmers failed to access valuable agricultural knowledge because TV and radio agricultural programmes were broadcasted during odd hours while 126 (40.1%) did not access agricultural knowledge through village meeting because such meetings put little importance on agriculture. Moreover, five (1.6%) farmers failed to access knowledge from some sources because of limited relevant agricultural knowledge. Finally, majority of the farmers (205, 65.3%) did not access some knowledge because of either inadequate or lack of agricultural extension services.

Results from focus group discussions also revealed that accessibility of agricultural knowledge among AKS actors was hindered by sources not being easily accessible, being found away from residential areas or language barriers. It was also found that lack of feedback from some communication channels limited the accessibility of agricultural knowledge. Participants from focus group discussions mentioned that limited ownership of ICT tools and lack of sources of

power to run ICT tools hindered accessibility of agricultural knowledge. Moreover, poor network/signal of some ICTs hindered accessibility of agricultural knowledge. Finally, it was mentioned that inadequate provision of agricultural extension services also hindered the accessibility agricultural knowledge.

Among key informants, buyers and input suppliers mentioned language barrier to have limited them from accessing some agricultural knowledge from some sources. Agricultural researchers revealed that subscription fees for accessing some journals limited them from acquiring knowledge. On the other hand, agricultural extension officers mentioned that they failed to acquire knowledge from online agricultural knowledge sources because there was no internet connectivity in their offices. Agricultural researchers mentioned that unreliable power supply hindered the accessibility of agricultural electronic information resources. These resources were from either offline or online sources. Finally, agricultural extension officers reported that few agricultural print resources were made available in their areas; this also hindered the accessibility of agricultural knowledge among AKS actors.

5.5.3 Factors stimulating accessibility of agricultural knowledge

Actors were asked to mention factors stimulating accessibility of agricultural knowledge. As found in Table 5.18, 303 (95%) of the farmers mentioned that accessibility of agricultural knowledge sources was the main factor stimulating agricultural knowledge accessibility. Others (153, 48.7%) mentioned that accessibility of agricultural knowledge was stimulated by ownership of communication tools while 206 (65.6%) stated that affordable mobile phone tariffs stimulated agricultural knowledge accessibility. Findings in Table 5.18 indicate that 279 (88.9%) of the farmers revealed that well developed ICT infrastructure stimulated agricultural knowledge accessibility while 297 (94.6%) mentioned that accessibility of agricultural knowledge was stimulated by reliable sources of power.

Findings in Table 5.18 further indicate that 160 (51%) of the farmers pointed out that broadcasting radio and TV agricultural programmes during relevant time stimulated accessibility of agricultural knowledge. Other farmers (102, 32.5%) mentioned that membership in farmers' group stimulated accessibility of agricultural knowledge. Moreover, 101 (32%) of the farmers

revealed that access to adequate agricultural extension services stimulated accessibility of agricultural knowledge.

Table 5.18: Factors stimulating accessibility of agricultural knowledge

Factor stimulating accessibility of agricultural knowledge	Frequency
Accessibility of agricultural knowledge sources	303 (95%)
Ownership of communication tools	153 (48.7%)
Affordability of mobile phone tariffs	206 (65.6%)
Well developed ICT infrastructure	279 (88.9%)
Reliable sources of power	297 (94.6%)
Broadcasting radio and TV agricultural programmes during relevant time	160 (51%)
Membership in farmers' groups	102 (32.5%)
Adequate agricultural extension services	101 (32%)

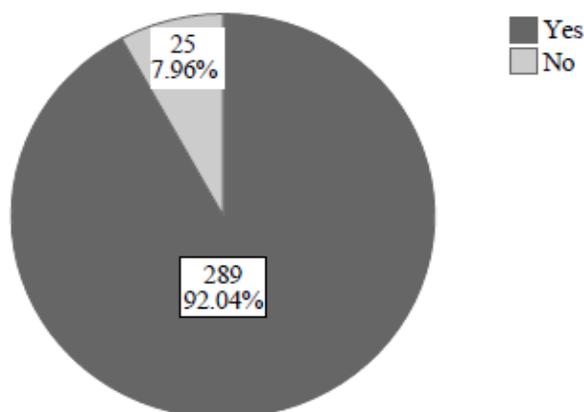
Additionally, findings from focus group discussions indicate that organizational/community culture stimulated agricultural knowledge accessibility. It was also mentioned that increased level of agricultural knowledge creation stimulated the accessibility of agricultural knowledge.

Agricultural researchers, extension staff and other agricultural service providers revealed that top management support strongly stimulated accessibility of agricultural knowledge. Lastly, it was found that involvement of different actors in agricultural knowledge management stimulated accessibility agricultural knowledge.

5.6 Agricultural knowledge sharing among actors in AKS

Actors were asked whether they shared agricultural knowledge. Findings in Figure 5.2 indicate that 289 (92%) of the farmers shared acquired agricultural knowledge and only 25 (08%) did not share. All other AKS actors involved in the study reported to share agricultural knowledge to other actors.

Figure 5.2: Sharing agricultural knowledge (N=314)



Farmers were further asked to mention the categories of agricultural knowledge shared. As shown in Table 5.19, most of the farmers (228, 72.6%) shared knowledge on seed selection techniques while very few (09, 2.9%) shared on agricultural credits. It was found that 151 (48.1%) of the farmers shared knowledge on weather, 26 (8.3%) on land preparation techniques, and 228 (72.6%) on seed selection techniques. Findings further indicate that 84 (26.8%) shared knowledge on seed sowing techniques, 137 (43.6%) on crop maintenance and 60 (19.1%) on post-harvest practices. Others (69, 22%) shared knowledge on agricultural marketing while nine (2.9%) shared knowledge on agricultural credits.

Table 5.19: Categories of agricultural knowledge shared (N=314)

Agricultural knowledge category	Frequency distribution	
	Yes	No
Weather	151 (48.1%)	163 (51.9%)
Land preparation techniques	26 (8.3%)	286 (90.3%)
Seed selection techniques	228 (72.6%)	86 (27.4%)
Seed sowing techniques	84 (26.8%)	230 (73.2%)
Crop maintenance	137 (43.6%)	177 (56.3%)
Post-harvest practices	60 (19.1%)	254 (80.9%)
Agricultural marketing	69 (22%)	245 ((78%)
Agricultural credits	09 (2.9%)	305 (97.1%)

Among key informants, agricultural knowledge related to their core roles was shared among themselves and farmers. Agricultural extension officers shared all categories of agricultural knowledge farmers needed; village and ward executives shared knowledge on input subsidy; while input suppliers shared knowledge on agricultural inputs. Buyers mentioned to share knowledge related to quality management of produce and prices while NGOs shared knowledge related to key interventions implemented. Radio and TV stations broadcasted different agricultural programmes, what they shared to other AKS actors depended much on what sponsors wanted to disseminate to intended audience. It was found that mobile phone operators shared different categories of agricultural knowledge through value added agricultural services.

5.6.1 Recipients of shared knowledge

Respondents were asked with whom they shared agricultural knowledge. As shown in Table 5.20, majority of the farmers (281, 96.2%) mentioned to share agricultural knowledge with fellow farmers, 82 (28.1%) with agricultural extension agents, 16 (5.5%) with village executives and 68 (17.5%) farmers shared to input suppliers. It was found further that 11 (3.8%) of the farmers shared agricultural knowledge with agricultural researchers; 27 (9.2%) with buyers; 39 (13.4%) with fellow members in farmers' group while 74 (25.3%) with village based agricultural advisors.

Table 5.20: Recipients of agricultural knowledge (N=314)

Recipient of agricultural knowledge	Frequency distribution
Agricultural extension agents	82 (28.1%)
Fellow farmers	281 (96.2%)
Village executives	16 (5.5%)
Agricultural researchers	11 (3.8%)
Input suppliers	68 (17.5%)
Buyers	27 (9.2%)
Farmers' group	39 (13.4%)
Village based agricultural advisor	74 (25.3%)

Findings from focus group discussions revealed that fellow farmers were the major recipients of agricultural knowledge. However, they shared agricultural knowledge with agricultural extension officers, village executives and agricultural input-suppliers too.

Findings from key informant interviews revealed that agricultural extension officers and researchers shared agricultural knowledge with farmers, colleagues and supervisors. Those from NGOs shared agricultural knowledge with farmers, colleagues, partners, donors, and the government. Input suppliers, buyers, warehouse operators and millers shared agricultural knowledge mainly with farmers and colleagues. Mobile phone operators and radio and TV stations were used as channels for sharing agricultural knowledge. Channels for sharing agricultural knowledge are presented in sub-section 5.6.2.

5.6.2 Channels used for sharing agricultural knowledge

Actors were further asked how agricultural knowledge was shared with recipients. Findings in Table 5.21 indicate that farmers shared agricultural knowledge through different ways. It was found that knowledge was shared through face to face oral communication; SMS, voice calls and village meetings. It was found that 192 (61.1%) of the farmers shared agricultural knowledge through face to face oral communication; 38 (12.1%) through SMS; others (110, 35%) through voice calls; while 92 (29.3%) shared agricultural knowledge during village meetings.

Table 5.21: Channels used to share agricultural knowledge among farmers (N=314)

Agricultural knowledge sharing channel	Frequency distribution
Face to face oral communication	192 (61.1%)
SMS	38 (12.1%)
Voice calls	110 (35%)
Village meetings	92 (29.3%)

Findings from focus group discussions were similar to those of the main survey. Findings from key informant interviews indicate that agricultural knowledge was shared through face to face oral communication to colleagues and supervisors and during trainings and seminars. Employees from NGOs reported to use Skype for meetings when some participants were away. They also used e-mails to share knowledge to individuals or groups. However, majority of the key informants mentioned to use mobile phones to reach recipients located far away. Mobile phones, leaflets/brochures, notice boards, radio and TV sets were reported to be used by some informants to share agricultural knowledge to a larger audience. It was found that choice of the

communication channels was mainly influenced by type of recipients of knowledge or whether the knowledge sharing process was formal or informal. Generally, mobile phones, meetings, seminars, trainings, workshops, conferences, internet and print materials were used for sharing agricultural knowledge.

5.6.3 Frequent recipients of agricultural knowledge

Respondents were asked to mention recipients with whom they frequently shared agricultural knowledge. As shown in Table 5.22, most of the farmers (234, 74.5%) very frequently shared agricultural knowledge with fellow farmers; 44 (14%) frequently shared knowledge with fellow farmers; while 33 (10.5%) did not share agricultural knowledge with fellow farmers.

Others (18, 5.7%) very frequently shared agricultural knowledge with agricultural extension officers; 58 (18.5%) frequently shared knowledge with agricultural extension officers; while 232 (73.9%) did not share agricultural knowledge to agricultural extension officers at all.

Table 5.22: Frequency of sharing agricultural knowledge to recipients (N=314)

Recipient of agricultural knowledge	Distribution of respondents at each level of frequency			
	Very frequently	Frequently	Infrequently	Not used
Agricultural extension officers	18 (5.7%)	58 (18.5%)	06 (1.9%)	232 (73.9%)
Fellow farmer	234 (74.5%)	44 (14%)	03 (1.0%)	33 (10.5%)
Village executives	02 (0.6%)	14 (4.5%)	02 (0.6%)	296 (94.3%)
Agricultural researchers	00 (00%)	11 (3.5%)	01 (0.3%)	302 (96.2%)
Input suppliers	21 (6.7%)	42 (13.4%)	05 (1.6%)	246 (78.3%)
Buyers	02 (0.6%)	16 (5.1%)	09 (2.9%)	287 (91.4%)
Farmers' group	03 (1.0%)	27 (8.6%)	09 (2.9%)	275 (87.6%)
Village based agricultural advisor	23 (7.3%)	36 (11.5%)	15 (4.8%)	240 (76.4%)

Among the least used recipients of agricultural knowledge (village executives, agricultural researchers, input suppliers, buyers and farmers; group), it was found that more than 78% of the farmers did not share agricultural knowledge with these recipients. Findings also indicate that 23 (7.3%) of the farmers very frequently shared agricultural knowledge with village based

agricultural advisor, 36 (11.5%) shared it frequently while 240 (76.4%) did not share agricultural knowledge with village based agricultural advisor at all.

5.7 ICTs in supporting agricultural knowledge management and AKS

Respondents were asked to mention ICTs used in their day to day life. Findings in Table 5.23 indicate that 213 (67.8%) of the farmers used radio sets, 84 (26.8%) used TV sets and 201 (64%) used mobile phones.

Table 5.23: ICTs used by farmers (N=314)

ICT tool used	Frequency
Radio sets	213 (67.8%)
TV sets	84 (26.8%)
Mobile phones	201 (64%)

Results from focus group discussions were similar to those from other farmers involved in the main survey. Findings from key informant interviews revealed that agricultural researchers, few agricultural extension officers and those from NGOs used computers, internet, mobile phones, radio and TV sets. Others reported to use mobile phones, radio and TV sets. However, computers, mobile phones, and radio and TV sets were found to be the most used ICTs among informants involved in the study.

5.7.1 Point of accessing ICT tools

Respondents were asked to mention points from which they accessed ICT tools. As shown in Table 5.24, majority of the farmers owned ICT tools; others accessed them from relatives, friends and kiosks/clubs. Among those using radio sets, 207 (97.2%) of them owned radio sets; four (1.9%) accessed them from relatives; and two (0.94) accessed the tools from friends.

Table 5.24: ICT tools access points

ICT tool	Where access ICT tool (within using specific ICTs)			
	Own	Relative	Friend	Kiosk/club
Radio set	207 (97.2%)	04 (1.9%)	02 (0.94%)	00 (00%)
TV set	63 (75%)	15 (17.9%)	04 (4.8%)	02 (2.4%)
Mobile phone	199 (99%)	02 (01%)	00 (00%)	00 (00%)

Findings in Table 5.24 indicate that among those using TV sets, 63 (75%) owned TV sets; 15 (17.9%) accessed from relatives; four (4.8%) from friends; and two (2.4%) from clubs. Findings show further that among those using mobile phones, 199 (99%) owned them and two (01%) accessed them from relatives. From Table 5.24, it can be derived that 107 (34.1%), 251 (80%) and 115 (36.6%) of the farmers did not own radio sets, TV and mobile phones respectively.

With respect to ICT access points, participants in focus group discussions revealed similar results to those of the main survey. Agricultural extension officers, researchers, mobile phone operators, employees in radio and/or TV stations and those in NGOs either owned ICT tools or accessed them from offices. ICTs accessed from offices were computers and internet. Mobile phones, radio and TV sets were owned by individuals. Other key informants mentioned to own mobile phones, radio and TV sets. With technological advancements internet services were accessed through mobile phones hence improving the level of accessibility and usage of these services among actors.

5.7.2 Using ICT tools for acquiring agricultural knowledge

Respondents were asked to mention ICT tools used for accessing agricultural knowledge. Findings in Table 5.25 indicate the frequency of usage of ICTs among farmers. Among those using radio sets, 193 (90.6%) used these tools for acquiring agricultural knowledge. Finding in Table 5.25 indicate that 68 (81%) of the farmers acquired agricultural knowledge TV sets. Others, 159 (79.1%) used mobile phones for acquiring agricultural knowledge. Generally, majority of those who mentioned to be using ICT tools used them for acquiring agricultural knowledge.

Table 5.25: ICT tools used for acquiring agricultural knowledge

ICT tool used	Frequency (within using specific ICT tool)
Radio sets	193 (90.6%)
TV sets	68 (81%)
Mobile phones	159 (79.1%)

Findings from focus group discussions revealed that farmers used mobile phones, radio and TV sets for either acquiring or sharing agricultural knowledge. It was found from key informant interviews showed that some of agricultural extension officers, researchers and employees of NGOs used computers for creating and storing agricultural knowledge while internet and mobile phones were used for sharing agricultural knowledge. However, they also mentioned to acquire agricultural knowledge through mobile phones, radio and TV sets. Input suppliers, buyers, warehouse operators, millers, councillors and village executives used mobile phones for sharing agricultural knowledge while radio and TV sets were used for acquiring knowledge. Moreover, mobile phones, radio and TV sets were also used for disseminating agricultural knowledge to a wider audience.

5.7.3 Categories of agricultural knowledge acquired by farmers through ICT tools

Respondents were asked to mention categories of agricultural knowledge acquired through ICTs. Findings in Table 5.26 indicate that 134 (69.4%) and 127 (65.8%) of the farmers used radio sets for acquiring knowledge on seed selection techniques and weather respectively. Moreover, it was found that 88 (45.6%) used radio sets for acquiring knowledge on crop maintenance while 40 (20.7%) acquired knowledge on agricultural marketing through radio sets. Others (39, 20.2%) acquired knowledge on post-harvest practices through radio sets while only five (2.9%) used radio sets for acquiring knowledge on agricultural marketing.

Among those using TV sets for acquiring agricultural knowledge, 52 (76.5%) acquired knowledge on weather, 48 (70.6%) on seed selection techniques and 19 (27.9%) on crop maintenance. It was also found that 15 (22.1%) of farmers used TV sets for acquiring agricultural knowledge on agricultural marketing, 10 (14.7%) on post-harvest practices and four (5.9%) on agricultural credits.

Table 5.26: Categories of agricultural knowledge acquired through ICTs tools

Agricultural knowledge category	Frequency of using ICT tools (within used for acquiring agricultural knowledge)			
	Radio set	TV set	Mobile Phone	
			Voice calls	SMS
Weather	127 (65.8%)	52 (76.5%)	107 (67.3%)	29 (18.2%)
Seed selection techniques	134 (69.4%)	48 (70.6%)	110 (69.2%)	38 (23.9%)
Crop maintenance	88 (45.6%)	19 (27.9%)	49 (30.8%)	23 (14.5%)
Post harvest practices	39 (20.2%)	10 (14.7%)	29 (18.2%)	17 (10.7%)
Agricultural marketing	40 (20.7%)	15 (22.1%)	45 (28.3%)	14 (8.8%)
Agricultural credit	05 (2.9%)	04 (5.9%)	03 (1.9%)	01 (0.62%)

Findings in Table 5.26 indicate that farmers used both voice calls and SMS for sharing or acquiring agricultural knowledge. It was found that more farmers used voice calls than SMS for sharing or acquiring agricultural knowledge. Findings indicate that 110 (69.2%) of the farmers acquired knowledge on seed selection techniques through voice calls; 107 (67.3%) acquired knowledge on weather through voice calls; and 49 (30.8%) acquired knowledge on crop maintenance through voice calls too. Moreover, voice calls were used by 45 (28.3%) of the farmers for acquiring knowledge on agricultural marketing; 29 (18.2%) for acquiring knowledge on post-harvest practices; and three (1.9%) for acquiring knowledge on agricultural credits.

Other farmers used SMS for acquiring agricultural knowledge. As shown in Table 5.26, SMS were used by 29 (18.2%) of the farmers for acquiring knowledge on weather, 38 (23.9%) on seed selection techniques and 23 (14.5%) on crop maintenance. Findings in Table 5.26 indicate further that 17 (10.7%) of the farmers used SMS for acquiring knowledge on post-harvest practices, 14 (8.8%) on agricultural marketing and one (0.62%) on agricultural credits.

Findings from focus group discussions were similar to those shown in Table 5.26. Results revealed that most of the farmers accessed and shared different categories of agricultural knowledge through mobile phones.

5.7.4 Time for acquiring agricultural knowledge through radio and TV programmes

Respondents were asked about the time they accessed agricultural radio and TV programmes. Findings in Table 5.27 indicate that farmers accessed agricultural radio and TV programmes from early morning to night. Among the 193 farmers who listened to agricultural radio programmes, 72 (37%) of them listened during the morning hours while 55 (28.5%) listened during the afternoon. Others (34, 17.6%) listened such programmes during the evening; 32 (16.6%) during the night; and three (1.6%) farmers in early morning. Among 68 farmers who watched agricultural TV programmes, 10 (14.7%) farmers watched during the morning and 18 (26.5%) during the afternoon. Others (33, 48.5%) watched the programmes during the evening, seven (10.3%) during the night and none of the farmers watched such agricultural programmes during early morning.

Farmers were further asked about preferred time for accessing radio and TV agricultural programmes. It was found that five (2.6%) farmers preferred to listen to radio agricultural programmes during the morning; 14 (7.3%) during the afternoon; and 98 (50.8%) during evening. Results also indicate that 68 (35.2%) farmers preferred to listen to radio agricultural programmes during the night and eight (4.1%) during early morning.

Table 5.27: Time for acquiring agricultural programs (N=within specific ICT tool)

Time of a day	Time accessed radio/TV agricultural program		Time preferred to access radio/TV agricultural program	
	Radio set	TV set	Radio set	TV set
Morning	72 (37.3%)	10 (14.7%)	05 (2.6%)	03 (4.4%)
Afternoon	55 (28.5%)	18 (26.5%)	14 (7.3%)	17 (25%)
Evening	34 (17.6%)	33 (48.5%)	98 (50.8%)	43 (63.2%)
Night	32 (16.6%)	07 (10.3%)	68 (35.2%)	05 (7.4%)
Early morning	03 (1.6%)	00 (00%)	8 (4.1%)	00 (00%)

With respect TV agricultural programmes, three (4.4%) of the farmers preferred to watch such programmes during morning while 17 (25%) preferred to watch during the afternoon. It was found that 43 (63.2%) of the farmers preferred to watch such programmes during the evening,

five (7.4%) during night, and none of the farmers mentioned to prefer watching programmes during early morning.

Findings from focus group discussions indicate that farmers preferred to listen and watch radio and TV agricultural programmes after work. They also mentioned that there were about one to five agricultural programmes broadcasted in a week. Representatives from radio and TV stations mentioned that it was difficult to air more agricultural programmes because there were no individuals or companies volunteering to sponsor such programmes.

5.7.5 Factors limiting usage of ICT tools in agricultural knowledge processes

Respondents were asked to mention factors which limited usage of ICT tools for acquiring or sharing agricultural knowledge. As shown in Table 5.28, three (1.6%) of the farmers mentioned that illiteracy limited them from using radio sets for acquiring agricultural knowledge; 26 (13.5%) were limited by poor radio signals; while 123 (63.7%) mentioned that agricultural radio programmes were aired during odd hours that they could hardly listen. Findings indicate that 59 (30.6%) of the farmers were limited from using radio sets by lack of power sources. It was also found that usage of radio sets among five (2.6%) of farmers was limited by the aired irrelevant contents. Moreover, 18 (9.3%) mentioned that expenses associated with maintaining radio sets and buying dry cells to limit them from using radio sets for acquiring agricultural knowledge. Other farmers (120, 62.2%) did not know the exact time when radio agricultural programmes were aired.

Among those who used TV sets for acquiring agricultural knowledge, one (1.5%) farmer mentioned illiteracy to limit usage; two (3.0%) were limited by poor TV network; while 45 (66.2%) mentioned that most agricultural TV programmes were aired during odd hours that they did not have time to watch. Others, 21 (30.9%) mentioned that lack of power sources to run TV sets limited them from watching agricultural programmes while two (3.0%) mentioned that irrelevant programmes aired limited usage of TV sets for accessing agricultural knowledge. Other farmers (12, 17.6%) were limited from watching TV agricultural programmes by expenses needed for subscribing TV channels while 49 (72.1%) did not know when agricultural programmes were broadcasted. Moreover, low ownership of TV sets among farmers limited TV

usage in acquiring agricultural knowledge as only 63 (20%) of the farmers involved in the study owned TV sets.

Table 5.28: Factors limiting usage of ICT tools in acquiring and sharing agricultural knowledge (N=within specific ICT tool)

Factor limiting usage of ICT tools	ICT tool		
	Radio set	TV sets	Mobile phones
Illiteracy	03 (1.6%)	01 (1.5%)	04 (2.5%)
Poor signals/networks	26 (13.5%)	02 (3.0%)	34 (21.4%)
Program aired during odd hours	123 (63.7%)	45 (66.2%)	00 (00%)
Lack of power sources	59 (30.6%)	21 (30.9%)	41 (25.8%)
Irrelevant content	05 (2.6%)	02 (3.0%)	100 (62.9%)
High expense/tariffs	18 (9.3%)	12 (17.6%)	75 (47.2%)
Limited awareness on when a program is aired	120 (62.2%)	49 (72.1%)	00 (00%)

Among the farmers using mobile phones for acquiring agricultural knowledge, four (2.5%) of them were limited by illiteracy while 34 (21.4%) were limited by poor mobile phone network coverage. Others (41, 25.8%) were limited by lack of sources of power while 100 (62.9) preferred to use mobile phones for non-agricultural purposes. Moreover, 75 (47.2%) were limited by high tariffs.

Findings from focus group discussions were similar to those presented in Table 5.28. Those involved in key informant interviews revealed that usage of ICTs for performing agricultural knowledge processes was limited by poor ICT network coverage, illiteracy on usage of some ICT applications and unreliable sources of power. Others mentioned that limited ownership of ICT tools and information illiteracy also limited the usage of ICTs in acquiring and sharing agricultural knowledge.

5.8 Role of the Government in enhancing access and use of agricultural knowledge

The Government of Tanzania has been implementing various interventions aiming at enhancing access and usage of agricultural knowledge. Findings from key informant interviews revealed this. The review of relevant documents (policies and reports) from the Ministry of Agriculture,

Livestock and Fisheries (MALF) (URT, 2013) and the Tanzania Communication Regulatory Authority (TCRA) (TCRA, 2011, 2012, 2013, 2015a, 2015b) showed how the government enhanced access and usage of agricultural knowledge. It was found that the Government strengthened agricultural research and development, provided agricultural training and extension services and established a reliable agricultural marketing system. Moreover, the Government created environment for the development of reliable communication infrastructure, invested in rural electrification and enhanced access to agricultural inputs. Furthermore, it was found that the Government created a favourable environment for the involvement of private sector in the creation and sharing agricultural knowledge among AKS actors.

5.8.1 Strengthening agricultural research and development

It was found that the government of Tanzania through MALF has been strengthening agricultural research and development so as to improve and optimize production, productivity, competitiveness and profitability of farmers. It was found that the Ministry had a chain of 18 agricultural research institutes spread throughout the country to cater for local agricultural challenges in each specific zone. It was found that these institutes developed, promoted and disseminated new technologies. They also produced and disseminated new seed varieties. Copy rights of developed seeds were sold to companies which reproduced such seeds in large scales before selling to farmers. It was found that the Government maintained quality of seeds through the Tanzania Official Seed Certification Agency. Moreover, results indicate that each agricultural research institute had an outreach department for sharing new development and technologies to farmers. Demonstration plots, leaflets, brochures and trainings were used for disseminating new knowledge, developments and technologies.

5.8.2 Agricultural training and extension services

Findings indicate that the government through MALF provided both long and short term trainings to students and agricultural extension officers. Agricultural extension trainees were trained at certificate, diploma or bachelor levels. It was also found that the Government through MALF and the Ministry of Regional and Local Governments provided refresher courses to agricultural extension officers through scheduled trainings and workshops. Findings from

agricultural extension officers indicate that such courses were rarely provided thus limiting agricultural extension officers from providing agricultural knowledge services to farmers.

It was reported that the main role of agricultural extension officers was to enhance farmers' learning through a variety of techniques and enhancing access to agricultural knowledge needed by farmers. Each district has a Department of Agriculture, Irrigation and Cooperatives led by the District Agriculture, Irrigation and Cooperatives Officer (DAICO) with the role of overseeing all agricultural development issues including provision of agricultural knowledge to farmers. It was found that DAICO made employment requests of agricultural extension officers to Ministry of Public Services Management through the Ministry of Regional and Local Governments.

Findings from the main survey, key informant interviews and focus group discussions revealed that each of the nine villages involved in the study had an agricultural extension officer. Findings revealed that farmers requested for different categories of agricultural knowledge from agricultural extension officers. It was found that farmers requested for knowledge on when to sow seeds, types of seeds, fertilizer and pesticide application and how to handle yield after harvest. Findings indicate that most farmers made requests during crop husbandry time. Results also indicate that face to face oral communication was mainly used when requests were made. Moreover, agricultural extension officers mentioned that they trained farmers through different techniques including establishing demonstration plots in villages. They also mentioned to have farmer to agricultural extension officer contact sessions whereby physical visits to farms were made so as to learn how farm activities were being carried out.

5.8.3 Creating suitable environment for development of reliable communication infrastructure

Findings from key informant interviews indicate that it was the role of the Government to ensure that rural areas had passable roads throughout the year. Local governments set aside funds for enhancing this. Through roads, transportation services were possible and some farmers were able to access some few agricultural booklets, leaflets, brochures and books on time. Findings from some villages indicate that most roads were passable throughout the year making it possible for transportation of agricultural inputs, produce and some agricultural print materials.

The Government of Tanzania has been creating suitable environment for telecommunication companies and private radio and TV stations to operate. To meet this, the Government established TCRA which regulated the postal, broadcasting and electronic communications sectors. According to TCRA (2012), operators were responsible for building and maintaining info-communication infrastructure and providing efficient and affordable ICT services to Tanzanians from both rural and urban areas. Findings from TCRA indicate that by the time the current study was being undertaken Tanzania had licensed 123 radio stations, 30 television stations, 44 postal and courier operators. It was found further TCRA also licensed 21 network facility licenses, 17 network services and 82 application services. Among radio stations, six were allowed to operate national wide, 17 regional wide and 100 radio stations were allowed to operate district wide. Findings from TCRA revealed that among the 30 TV stations registered and operating in Tanzania, five had national coverage, five had regional coverage and 20 had district coverage.

In Morogoro region there were nine radio stations covering all districts in the region. Moreover, there were other radio stations with national wide coverage which could be accessed in region. Thus, farmers had a wide range of choice to make in terms of which radio station to listen to. Tanzania migrated from analogue to digital TV broadcasts in 2015. Results indicate there were several companies providing digital TV services in Tanzania. However, Azam, Zuku, Startimes, Dstv, Ting, Agape and Continental were the most common. With digital access to television broadcasts, farmers in rural areas could have access to both categories of coverage. Moreover, it was found that Morogoro region had two TV stations with district coverage.

It was found that Vodacom, Airtel, Tigo, Zantel and TTCL were the major mobile phone operators with countrywide network coverage. Results indicate that by September 2015 Vodacom had 12,520,645 subscribers; Airtel had 10,887,742; Tigo had 10,639,610; Zantel had 1,567,879; and TTCL had 304,214 subscribers. This made a total of 35,920,090 subscribers of mobile phone services in the country. It was found from TCRA that there were other mobile phone operators including Halotel and Sasatel which were still penetrating into the market. Moreover, some mobile phone operators provided some agricultural knowledge services to farmers. Vodacom had the agricultural club "*Kilimo Klab*" and Tigo had the Tigo Club "*Tigo*

Kilimo” which both provided agronomic, agricultural market and weather information to farmers.

Since most communication devices require access to reliable power, Tanzania set strategies to enhance access to power in rural areas. In 2005, Tanzania established the Rural Energy Agency (REA), an autonomous institution to promote and facilitate access to power in rural areas of mainland Tanzania. Findings indicate that the Government has been supporting REA through funds and technical expertise through the Tanzania Electric Supply Company Limited. To the time the current study was undertaken, power infrastructure was being developed in most villages. Moreover, among the nine villages where the current study was undertaken only one village had no electric power. Among other benefits, access to power helped farmers recharge mobile phones and easily access radio and TV broadcasts.

5.8.4 Enhancing access to agricultural inputs

The Government of Tanzania has put in place different strategies to enhance usage of acquired agricultural knowledge among farmers. The Government has a section in the Crop Development Division of MALF which initiated and reviewed policies on agricultural inputs, inspected and certified crop varieties and seeds and monitored usage of agricultural inputs. The Government had also imposed agricultural input subsidies that more farmers can afford to buy and use inputs thus putting into use acquired agricultural knowledge.

5.8.5 Creating favourable environment for involvement of private sector in creation and sharing agricultural knowledge

It was reported during key informant interviews that the Government recognized the role played by the private sector in socio-economic development in Tanzania. In 2010, the “Public Private Partnership Act, 2010” was developed. It was found that MALF had many partners operating throughout the country. It was reported that the cooperation between the government and the private sector was being strengthened and promoted so as to improve socio-economic development. Actors from the private sector including local and international NGOs and private companies were involved in implementing agricultural related projects mainly in rural areas in

the country. Findings indicate that these organizations were involved in provisions of good agricultural practice trainings to other actors. Interventions aimed at improving agricultural research, seed multiplication, post-harvest processing, developing agricultural irrigation systems, and agricultural marketing systems. Results indicate that NGOs and private companies worked very closely with local and central governments in implementing agricultural interventions. It was revealed that before starting operations they had to make introductions and familiarizations with the DAICO office. This was done so as to create a common understanding and lay down necessary strategies which helped the two sides to work together. Findings also indicate that areas with more partners implementing agricultural interventions had better productivity.

5.9 Significant variables that influence AKS usage among actors

The study determined significant variables that influenced AKS usage among actors. All farmers involved in this study mentioned to use AKS for either acquiring/creating or sharing knowledge. AKS was also used for storing and disseminating agricultural knowledge. Moreover, findings presented in this chapter have shown that there were several variables which influenced usage of AKS among actors. The following sub-sections give details of each variable influencing AKS usage among actors.

5.9.1 Influence of type of AKS on AKS usage

Findings in Table 5.29 on page 191 indicate that the level of usage of AKS differed from one type of AKS to the other. Regardless of the influence of demographic characteristics most farmers used human based system. It was found that 310 (98.7%) of the farmers used human based system. Findings indicate that ICT based system followed in level of usage while the paper based system was the least used one.

As shown in Table 5.11 on page 160, Table 5.21 on page 177, Table 5.22 on page 178 and Table 5.29 on page 191, easily accessible and cheap AKS were more used than those which were not easily accessible and expensive. Findings indicate further that AKS access points found around actors were more used than those found far away (see Tables 5.11 on page 160 and Table 5.24 on page 180). Moreover, AKS involving more listening and talking were used more than those

which involved reading and writing (see Tables 5.11 on page 160, Table 5.21 on page 177 and Table 5.26 on page 182). For these reasons, more farmers used human based system followed by ICT based system while paper based system was the least used.

5.9.2 Influence individual factors on usage of AKS

Individual factors have a direct influence on some independent variables and sometimes on dependent variables. Individual factors include literacy, income, sex, and farming experience. Findings in Table 5.29 indicate that literacy, income, sex, and farming experience influenced usage of agricultural knowledge sources. These factors may directly or indirectly hinder or influence usage of AKS.

Table 5.29: Influence of demographic characteristics on AKS usage (N=314)

Demographic variables		Type of AKS		
		Human based system	Paper based system	ICT based system
Sex	Male	151 (98.7%)	26 (17%)	125 (81.7%)
	Female	159 (98.8%)	13 (08.1%)	107 (66.5%)
Age group	15-25	22 (100%)	00 (00%)	18 (81.9%)
	26-35	78 (98.7%)	07 (08.9%)	56 (70.9%)
	36-45	79 (98.8%)	14 (17.5%)	59 (73.8%)
	46-55	42 (100%)	06 (14.3%)	36 (85.7%)
	56-65	89 (100%)	12 (13.5%)	63 (70.8%)
Level of education	Informal	38 (100%)	02 (05.3%)	14 (42.1%)
	Adult	13 (92.9%)	02 (14.3%)	10 (71.4%)
	Primary	217 (98.6%)	29 (13.2%)	170 (77.3%)
	Secondary	42 (100%)	06 (14.3%)	36 (85.7%)
Farming experience	01-10	120 (100%)	13 (10.8%)	88 (73.3%)
	11-20	78 (97.5%)	10 (12.5%)	62 (77.5%)
	21-30	56 (98.7%)	07 (12.3%)	41 (71.9%)
	>30	56 (98.7%)	09 (15.8%)	41 (71.9%)
Average yield (in 100 kgs bags)	1-10	13 (100%)	00 (00%)	05 (38.5%)
	11-20	109 (99.1%)	14 (12.7%)	80 (72.7%)
	21-30	51 (100%)	06 (11.8%)	44 (86.3%)
	31-40	28 (96.6%)	04 (13.8%)	21 (72.4%)
	41-50	08 (100%)	02 (25%)	07 (87.5%)
	>50	95 (97.8%)	13 (13.4%)	71 (73.2%)

Findings in Table 5.29 indicate that the influence of demographic characteristics on usage of human based system was very minimal. Usage of paper based system was slightly influenced by sex of the user as more male users (26, 17%) reported to use it than females (13, 08.1%). Moreover, usage of paper based system somehow increased with age of the user (see Table 5.29 on page 204 for details). Furthermore, the level of usage of paper based system was influenced by level of education of actors. As shown in Table 5.29, the level of usage of paper based system increased with level of education. Additionally, it was found that usage of paper based system slightly increased with an increase in farming experience (see Table 5.29 for details). There was no clearly defined influence of level of yield on usage of paper based system.

Findings in Table 5.29 indicate that sex influenced usage of ICT based system. It was found that 125 (81.7%) of the male farmers and 107 (66.5%) of the female farmers used ICT based system. Moreover, usage of ICT based system slightly decreased with age. It is shown in Table 5.29 that more young farmers used ICT based system than old ones.

Findings in Table 5.29 also indicate that the level of education influenced the usage of ICT based system. It is found that the level of usage of ICT based system increased with an increase in level of education. However, experience in farming and yield showed no clearly defined influence on usage of ICT based system.

A cross tabulation analysis was run to determine the association between demographic characteristics and usage of different types of AKS. Results in Table 5.30 indicate that level of education has an influence on usage of human based system ($\text{Eta} = 0.125$) but it has a slightly stronger influence on usage of ICT based system ($\text{Eta} = 0.278$). It was also found that age group of farmers influenced usage of AKS. Results in Table 5.30 also indicate that age group had a slightly strong influence on usage of paper based system ($\text{Eta} = 0.154$) while it had a low influence on usage of ICT based system ($\text{Eta} = 0.129$) and on human based system ($\text{Eta} = 0.128$). Moreover, farming experience had a slightly stronger influence on usage of paper based system ($\text{Eta} = 0.148$) than on usage of the other two types of AKS.

Table 5.30: Strength of association between usage of AKS and demographic characteristics (N=314)

Usage of AKS by demographic characteristics	Eta	Eta Squared
Use human based system * Level of education	.125	.016
Use human based system * Age group	.128	.016
Use human based system * Years in agricultural activities	.112	.013
Use human based system * Total yield in 100 kg bags	.092	.008
Use ICT based system* Level of education	.278	.077
Use ICT based system* Age group	.129	.017
Use ICT based system* Years in agricultural activities	.070	.005
Use ICT based system* Total yield in 100 kg bags	.030	.001
Paper based system used * Level of education	.082	.007
Paper based system used * Age group	.154	.024
Paper based system used * Years in agricultural activities	.148	.022
Paper based system used * Total yield in 100 kg bags	.067	.004

A cross tabulation was run to determine the influence of sex on usage of ICT and paper based system. The influence of sex of respondents on usage of human based system was not considered because it was found that actor's sex had no influence on usage of human based system (see Table 5.29 on page 191 for details). Results in Table 5.31 indicate that there was an association between sex of user and usage of AKS. It was found that usage of both ICT (Phi = .173) and paper (Phi = .135) based AKS was influenced by sex of the user. These results indicate that usage of ICT based system was influenced more by sex of the user than usage of paper based system.

Table 5.31: Strength of association between ICT usage and sex of farmers (N=314)

AKS by sex of user	Variable measurement	Measure of association	Value	Approx. Sig.
Usage of ICT based system* Sex of user	Nominal by Nominal	Phi	.173	.002
		Cramer's V	.173	.002
Usage of paper based system * Sex of user	Nominal by Nominal	Phi	.135	.017
		Cramer's V	.135	.017

5.9.3 Influence of knowledge usefulness on AKS usage

The frequency of acquisition of some categories of agricultural knowledge determined the level of usage of AKS. Findings in Table 5.8 on page 154 and Table 5.9 on page 156 indicate the level of acquisition of knowledge was determined by the perceived importance of knowledge among AKS actors. It was for this reason some categories of agricultural knowledge were either used very frequently, frequently, infrequently or not used at all. Moreover, agricultural knowledge perceived to be more useful was shared more among actors (see Table 5.19 on page 175 for details).

5.9.4 Influence of accessibility of agricultural knowledge sources on AKS usage

Accessibility of agricultural knowledge sources is explained by source availability, response time after consulting the source and awareness about the existence of agricultural knowledge sources. Other factors that describe accessibility of agricultural knowledge sources include appropriateness of time for accessing the source and ownership of communication tools. The influence of accessibility of agricultural knowledge sources on usage of AKS has been proven by findings presented in Table 5.15 on page 169, Table 5.16 on page 171 and Table 5.17 on page 172. Findings from these tables indicate that sources which were easily accessible were used more than those which were hardly accessible. Moreover, quality of the radio, TV and mobile phone network influenced the accessibility of agricultural knowledge sources and usage of AKS (see Table 5.15 on page 169 and Table 5.28 on page 185). Likewise, usage of agricultural knowledge sources was influenced by the availability of source of power among actors in AKS (see Table 5.15 on page 169 for details).

To determine the influence of availability of agricultural knowledge source on usage of AKS, the strength of association between usage of major ICTs and point of access was measured. Findings in Table 5.32 on page 196 indicate that there was a strong association between ownership of ICTs and using them for acquiring agricultural knowledge. As shown in Table 5.32 on page 196, ownership of radio sets strongly influenced usage of radio sets for acquiring agricultural knowledge ($\Phi = 0.845$, Cramer's $V = 0.845$). Results further indicate that ownership of TV also strongly influenced TV usage for acquiring agricultural knowledge ($\Phi = 0.730$, Cramer's $V =$

0.730). Likewise, ownership of mobile phones strongly influenced usage of mobile phones for acquiring and sharing agricultural knowledge ($\Phi = 0.803$ and Cramer's $V = 0.803$).

It was found that accessing ICTs from relatives and friends had a moderate association with usage of these tools for acquiring agricultural knowledge. Moreover, results indicate that there was a moderate influence between accessing TV broadcast from relatives and friends and using TV sets for acquiring agricultural knowledge ($\Phi = 0.371$, Cramer's $V = 0.371$). Findings indicate further that there was a weak association between accessing mobile phone services from relatives/friends and using mobile phones for acquiring or sharing agricultural knowledge ($\Phi = 0.056$, Cramer's $V = 0.056$). However, there was a negative association between accessing TV broadcast from clubs or kiosks and watching TV agricultural programmes in clubs or kiosks ($\Phi = -0.030$, Cramer's $V = 0.030$). Moreover, there was a negative association between accessing mobile phones from kiosk and using them for acquiring or sharing agricultural knowledge ($\Phi = -0.057$, Cramer's $V = 0.057$). Thus, those who owned ICTs had more access to these tools and used them more for either sharing or acquiring agricultural knowledge.

Table 5.32: Strength of association between ICT usage and ICT access points (N=314)

Usage of ICTs against point of access	Variable measurement	Measure of association	Value	Approx. Sig.
Use radio to acquire agricultural knowledge * Own radio	Nominal by Nominal	Phi	.845	.000
		Cramer's V	.845	.000
Use radio to acquire agricultural knowledge * Access radio from relatives or friends	Nominal by Nominal	Phi	.101	.074
		Cramer's V	.101	.074
Use radio to acquire agricultural knowledge * Access radio from club or kiosk	Nominal by Nominal	Phi	. ^a	
		Cramer's V		
Use radio to acquire agricultural knowledge * Own TV	Nominal by Nominal	Phi	.730	.000
		Cramer's V	.730	.000
Use radio to acquire agricultural knowledge * Access TV from relatives or friends	Nominal by Nominal	Phi	.371	.000
		Cramer's V	.371	.000
Use TV to acquire agricultural knowledge * Access TV from club or kiosk	Nominal by Nominal	Phi	-.030	.598
		Cramer's V	.030	.598
Use radio to acquire agricultural knowledge * Own mobile phone	Nominal by Nominal	Phi	.803	.000
		Cramer's V	.803	.000
Use radio to acquire agricultural knowledge * Access mobile phone from relatives or friends	Nominal by Nominal	Phi	.056	.323
		Cramer's V	.056	.323
Use mobile phone to acquire agricultural knowledge * Access mobile phone from club or kiosk	Nominal by Nominal	Phi	-.057	.310
		Cramer's V	.057	.310

5.9.5 Influence of ease of use of the system on AKS usage

The amount of efforts a user had to exert in using AKS influenced the level of usage of AKS. In this study, effort is explained in terms of affordability, level of education, ability to own communication tools and pay for tariffs. It was also found that users who did not have enough income did not manage to own communication tools (see Table 5.15 on page 169 and Table 5.16 on page 171). Moreover, users had to pay for tariffs so as to use mobile phones. As shown in Table 5.33, there was a negative relationship between high mobile phone tariffs and using mobile phones for acquiring or sharing agricultural knowledge. The Phi value of -0.029 shows that there

was a negative association between high tariffs and using mobile phones for acquiring agricultural knowledge.

Table 5.33: Strength of association between affording tariffs and usage of mobile phones (N=314)

Tariffs against usage	Type of variable	Measure	Value	Approx. Sig.
Affording mobile phone tariffs *	Nominal by Nominal	Phi	-.029	.657
Using mobile phones for accessing agricultural knowledge		Cramer's V	.029	.657
N of Valid Cases			234	

Lastly, findings from Table 5.14 on page 167 and Table 5.29 on page 191 indicate that actors in AKS needed to be literate so as to consult some agricultural knowledge sources. Illiterate actors failed to optimize AKS usage because they lacked necessary skills for either acquiring or sharing agricultural knowledge.

5.9.6 Influence of availability of agricultural knowledge on AKS usage

Availability of agricultural knowledge influences AKS usage. Availability of knowledge is determined by one's awareness on the presence of the needed knowledge (see Table 5.15 on page 169 and Table 5.17 on page 172), frequency of usage of some knowledge sources (refer Table 5.12 on page 162), and usage of newly acquired agricultural knowledge (see Figure 5.1 on page 157). Findings indicate that actors used AKS when they believed it had the needed knowledge.

A cross tabulation was run to determine the association between accessing radio and TV agricultural programmes. As found in Table 5.34, there was an association between using radio and TV sets for acquiring agricultural knowledge and time of broadcast. The association between accessing radio and TV agricultural programmes and ordinary broadcast time had Phi value of .284 and Cramer's V value of .284 for radio agricultural programmes and Phi value of .718 and Cramer's V value .718 for TV agricultural programmes. Results indicate further that the association between accessing radio agricultural programmes and farmers' preferred time had a Phi and Cramer's V value of .368. It was further found that the association between accessing

TV agricultural programmes and farmers' preferred watching time had a Phi value of .718 and Cramer's V value of .755. These findings indicate that more farmers could access radio and TV agricultural programmes at preferred time than at ordinary time.

Table 5.34: Association between accessing radio and TV agricultural programmes and broadcast time (N=314)

Radio/TV for acquiring agricultural knowledge against preferred access time	Variable type	Measure	Value	Approx. Sig.
Radio used for accessing agricultural knowledge * Broadcast time of agricultural programs	Nominal by Nominal	Phi	.284	.006
		Cramer's V	.284	.006
N of Valid Cases			203	
Radio used for accessing agricultural knowledge * Preferred broadcast time of agricultural programs	Nominal by Nominal	Phi	.368	.000
		Cramer's V	.368	.000
N of Valid Cases			204	
TV used for accessing agricultural knowledge * Broadcast time of agricultural programs	Nominal by Nominal	Phi	.718	.000
		Cramer's V	.718	.000
N of Valid Cases			128	
TV used for accessing agricultural knowledge * Preferred broadcast time of agricultural programs	Nominal by Nominal	Phi	.755	.000
		Cramer's V	.755	.000
N of Valid Cases			129	

5.9.7 Social influence and AKS usage

Social influence was found to be exerted by two forces namely expert effect and majority effect. Expert effect was exerted by agricultural extension officers; input suppliers and village based agricultural advisors (refer Table 5.13 on page 164 for details). Farmers got directive on how to perform different agricultural activities from these actors. Village and ward agricultural extension officers received orders from their supervisors the District Agricultural Irrigation and Cooperative Officers. Majority effects were mainly exerted among peers, fellows and colleagues. Both these forces influence usage of AKS among farmers because farmers had to acquire

recommended agricultural knowledge while agricultural extension officers had to follow directives given from supervisors.

5.9.8 Influence of ownership of communication tools on AKS usage

Findings in Table 5.24 on page 180 indicate that actors accessed communication tools from different access points. Table 5.25 on page 181 shows that majority of those who owned communication tools used them for different agricultural purposes. Moreover, Table 5.17 shows that lack of ownership of communication tools limited acquisition and sharing of agricultural knowledge. Furthermore, Table 5.27 on page 183 indicates that farmers acquired agricultural knowledge through radio and TV sets during mornings and evenings respectively. For acquiring such knowledge during the specified time, it was necessary for actors to own communication tools. Thus, ownership of communication tools had a strong influence on usage of AKS.

5.9.9 Influence of community culture on AKS usage

Table 5.11 on page 160, Table 5.12 on page 162 and Table 5.24 on page 180, revealed that culture had a strong influence on where to access knowledge and to whom to share acquired knowledge. Community culture builds strong ties and trust among actors which influence how agricultural knowledge is shared and accessed. Findings in Table 5.12 on page 162 and Table 5.22 on page 168 indicate that knowledge sources and communication channels which were more trusted by farmers were used more. It was for this reason some agricultural knowledge sources were used by majority of users and more frequently than others (see Table 5.12 on page 162 for details).

5.9.10 Influence of communication infrastructure on AKS usage

Findings in Table 5.15 on page 169 and Table 5.17 on page 172 indicate that infrastructure played an important role in enhancing access to agricultural knowledge. Table 5.17 indicates that power supply and ICT network/signals were important for using ICTs in performing agricultural knowledge processes. Investments in ICT, power and road infrastructure enhanced access to agricultural knowledge.

5.10 Chapter summary

This chapter presented the findings of the investigation on how AKS can be strengthened for improved rural livelihoods in Tanzania. The overall results indicate that actors in the agricultural sector used different types of AKS. Results indicate that most actors used human based system while paper based system was the least used. It was also found that each actor played a specific role in AKS.

Findings indicate that actors acquired and used different categories of agricultural knowledge. More actors acquired knowledge on weather and seed selection techniques. It was found that farmers acquired agricultural knowledge from different sources. Among the most used agricultural knowledge sources were fellows and radio sets.

It was found that not all of the acquired knowledge was used by actors. Very few among farmers used all of the acquired agricultural knowledge. Some of the reasons for the low usage of acquired agricultural knowledge included: accessing knowledge lately and limited access to some inputs.

Results indicate that most actors shared agricultural knowledge. Knowledge on seeds was found to be shared more. Majority of AKS actors mentioned farmers as recipients of shared knowledge. Sharing agricultural knowledge among actors was mainly through face to face oral communication.

Among ICTs, radio sets are mentioned to be the most used. Other ICTs commonly used were TV sets, mobile phones, computers and internet. ICTs were used for acquiring, creating, sharing, storing, and disseminating agricultural knowledge. Usage of ICTs was mainly limited by lack of power sources, low ownership of ICT tools, high tariffs and poor ICT infrastructure.

The Government played major roles in enhancing agricultural knowledge generation and dissemination. It also created suitable environment for the private sector operation in agriculture. Moreover, the government invested in infrastructure which enabled usage of AKS.

Finally, findings indicate that there were key variables that influenced usage of AKS. It was found that type of AKS, accessibility of knowledge sources, knowledge usefulness and knowledge

availability influenced usage of AKS. Other variables influencing AKS usage were community culture, ownership of communication tools and infrastructure. It was found that social influence, efforts needed to use AKS and individual factors also influenced usage of AKS. The following chapter interprets and discusses in details all findings presented in this chapter.

CHAPTER SIX

INTERPRETATION AND DISCUSSION OF RESEARCH FINDINGS

6.1 Introduction

The previous Chapter presented research findings of the study. The current Chapter interprets and discusses research findings presented in Chapter Five. Interpretation of research findings is an important process; Murray (2011) describes it to give meaning to analyzed data. After assigning meaning to research findings, discussion is made so as to have better understanding of the problem under study. As reported by Labaree (2014), discussion of research findings is an important process because it explains the meaning of the findings and why they are important; relates the findings to similar studies; and considers alternative explanations of the findings. Thus, interpretation and discussion of research findings is set to have a clear understanding of the topic under study while being guided by the overall objective. As explained in Section 1.5 of Chapter One, the overall objective of the study was to investigate how AKS can be strengthened for improved rural livelihoods in Tanzania so as to recommend a model for enhancing access to agricultural knowledge among actors. The specific objectives of study were listed in Section 1.5.1 of Chapter One. In order to address these objectives, the study answered the following key research questions:

- i. Which types of AKS are used in the study area?
- ii. What categories of knowledge do AKS actors need?
- iii. Which factors hinder access to agricultural knowledge among AKS actors?
- iv. How is agricultural knowledge shared among actors forming the AKS?
- v. How ICTs support agricultural knowledge management and AKS?
- vi. What roles are played by the Government in enhancing access to and use of AKS?
- vii. What are the significant variables that influence AKS usage among actors?

Presentation of the current chapter follows the order of research questions listed above. The literature review in Chapter Three provided some insights for research question one and two while research question seven has been discussed in Chapter Two. Moreover, the reviewed literature from Chapter Three provided a basis for comparison with research findings presented in Chapter Five.

6.2 Characteristics of respondents

The current study had neither specific objective nor research question on demographic characteristics of AKS actors. However, due to the strong influence of actors' demographic characteristics on AKS usage the study found it important to collect adequate information on each characteristic. Demographic characteristics (information on sex, age, level of education, average yield and experience in agricultural related activities) of the respondents have been presented in Section 5.2 of Chapter Five. As discussed in Chapter Two of this study, these factors are considered to have a moderating role when it comes to usage of Information Systems. This is supported by Serenko, Turel and Yol (2006) and Venkatesh, Morris, Davis, and Davis (2003) who describe demographic characteristics to influence major variables in system usage. The findings of impacts of these characteristics on AKS usage have been presented in the proceeding sections of the same chapter.

From Section 5.2 of Chapter Five, it can be found that majority of farmers were in the 56-65 age group. These findings have been revealed by several studies in both developing and developed countries including Oluwasegun (2013) and Rigg (2006) who reported that majority of the farmers were elders. Among the 314 farmers involved in the study only seven percent were between 15-25 years of age. In general, fewer young people involved themselves in agricultural activities than the old ones. These findings are explained by two major issues: firstly, most young people between the age of 15 and 25 years were in schools attending secondary and tertiary education; and secondly, young people shy away from agricultural activities and migrate to urban areas for non-agricultural activities. This is supported by Beegle, Deweerdt and Dercon (2011) who also found that young people in Tanzania migrated from rural agricultural based communities to urban areas for non-agricultural activities.

Findings in Section 5.2.2 of Chapter Five showed that majority of the respondents (220, 70.1%) had primary level of education. This is a common trend in Tanzania because most of those who do not pass and qualify for secondary education are absorbed by the agricultural sector as farmers. Findings showed further that among the 38 farmers with informal education, 31 (81.6%) were female farmers. This is explained by Mlyakado (2012) who reported that educational opportunities among females in Tanzania were limited. It was found that seven (4.6%) male farmers had adult education as compared to seven (4.3%) female farmers with the same level of education; 112 (73.2%) of the male farmers had primary education as compared to 108 (67.1%) female farmers; and 27 (17.6%) of the male farmers had secondary education compared to 15 (9.3%) female farmers. Mongi, Majule and Lyimo (2010) describe level of education as a factor influencing understanding and decision making in agricultural undertaking. Those with higher education are more likely to make rational decisions regarding using scarce resources than those with low education. For this case, important measures are needed to improve educational opportunities among females.

Another important factor influencing agricultural production is family size and marital status. According to Lowder, Skoet and Singh (2014), family size tells about the number of members in a family and family labor for agricultural production for family farms. It can also tell about the consumption patterns of what has been produced in farms. Marital status tells about who is the head of the household. La Ferrara (2010) describes that marital status also tells about who decides for the family. As presented in Section 5.2.3 of Chapter Five, majority of the farmers (151, 48.1%) were from households with four to six family members. These results are supported by NBS (2012) which showed that the average family size in Tanzania is 4.8. Most respondents (222, 70.7%) came from married couples. These findings are also supported by NBS (2012) which showed that majority of Tanzanians come from married couples. NBS (2012) showed further that majority of people from Morogoro Region come from married couples too. With married couples in the three districts, fathers were heads of households because the patriarch system was followed. This implies that fathers were more involved in making decisions about various family issues including agricultural activities.

Experience in agricultural activities was measured by number of years one has been involved in farming. Experience could tell about actor's agricultural knowledge behaviour built over time. Findings on farming experience of farmers have been presented in Section 5.2.4 of Chapter Five. It was found that more farmers (120, 38.2%) had one to ten years of farming experience. Although farmers' age was an important determinant of farming experience, findings indicate that age did not necessarily tell about one's farming experience because some migrated to farming after spending some years in non-agricultural activities while others joined farming to supplement income after retiring from previous employment. Regardless of their experience in farming activities, the number of active farmers decreased as they approached 65 years of age. This is explained by the fact that farmers retired from farming as they became old because farming requires physical strength which always declines with an increase in age.

Farmers involved in the study grew maize or paddy but some grew both of the two crops. These results are in line with those of URT (2012) which showed that maize and paddy were the most important cereal crops grown in Morogoro Region. Maize was mainly grown in Kilosa and Mvomero districts while paddy was predominant in Kilombero and Mvomero districts. Farm size for maize was between one to five acres. This is almost similar to what was reported by URT (2012) who stated that the average farm size in Kilosa, Kilombero and Mvomero districts was two hectares. Moreover, few farmers who grew paddy had larger farms; this is mainly explained by the fact that the capital needed for growing paddy was slightly higher than that of maize.

Average yield was an important determinant of usage of AKS because yield from farm activities was an important indicator of farmer's income. Average yield was measured by the number of 100kg bags harvested within an acre. Majority of the farmers harvested between one and ten bags of major crops grown. This is supported by URT (2012) which reports that maize and paddy productivity in Morogoro Region was generally low and that the average yield for maize was 0.72 tons per hectare. Few farmers had high yield because less than five percent of maize growers harvested between 21 and 30 bags while 18.9% of paddy growers harvest between 21 and 30 bags. This is explained by high level of adoption of recommended good agricultural practices among the few maize and paddy growers.

Generally, age, sex, level of education, experience in agricultural activities and average yield were important characteristics of the farmers. These characteristics had a strong influence on the way farming was being conducted and in one way or the other they influenced farmers' livelihoods. Details on how each moderated AKS usage are given in proceeding sections of this chapter.

6.3 AKS used by actors in agricultural sector

The study revealed that three types of AKS were used by actors in the agricultural sector. These were human based, paper based and ICT based system. Human based system was made up of human beings who created new agricultural knowledge mainly through observation and experience, stored acquired knowledge in human memory and shared it through face to face oral communication. Findings revealed that this was the most used AKS among the farmers as 310 (98.7%) of the farmers involved in the study mentioned to use it. These results are supported by Lwoga (2011) who also found that agricultural knowledge management among farmers is based on human observation for knowledge creation, human memory for knowledge storage and the oral face to face communication for knowledge sharing.

Findings indicate that 231 (73.6%) farmers used ICT based system. This type of AKS was made up of ICT tools; they were used for capturing, sharing and storing agricultural knowledge. Farmers used ICTs mostly for acquiring and sharing agricultural knowledge. Radio and TV sets were the most used for acquiring agricultural knowledge while mobile phones were used for both acquiring and sharing agricultural knowledge. None of the farmers mentioned to use ICTs for creating agricultural knowledge. Likewise, majority of the other AKS actors used ICTs for capturing, sharing and storing agricultural knowledge. However, some ICTs were used by agricultural researchers for creating agricultural knowledge too.

The other type of AKS used by actors was the paper based system. With this type of AKS, paper was used as a carrier of data during data collection; it was used for storing knowledge; and finally used for knowledge sharing. Among farmers, the usage of paper based system was found to be the lowest as only 39 (12.4%) of the farmers used it. These findings are supported by Lwoga (2011) who reported that print materials are not used much by farmers. As reported by

Mtega (2012), usage of print materials was somehow limited by impassable roads mainly during rainy season, limited postal services network and high illiteracy levels. Moreover, unavailability of rural library services made it difficult for farmers to have access to and use of agricultural print materials. However, actors other than farmers used both human based, paper based and ICT based AKS. Decision of what type of AKS to use depended on who were involved in agricultural knowledge processes. Choice of type of AKS also depended on the nature of the organizational/community culture, level of communication infrastructure, and recipient of intended knowledge.

6.3.1 Roles of key AKS actors

AKS actors depended on each other when performing their activities. Broadly, there were three key AKS actors namely the Government, farmers and the private sector. These actors were either involved in agricultural knowledge creation, usage, sharing and dissemination.

6.3.1.1 The role of the public sector in AKS

Being the main actor in creation and dissemination of agricultural knowledge, the Government performed several agricultural knowledge management roles. The Government through the MALF developed the National Agricultural Policy which was implemented to enhance agricultural development, food security and improvement of rural livelihoods. Among the key issues stipulated in the National Agricultural Policy of 2013 is enhancing access to and usage of latest agricultural knowledge among actors in the agricultural sector. This was made possible through investing in agricultural research and training, agricultural extension and education services, and providing favourable environment for the involvement of the private sector in creation and dissemination of agricultural knowledge. The Government established agricultural research institutes which created agricultural knowledge needed by other actors. These institutes also generated new developments and technologies needed by other AKS actors for transforming the agricultural sector.

The government instituted a top-down agricultural knowledge transfer model where agricultural research institutes were knowledge creators while farmers were considered as consumers. This

was also reported by Lwoga (2011) who found that agricultural research institutes in Tanzania generated technical knowledge which was transferred to farmers through agricultural extension services. Agricultural extension officers were placed from zone to village level and had a single role of enhancing access and usage of state of art agricultural knowledge among farmers. Agricultural extension officers were trained to impart farmers with needed skills and educate them on improved agricultural practices. They also acted as agricultural knowledge brokers because they acquired knowledge from multiple sources and made it available to farmers. Each zone had a Zone Agricultural Extension Office which acted as a link between agricultural research institutes and other actors in the zone. Practical problems faced by farmers were channeled to agricultural research institutes through agricultural extension officers.

The top-down agricultural knowledge transfer model considered farmers as recipients and not generators of knowledge which empirically is not the case. Several studies conducted in Tanzania (Benard *et al.* 2014; Mtega 2012; Lwoga 2011) have shown that farmers created agricultural knowledge through observation and experience and shared it with fellow farmers. Describing farmers' agricultural knowledge creation role; Lwoga (2011) reported that farmers created new agricultural knowledge through personal experience, social group gatherings, demonstration and observation and farmer groups. This implies that farmers were involved in creations, usage and sharing of agricultural knowledge.

6.3.1.2 The role of the private sector in AKS

The private sector was found to be an important partner to agricultural development in the country. Its presence was through input suppliers, services providers and producers (Kimaro, Mukandiwa and Mario 2010). The National Agricultural Policy of 2013 mentions that greater involvement of the private sector in agricultural production, processing, marketing and the provision of support services is important for the sector's development. The private sector in Tanzania has been empowering other actors in the agricultural sector and improving their capacities in making rational decisions regarding allocation of resources (Lema and Kapange 2006). Findings in section 5.3.1 indicate that input suppliers, buyers of agricultural produce, radio and TV stations were among AKS actors from the private sector. Others were mobile phone

operators, local and international NGOs, warehouse operators, millers and private companies. Farmers' associations which were formed and managed by farmers were also among AKS actors from the private sector.

Input suppliers operated agro-shops in villages from which farmers bought agricultural inputs. There was an umbrella organization for input suppliers from each district which was there to manage rights of members. Findings in sub-Section 5.3.2 of Chapter Five indicate that few attendants of agro-shops had agricultural related backgrounds. Having adequate agricultural skills was important for one to provide agricultural services better. This was more important because input suppliers were among the sources of agricultural knowledge as 105 (33.4%) of the farmers mentioned to consult them (see Table 5.11 on page 160 for details). Lacking basic agricultural skills was dangerous as some farmers were illiterate; they could hardly read and understand what was written in packages or accompanied brochures and only believed on what was said by attendants of agro-shops. Skilful agro-shop attendants were mentioned to be more useful, it was reported by some farmers that they had to go to an agro-shop located at a distance from their village for just consulting a skilful agro-shop attendant.

The Government through the National Food Reserve Agency bought agricultural produce from few farmers for the national grain reserve. Majority of the farmers sold their agricultural produce to private companies and individual buyers. Findings on Table 5.11 on page 160 indicate that 33 (10.5%) of the farmers used buyers of agricultural produce as their sources of agricultural knowledge. Buyers mentioned to have been disseminating knowledge on quality and grades of agricultural produce. Generally, buyers played an important role not only as source of agricultural knowledge but also as a source of income among farmers.

NGOs played an important role in AKS. In the study area there were many NGOs. Among them were MVIWATA which operated in all of the three districts and NAFKA project under Feed the Future which operated in Kilombero and Mvomero districts. These organizations imparted agricultural knowledge to farmers and other actors in maize and rice value chain mainly through trainings and demonstration plots. Farmers were trained on agricultural production and collective marketing. Knowledge on agricultural production helped in increasing the level of productivity

while that of collective marketing increased farmers' bargaining power and helped in setting prices for their agricultural produce. This is supported by Kawa and Kaitara (2007) who reported that through collective marketing farmers could do gross margin analysis and can set selling prices covering production costs and a reasonable amount of profit.

These NGOs formed farmers' groups which later graduated into farmers' associations. As shown in Table 5.11 on page 160, 63 (20.1%) of the farmers acquired agricultural knowledge through farmers' group. They also trained promising and progressive farmers who later had to work as village based agricultural advisors. Findings in Table 5.11 indicate that 120 (38.2%) of the farmers acquired agricultural knowledge through village based agricultural advisors.

The NAFKA project under Feed the Future supported input suppliers through grants which aimed at enhancing access to agricultural inputs that farmers could use after having adequate knowledge on good agricultural practices. The NAFKA Project Report of 2014 indicated that input suppliers who were granted agro-dealer grants had to establish demonstration plots for farmers to learn from. They also had to train farmers on good agricultural practices. MVIWATA on the other hand played an important role on training and mobilizing farmers to form savings and credit organizations. They also had a mobile agricultural marketing information system which provided farmers with latest information on prices and markets for agricultural produce.

Most villages had warehouses which were either owned by farmers' associations or some individuals. In most cases warehouses had milling machines for processing farm produce. Farmers decided to either process harvest before selling or sell unprocessed produce. Warehouse operators mentioned to have been sharing knowledge on how to store agricultural produce after harvest. Warehouse operators worked closely with buyers who used warehouses as collection points of bought agricultural produce. As farmers visited warehouses, they learnt how to store their harvest. Those who marketed their harvest collectively used such skills for better storage of what they left as food for their families.

The other important AKS actors were print media, radio and TV stations. Newspapers were mainly from Dar es Salaam city while radio and TV stations were either from within (district or community stations) or outside the region. Radio and TV stations located outside Morogoro

region were accessed in all of the three districts and had regional representatives. As found from Table 5.11 on page 160, radio and TV stations played an important role in disseminating agricultural knowledge. It was found that 193 (61.5%) and 80 (25.5%) of the farmers acquired agricultural knowledge through radio and TV sets respectively.

Mobile phone operators played important roles in facilitating communication among AKS actors. Findings in Table 5.11 on page 160 indicate that 152 (48.4%) of the farmers either acquired or shared agricultural knowledge through mobile phones. Tigo, Vodacom Tanzania and Zantel (Etisalat) had agricultural value added services for farmers. Such services were accessed via four mobile channels: Unstructured Supplementary Service Data (USSD), push SMS subscription, Interactive Voice Response (IVR) and a helpline (Palmer and Pshenichnaya 2015). AKS actors used mobile phones for mobile money transfer services and other agricultural information services. This is supported by Palmer and Pshenichnaya (2015) who found that mobile phone operators provided agronomic tips, market price information and weather forecasts. Generally, mobile phone operators facilitated accessibility of several services to AKS actors.

6.3.2 Linkages among actors in the agricultural sector

There was a poor linkage between farmers, agricultural extension officers and agricultural research institutes. Few farmers had access to agricultural extension officers. This was mainly due to the low agricultural extension officer to farmers' ratio in Tanzania. This is also reported by Daniel (2013) who found that few farmers in Tanzania had access to agricultural extension services due to limited number of agricultural extension officers. Moreover, due to limited number of agricultural extension officers who acted as brokers between agricultural research institutes and farmers, most of farmers' practical problems were not communicated to agricultural research institutes. Despite having agricultural research institutes in all of the three districts, the linkage between farmers from neighbouring and agricultural research institutes was still poor that farmers had to go through such bureaucratic procedures so solving their agricultural problems. Furthermore, there were no structured agricultural markets. This resulted into limited access to agricultural markets information among actors in the sector. In addition, most agricultural programmes broadcasted by radio and TV sets were during odd hours. As

stated by Mtega (2012), broadcasting agricultural programmes during odd hours made such programmes useless because few of the intended audience accessed them. Lastly, late delivery of agricultural inputs made it difficult for farmers to use all of the acquired agricultural knowledge. To a great extent all these left AKS actors from the two ends unlinked.

6.4 Agricultural knowledge acquired by AKS actors

AKS actors acquired agricultural knowledge for their agricultural activities. The categories of agricultural knowledge acquired differed from one AKS actor to the other depending on one's involvement in agriculture. As indicated in Table 5.7 on page 152, farmers acquired agricultural knowledge related to weather; farm preparation; seed selection techniques; seed sowing techniques; and crop maintenance. Mtega (2012) and Lwoga (2011) reported the same that farmers needed knowledge related to weather, farm preparation, seeds, crop maintenance, post-harvest practices, credits and agricultural marketing. Decision on what category of agricultural knowledge to acquire depended on perceived usefulness of knowledge. For this reason, most farmers acquired knowledge on seed selection techniques, weather and crop maintenance while few acquired knowledge on land preparation and credits. These findings are similar to those reported by Bernard *et al.* (2014) and Mtega (2012) who also found that most farmers reported to need knowledge on seeds, weather and crop maintenance. Most farmers perceived that it was important to decide on the best seed varieties while considering levels yield and marketability of each seed variety. Farmers knew that some seeds were more marketable but had low yields while others had high yield while being less marketable. It was important for farmers to have a clear understanding about all conditions surrounding each seed variety before sowing.

Rainfall unreliability made it important for most AKS actors to acquire knowledge on weather. Actors mentioned that knowledge on weather was not limited to when it was going to rain but included seed varieties suitable for the changing climate. Tolerance of seeds to drought was taken into consideration because most farmers were affected by drought and rainfall unreliability on one time or the other. With regard to knowledge on crop maintenance, farmers mentioned it to be important for better yields as it was about managing crops after germination. They mentioned to include knowledge on proper usage of top dressing fertilizers, pesticides and herbicides. These

findings are supported by scholars (Benard *et al.* 2014; Mtega, Dulle and Benard 2013; Lwoga 2011) who also reported that farmers needed knowledge on application of fertilizers, pesticides and herbicides for better maintenance of crops and for improved yields.

Some farmers mentioned to acquire knowledge on post-harvest practices because they stored agricultural produce for food consumption or sales when prices become better. Farmers acquired such knowledge because it was important for limiting post-harvest losses. As shown in Table 5.7 on page 152, few (112, 35.7%) of the farmers acquired knowledge on post-harvest practices because most farmers used traditional food storage systems. It was mentioned that farmers preferred traditional storage techniques because they were simple and inexpensive. Those who acquired knowledge on post-harvest practices mentioned to have been selling their harvest when prices were better. Few other AKS actors acquired knowledge on agricultural marketing. The number was low as most farmers mentioned that during harvest time middlemen went throughout their villages looking for agricultural produce. Prices during harvest time were very low and almost uniform due to oversupply of agricultural produce. They mentioned that if one wanted to sell harvests outside their villages then extra costs must be met. This limited most farmers from acquiring knowledge on agricultural marketing.

Knowledge on agricultural credits was least acquired by farmers. Most farmers mentioned that there were no credits set aside for farming activities. Others mentioned that they feared borrowing because they could lose collaterals they would have to put so as to secure credits. Fear for credits limited the number of farmers acquiring knowledge on agricultural credits.

As mentioned in Section 5.4 of Chapter Five, other actors acquired agricultural knowledge related to their roles. Due to nature of their roles, some AKS actors acquired all categories of agricultural knowledge. Among those who acquired all categories of agricultural knowledge were agricultural extension officers. These actors acquired all categories of knowledge because they served farmers with different knowledge needs. Moreover, they linked farmers and agricultural research institutes. These findings are in line with those of Akpalu (2013) and Klerkx and Leeuwis (2008) who also found that agricultural extension officers disseminated different types of agricultural knowledge and acted as bridges between researchers and farmers.

Agricultural researchers had the main role of generating new knowledge farmers needed for improving agricultural activities. To meet their role they had to acquire knowledge related to agricultural research problems at hand. After identifying solutions they reported to share research outputs to farmers through agricultural extension officers. Mangombe and Sabiiti (2013) supported these findings by stating that agricultural researchers generated knowledge, agricultural extension officers transferred knowledge while farmers utilized generated knowledge.

NGOs acquired agricultural knowledge related to the type of projects they implemented. The two NGOs (NAFAKA and MVIWATA) involved in the three districts implemented interventions aiming at improving smallholder farmers' level of productivity and profitability. This involvement required the two organizations to acquire all categories of agricultural knowledge beneficiaries could need to support farming and related activities.

The communication sub sector in Tanzania was primarily dominated by the private sector. There were more privately owned radio and TV stations than public owned ones. The Government only owned the Tanzania Broadcasting Corporation with several radio and TV stations. In agriculture, radio and TV stations were used for disseminating agricultural knowledge to actors. In most cases NGOs and private companies sponsored radio and TV agricultural programmes for educating farmers and other AKS actors. Among 213 (67.8%) and 84 (26.8%) of the farmers who used radio and TV sets respectively 193 (90.6%) and 68 (80.8%) of them used radio and TV sets for acquiring agricultural knowledge respectively (Table 5.24 on page 180 and 5.25 on page 181 for details). The categories of agricultural knowledge disseminated through radio and TV sets depended on the type of interventions implemented by sponsors. However; most private companies sponsored programmes on certified seeds, fertilizers, pesticides and quality management of harvested crops. This is supported by scholars (Siyao 2012; Lwoga 2011; Kapange 2004; Arokoyo 2003) who also found that private companies involved in agriculture disseminated knowledge on agricultural inputs through radio and TV programmes they sponsored.

Mobile phone operators played a key communication role in AKS. AKS actors used mobile phones for communicating with colleagues on agricultural and non agricultural issues. Mobile phone operators providing value added agricultural services acquired and disseminated different

categories of agricultural knowledge. Palmer and Pshenichnaya (2015) found that through mobile phone value added agricultural services AKS actors accessed agronomic knowledge they needed for farming.

6.4.1 Preference of agricultural knowledge among AKS actors

Preference of agricultural knowledge among AKS actors was determined by the frequency of acquisition of knowledge. Agricultural knowledge categories which were most acquired were the most preferred and those least acquired were least preferred. For this case, the level of acquisition of agricultural knowledge was categorized as “*very frequently*”, “*frequently*”, “*infrequently*” or “*not acquired at all*”.

Preference of agricultural knowledge varied among AKS actors and differed by key activities of each actor. Among farmers, preference of agricultural knowledge was found to differ according to perceived usefulness of agricultural knowledge. Among different categories of agricultural knowledge, weather was mentioned to be acquired very frequently by 147 (46.8%) of the farmers; frequently by 44 (14%); infrequently by 20 (6.4%). Farmers who very frequently or frequently acquired knowledge on weather mentioned to need such knowledge because farming was mainly rain-fed. This is supported by Kijazi, Chang’ a, Liwenga, Kanemba and Nindi (2013) who also reported that most farmers in Tanzania acquire knowledge on weather because agricultural food production was widely rain-fed. The few who infrequently acquired knowledge on weather reported that they had farms in irrigation schemes.

Another knowledge very frequently acquired by more farmers was knowledge on crop maintenance. As found in Table 5.8 on page 154, knowledge on crop maintenance was acquired very frequently by 105 (33.4%) of the farmers as opposed to 83 (26.4%) and 27 (8.6%) of the farmers who mentioned to acquire it frequently and infrequently respectively. Those who acquired it very frequently or frequently mentioned that knowledge on crop maintenance was important for better maintenance of crops and improved yield. These findings are supported by Mundree (2016) who describes that knowledge on crop maintenance is important for increased yields. Those who either acquired it infrequently or did not acquire it at all mentioned to employ traditional farming systems.

Seeds are probably the most important inputs among most farmers (Asiedu-Darko 2014). It is for this reason most farmers mentioned to acquire knowledge on seed selection techniques. They mentioned that knowledge on selection helped them to know the characteristics and marketability of different seed varieties. Most farmers reported to select seeds basing on yield and marketability. It was for this reason that majority of the farmers acquired knowledge on seed selection techniques very frequently (131, 41.7%) or frequently (137, 43.6%). Those who either acquired knowledge on seed selection techniques infrequently or did not at all mentioned to prefer sowing traditional seeds.

Farmers who were members of farmers' groups mentioned to have acquired knowledge on land preparation and seed sowing techniques. They mentioned to acquire such knowledge through demonstration plots where they gained skills on good agricultural practices. Despite the importance of farm preparation and seed sowing techniques to yield, most of the farmers (231, 73.6%) mentioned not to acquire these categories of knowledge. These farmers mentioned to employ traditional farm preparation and seed sowing techniques because employing recommended techniques was time consuming. Those who did not adopt the suggested land preparation techniques mentioned that they do not make bunds during farm preparation and employed seed broadcasting system for seed sowing because it was easy. Bunds were important for better water management in farms while suggested seed sowing techniques ensured appropriate spacing between crops that each piece of land maintains the recommended number of plants. Farmers who participated in demonstration plot activities mentioned to adopt either direct sowing or transplanting seeds to farms and employed recommended spacing between plants. Knezevic, Evans and Mainz (2003) describe that recommended spacing between plants influence growth and development of crops and simplify weed removal.

Other agricultural knowledge categories were preferred by few farmers. Most of the farmers (200, 63.7%) did not acquire knowledge on post-harvest practices. They mentioned to use traditional storage facilities and techniques for storing harvests. Those who either acquired post-harvest knowledge very frequently (18, 5.7%) or frequently (49, 15.6%) were mostly members of farmers' groups who learnt on post-harvest procedures after harvesting crops from demonstration plots; others were farmers who sold their harvests during off-season for better

prices. These farmers had to learn on how to preserve their harvest so as to prevent quality loss and limit post-harvest losses.

Knowledge on agricultural marketing was preferred by few farmers because there were no formal marketing structures to rely on. Some did not acquire knowledge on agricultural marketing because they never sold their produce to limited harvests. Others sold their harvests to buyers who used to go from one household to the other searching for agricultural produce to buy. Moreover; since during harvest time prices were almost uniform, it was useless to seek for market related information. There were few farmers who either very frequently (26, 8.3%) or frequently (36, 11.5%) acquired such knowledge. Farmers acquiring knowledge on agricultural knowledge did this so as to look for better markets outside their villages where they could have better prices.

Majority of the farmers (271, 86.3%) did not acquire knowledge on agricultural credits while few mentioned to have acquired it very frequently, frequently or infrequently. These findings are supported by Mtega (2012) who found that very few farmers preferred knowledge on agricultural credits while majority dislike it because they were afraid of losing whatever has been put as collateral.

Preference of agricultural knowledge among other actors was influenced by their involvements in AKS. Due to their roles in AKS, agricultural extension officers had to frequently acquire all categories of agricultural knowledge. This was because they had to share acquired knowledge to farmers with varied agricultural knowledge needs. Agricultural extension officers were advisors, technicians and brokers operating between agricultural research institutions and the farm families (Anaeto, Asiabaka, Nnadi, Ajaero, Aja, Ugwoke, Ukpongson and Onweagba 2012). As brokers, agricultural extension officers linked farmers and other AKS actors to different sources of agricultural knowledge including agricultural research institutes, universities, colleges and the government. On the other hand, agricultural researchers mentioned to acquire very frequently knowledge related to practical problems they had to solve during a given period of time.

NGOs implemented different interventions among AKS actors. They frequently acquired categories of agricultural knowledge related to their interventions. For example, MVIWATA and

NAFAKA implemented interventions aiming at increasing agricultural productivity and profitability. For this case, they frequently acquired and disseminated different categories of agricultural knowledge to meet needs of farmers, input suppliers and warehouse operators. Likely, input suppliers frequently acquired knowledge related to their key role. They mentioned to acquire knowledge related to dosage and usage of agro-chemicals and preference of farmers with respect to types of seeds. Warehouse operators mentioned to frequently acquire knowledge on post-harvest techniques and quality management. Owners of private seed companies mentioned to acquire knowledge on weather, crop maintenance, post-harvest practices and seed marketing strategies.

Radio and TV stations were used as channels for sharing agricultural knowledge. Agricultural programmes aired were sponsored by either private companies, NGOs or the Government. For them, their main role was to make sure that other AKS actors had access to what sponsors wanted to disseminate. On the other hand, mobile phone operators provided communication services and agricultural value added services to other actors. Before providing agricultural value added services to intended audience, mobile phone operators were required to acquire different categories of agricultural knowledge.

6.4.2 Categories of agricultural knowledge acquired during each stage of the cropping calendar

The cropping calendar included several stages namely farm preparation, sowing, crop maintenance, harvest and post-harvest. AKS actors acquired agricultural knowledge related to core activities performed during each stage of the cropping calendar. With respect to knowledge on weather, findings in Table 5.9 indicate that 208 (66.2%) of the farmers acquired it before or during farm preparation. Dependency on rain-fed food production system necessitated farmers to acquire this category of knowledge during this stage of the cropping calendar. It was also found that 117 (37.3%) acquired knowledge on weather before or during sowing seeds. This was because seeds required water for germinating. Thus, farmers had to have adequate knowledge on weather before or during sowing seeds. It was also found that 150 (47.8%) acquired knowledge on weather during crop maintenance. Those who acquired it during this stage mentioned that

fertilizer application required a certain level of humidity and if applied when the land was too dry crops could be dehydrated. Moreover, those who acquired knowledge on weather during weeding mentioned that weeding was more effectively done if rains stopped for few days that weeds may easily shrivel and finally dry up. Findings indicate further that 30 (9.6%) of the farmers acquired knowledge on weather during harvest time. Those acquiring it during harvest time mentioned that it was important to make sure that there were no more rainfalls before embarking on harvesting. This is explained by the fact that humidity destroys harvests because if grains are subjected to water they start germinating. Few farmers (09, 2.9%) mentioned to acquire it during post-harvest stage. Likewise, these farmers acquired knowledge on weather so as to manage the humidity and quality of yields.

Findings in Table 5.9 on page 156 indicate that all farmers (83, 26.4%) who acquired knowledge on how to prepare farms acquired it during farm preparation. They reported to have acquired knowledge on deep ploughing and bund making for better water management. This category of knowledge was found to be more useful because some villages experienced droughts, unreliable or short rainfalls.

Some of the farmers (195, 62.1%) acquired knowledge on seed selection techniques during farm preparation while others (194, 61.8%) acquired it during seed sowing. Acquiring this category of knowledge during farm preparation was important because farmers needed adequate time to select best seeds varieties. Those who acquired it during seed sowing explained that they had to make selection among the many seed varieties sold by input suppliers and that they just needed to know qualities of each variety before making decision. Others, 23 (7.3%) and 13 (4.1%) acquired knowledge on seeds during post-harvest. This is explained by the fact that some farmers used seeds from previous seasons; knowledge on seed selection techniques helped them decide on what should be kept as seeds as they were harvesting.

Farmers (83, 26.4%) who needed knowledge on seed sowing techniques acquired it during seed sowing stage. They mentioned that it was the relevant time for accessing it because what was being done in demonstration plots was easily adopted in their farmers. On the other hand, majority (211, 67.2%) of the farmers acquired knowledge on crop maintenance during weeding

and top dressing fertilizer application. Crop maintenance involved top dressing, weeding, and pesticides application. Farmers who acquired this category of knowledge mentioned that they acquired it during relevant time as such knowledge was not needed during any other time of the cropping calendar.

Farmers acquired knowledge on post-harvest practices. Findings in Table 5.9 on page 156 indicate that 75 (2.9%) and 112 (35.7%) acquired it during harvest and post-harvest stage respectively. This is explained by the fact that farmers acquired this category of knowledge during this stage because it was relevant time for proper management of what they harvested. Farmers who managed stocks for sale during off season acquired this category of agricultural knowledge so that they may be able to maintain the quality of stored yields. Likewise, knowledge on agricultural marketing was acquired during or after harvest because it was time to sell what was harvested. Those who acquired such knowledge during farm preparation and crop maintenance stages retained some of the stock to be sold during off season. On the other hand, the few farmers who acquired knowledge on credits acquired it when they wanted to access credit.

Other AKS actors acquired agricultural knowledge according to the cropping calendar. It was for this reason agricultural extension officers acquired adequate knowledge for each stage of the cropping calendar. NGOs, input suppliers, private companies, buyers and warehouse operators also acquired knowledge categories related to key roles being performed during each stage of the cropping calendar.

6.4.3 Reasons for not using some of the acquired agricultural knowledge

Not all of the acquired agricultural knowledge was used by actors. Among farmers, only 61 (19.43%) used all of the acquired agricultural knowledge. Findings in Table 5.10 on page 158 indicate that 21 (6.7%) did not afford to buy agricultural inputs. This is explained by the fact that most agricultural inputs were sold at high prices that most farmers could not afford. The government subsidized some inputs which were available to few. This limited the number of farmers who used some of the acquired agricultural knowledge. Others, 30 (9.6%) found some knowledge to be useless after acquiring it. These farmers did not properly assess their knowledge

needs and ended up acquiring what they did not need. Other farmers (145, 46.2%) did not use acquired knowledge because they acquired it lately. This was mentioned by most farmers who acquired agricultural knowledge through demonstration plots. Farmers reported that most demonstration plots were lately established that what they learnt could not be practiced in their farms. It was also found that 56 (17.8%) did not put into use some of the acquired agricultural knowledge because some of the needed agricultural inputs were not available or were delivered lately. Among agricultural inputs which were either not available or delivered lately were some types of pesticides, basal and top dressing fertilizers. This limited farmers from using acquired knowledge on crop maintenance.

Some (35, 11.1%) of the farmers did not put into use all of the acquired agricultural knowledge because it was time consuming to use some of the acquired skills. Among the skills which were not adapted by most farmers was the use of on appropriate spacing during sowing. Most farmers found it to be time consuming while others explained to prefer traditional sowing techniques besides acquiring skills on modern sowing techniques. They explained that employing learnt skills was considered to be difficult and time consuming.

Generally, most actors did not put into use most of the agricultural knowledge acquired. This is because some categories of agricultural knowledge or inputs were either delivered lately or not available at all. Others did not use knowledge because they failed to realize the importance of knowledge. It is the role of all AKS actors to ensure that all needed inputs and knowledge are timely delivered and put into use.

6.4.4 Agricultural knowledge sources used by AKS actors

AKS actors acquired agricultural knowledge from different sources. These sources were either human based sources, ICT based or paper based sources. Human based sources used were fellow farmers, colleagues, agricultural extension officers, input suppliers, buyers of agricultural produce, and researchers. ICT based sources used for acquiring agricultural knowledge were radio and TV sets, computers, internet and mobile phones. AKS actors also used books, booklets, newspapers, leaflets and brochures as paper based sources.

Findings in Table 5.11 on page 160 indicate that human based sources were most used for acquiring agricultural knowledge. Majority of the farmers (305, 97.1%) acquired agricultural knowledge from fellow farmers. Others, 120 (38.2%), 105 (33.4%) and 102 (32.5%) acquired agricultural knowledge from village based agricultural advisors, input suppliers and agricultural extension officers respectively. Similar findings were reported by Benard *et al.* (2014) who found that actors in the agricultural sector preferred acquiring knowledge from fellows and other sources they could consult orally. AKS actors acquired knowledge from colleagues and fellows because such sources were believed to be cheap, knowledgeable, available and easily consulted. Human based agricultural knowledge sources which were used by few AKS actors were not trusted or found away from residential areas.

Among farmers using ICT based sources for acquiring agricultural knowledge, majority (193, 61.5%) used radio sets. Scholars (Mtega 2012; Lwoga 2010; Sife *et al.* 2010) found that this was due to the increased number of regional, district and community radio stations with wide radio coverage. Moreover, the high level of usage of radio sets is explained by the high level of ownership of radio sets among farmers. This is supported by Sife *et al.* (2010) who also found that radio sets were widely used in rural areas. Moreover, radio broadcasts could also be accessed through mobile phones which were owned by many rural people.

Likewise, mobile phones were used by most AKS actors for normal communication purposes while some accessed agricultural knowledge through these tools. Findings in Table 5.11 on page 160 indicate that 152 (48.4%) farmers acquired agricultural knowledge through mobile phones. Farmers accessed some SMS about agronomic practices direct from mobile phone operators. This is supported by Palmer and Pshenichnaya (2015) who also reported that mobile phone operators in Tanzania provided agronomic tips, marketing information and weather forecasts to agricultural actors through SMS. Mobile phones were also used as channels for consulting fellow farmers, agricultural extension officers, input suppliers or buyers through both voice calls and SMS. This is in line with what was reported by Lwoga *et al.* (2011a) who found that farmers used mobile phones for accessing agricultural knowledge from some agricultural knowledge sources.

TV sets were also used for acquiring agricultural knowledge. Among the farmers, few (80, 25.5%) acquired agricultural knowledge through TV sets. The usage of TV sets as source of agricultural knowledge was limited by ownership and lack of sources of power. Sife *et al.* (2010) also reported that low ownership of TV sets and lack of sources of power limited usage of TV sets in rural areas.

Among other AKS actors, TV sets were used mainly for acquiring or disseminating agricultural knowledge. With an exception of NGOs and private companies who disseminated agricultural knowledge through TV stations, others used TV sets for acquiring agricultural knowledge. Agricultural researchers, workers from NGOs and private companies, and some few agricultural extension officers used computers and internet. Usage of computers was low because few had access to these tools. Likewise, due to low internet connectivity in the country few AKS actors had access to internet services. However, advancements in mobile phone technologies have made it possible for actors to access internet services via mobile phones. However, none of the farmers mentioned to use internet services for accessing agricultural knowledge.

AKS actors used different paper based sources of agricultural knowledge. They used books, booklets, leaflets, newspapers and brochures. It was found that paper based agricultural knowledge sources were least used among the farmers (only 55 (17.5%) used these sources). This is explained by the unavailability of such sources in most villages. Moreover, low literacy levels among farmers also resulted into limited usage of paper based agricultural knowledge. Same results were reported by Mtega (2012) who also found that usage of agricultural print resources among farmers was limited by several factors including low literacy.

Most of the other AKS actors used paper based sources for accessing agricultural knowledge. Due to the nature of their work, agricultural extension officers and researchers consulted books and other print resources in search for agricultural knowledge. Input suppliers mainly used booklets, brochures and leaflets while buyers of agricultural produce mainly used newspapers for the same purpose.

6.4.4.1 Frequency of usage of agricultural knowledge sources among AKS actors

Preference in agricultural knowledge source was measured by the frequency of usage of knowledge sources. It was found that human based agricultural knowledge sources were the most frequently used sources. Fellow farmers as an agricultural knowledge source was found to be the most frequently used agricultural knowledge source as majority of the farmers (241, 76.8%) used it very frequently. Village based agricultural advisors followed in order of preference as 77 (24.5%) used it very frequently. Farmers used most frequently these sources because they were found near their residential areas and were accessed free of charge. This is supported by Mtega (2012) who found most farmers use agricultural knowledge sources which were affordable and close to residential areas.

Agricultural extension officers and input suppliers were found to be used frequently by 59 (18.8%) of the farmers. Lwoga *et al.* (2011a) reported these to be among the important agricultural knowledge sources. Moreover, due to the perceived importance of these sources to farmers the government of Tanzania enhanced access to agricultural extension services in most villages in the country. It was found that each village had a single agricultural extension officer; each village had also few agro-shops too. Due to the large number of farmers, it was impossible for one agricultural extension officer and few agro-shop attendants to serve thousands of farmers in a village. The same findings are reported by Daniel (2013) who also found that agricultural extension officer to farmers' ratio in Tanzania was too small that one extension officer had a large number of farming households to serve resulting into limited accessibility of agricultural extension services among most farmers.

Other human based agricultural knowledge sources were rarely used. These included buyers, village executives, agricultural researchers, trainings and seminars, farmers' groups and churches/mosques. This is explained by the fact that some of these sources were not easily reachable while others needed some fees for one to consult them. Churches and mosques were not used because they were believed to lack agricultural knowledge. This is supported by King and Rollins (1999) who also found that farmers preferred knowledge rich sources and shy away from knowledge poor sources.

Mobile phones and radio sets were the most frequently used among ICT based agricultural knowledge sources. This is explained by the increasing mobile phone network in both urban and rural areas in Tanzania. Moreover, increased usage of mobile phones and radio sets is explained by the increasing number of regional, district and community radio stations in the country. Furthermore, increased usage of agricultural radio broadcasts can be explained by the portable and affordability of radio sets. This is supported by Salawu (2012) who found that affordability and portability of radio sets made it possible for more people to acquire agricultural knowledge. The high level of listening to agricultural broadcasts is also explained by the fact that such programmes could be accessed through mobile phones with frequency modulation application.

Among the farmers, TV sets were used by few (39, 12.4%). Usage of TV sets as an agricultural knowledge source was limited by low ownership and lack of source of power mainly in marginalized areas of most villages. Sife *et al.* (2010) support this observation by urging that ownership of ICT tools is an important determinant of level of usage, those owning ICTs are more likely to use them more frequently than none owners.

Paper based agricultural knowledge sources were least used by farmers. This is explained by their unavailability in most rural areas. Lack of libraries and rural resource centres also explained why print resources were least used. Moreover, low literacy among farmers limited the usage of paper based knowledge sources even when they were made available. This is in line with what was reported by Mtega (2012) who found that low literacy among farmers limited usage of print resources among farmers.

Among other AKS actors, usage of agricultural knowledge sources was influenced by the effectiveness of knowledge sources in delivering intended outcomes. Agricultural researchers and employees from NGOs mentioned to use internet services because the source was very rich in terms knowledge. Agricultural extension officers, input suppliers and buyers mentioned to use print resources and mobile phones. Others used trainings, workshops, conferences and seminars as sources of agricultural knowledge because they perceived these sources to be more effective.

6.4.4.2 Factors influencing usage of agricultural knowledge sources

Several factors were identified to influence usage of agricultural knowledge sources. Sub sections 6.4.4.2.1 to 6.4.4.2.3 give details on how each factor influenced the usage of agricultural knowledge sources among AKS actors.

6.4.4.2.1 The influence of sex of actors on usage of agricultural knowledge sources

Sex of the actors influenced the choice and usage of agricultural knowledge sources. Among the farmers, it was found that more male farmers (62, 40.5%) than female farmers (40, 24.8%) reported to acquire agricultural knowledge from agricultural extension officers. This is explained by the fact more agricultural extension officers were male and due to some cultural barriers females were not allowed to talk to males. This is supported by Oniang'o (2005) who also found that male farmers had greater contact with extension services than female farmers because cultural restrictions prevented male extension officers from meeting with women farmers. Moreover, regardless of their sex both male and female consulted fellow farmers whenever they encountered problems. This is supported by Benard *et al.* (2014) and Lwoga (2011) who also found that regardless of the sex of farmers, fellow farmers was the most useful source of agricultural knowledge among farmers. This is partly explained by the fact that both male and female farmers were involved in farming and in most cases shared knowledge among themselves.

Findings in Table 5.13 on page 164 indicate that slightly more male farmers (30, 19.6%) and female farmers (20, 12.4%) acquired agricultural knowledge through trainings and seminars. This is explained by the fact that more male farmers were given training opportunities than females. This is supported by Mlyakado (2012) who reported that educational opportunities among females in Tanzania were lower than those of males. Moreover, traditional division of labour limited most female farmers from travelling away for attending trainings or seminars because they had to attend their families. Similar findings were reported by Gwivaha (2015) who found that daily domestic workload hinders females from attending agricultural trainings.

It was found that 21 (13.7%) of the male and 12 (7.5%) female farmers acquired agricultural knowledge from buyers of agricultural produce. This is explained by the fact that males who were also heads of households were involved in selling agricultural produce. The few females who consulted buyers for knowledge on agricultural marketing were mainly those who headed their households. Moreover; since most buyers were males then female farmers were also limited from accessing agricultural knowledge from them due to cultural restrictions.

The usage of ICT based sources was highly influenced by sex of the farmer. As shown in Table 5.13 on page 164, 112 (73.2%) male and 81 (56.1%) female farmers acquired agricultural knowledge from radio sets. Most farmers listened to radio programmes after farm activities. However, this was the time when most female farmers had to prepare meals for the households hence limiting them from acquiring agricultural knowledge through radio sets. This is in line with what was reported by Mtega (2012) found that most female farmers did not access radio programmes because after farm activities they were pre-occupied with household duties. Likewise, more male farmers (46, 30.1%) acquired agricultural knowledge through TV sets as opposed to 34 (21.1%) female farmers. This is also explained by the sex based division of labour which forced female farmers to involve themselves in other household activities soon after farm work. Male farmers used this time to rest and relax thus having adequate time to access TV programmes at home or visit friends, neighbours or clubs for the purpose. However, more female farmers (68, 42.2%) used mobile phones as sources of agricultural knowledge than male farmers (84, 34.9%). This is explained by the fact that females were more involved in farming activities and therefore encountered more challenges. They consulted different sources through mobile phones so as to get immediate feedback. Similar results were reported by Martin and Abbott (2011) who found that more male farmers used mobile phones than females but more female farmers used mobile phones for requesting knowledge on agriculture.

Among other AKS actors, sex had an insignificant influence on usage of most sources of agricultural knowledge. Only agricultural knowledge sources found away from residential areas were used more by male than female AKS actors. However, sex based division of labour still influenced the usage of ICT sources particularly TV and radio sets.

6.4.4.2.2 The influence of other demographic characteristics on usage of agricultural knowledge sources

It was found that age, level of education, farming experience, farm size and average yield positively influenced or negatively usage of agricultural knowledge sources (see Table 5.14 on page 167 for details). Results indicate that there was a weak positive relationship (Spearman Correlation Coefficient = 0.098) existing between age of the farmer and usage of fellow farmers as source of agricultural knowledge. These findings mean that dependency on fellow farmers as source of agricultural knowledge slightly increased with an increase in age of the farmer. This can be explained by the fact that more young farmers relied on sources other than fellow farmers than old farmers did. Moreover; there was a weak negative relationship existing between farmer's age and the use of agricultural extension officers, mobile phones and radio sets. These findings explain that the level of usage of these sources of agricultural knowledge slightly decreased with an increase in age of the farmer. Due to the limited number of agricultural extension officers most old farmers decided to use their farming experience in solving any encountered challenge. Moreover, due to techno phobia some of the old farmers shied away from some ICTs. Likewise; there was a weak negative relationship existing between farmers' age and acquiring agricultural knowledge from trainings/seminars, input suppliers, buyers, demonstration plots, farmer's groups, and village based agricultural advisors. This is also explained by the preference of farming experience to other sources of agricultural knowledge among old farmers.

Findings in Table 5.14 on page 167 show that there was a weak negative relationship existing between farmers' level of education and usage of some agricultural knowledge sources (Spearman Correlation Coefficients ranging from -0.002 to -0.195). This indicates that an increase in level of education had a slight negative impact on choice of agricultural knowledge sources. In other words, farmer's level of education was rarely used as a factor for determining sources of agricultural knowledge but rather as a factor for using acquired agricultural knowledge properly. This is supported by Ngathou, Bukenya and Chembezi (2006) who also describe level of education of farmers to have high influence on how farmers use acquired agricultural knowledge rather than in choosing agricultural knowledge sources.

Results in Table 5.14 on page 167 indicate that there was a weak positive relationship existing between farmers' farming experience and acquiring agricultural knowledge from fellow farmers ($r=0.111$); radio sets ($r = 0.016$); TV sets ($r = 0.036$); mobile phones ($r = 0.017$); and demonstration plots ($r = 0.014$). These findings explain that as farming experience increased farmers' dependency on these agricultural knowledge sources increased slightly. This explains that with an increase in number of years one has been involved in agriculture perception on the importance of these agricultural knowledge sources increases. Farmers can be able to determine the potential of different sources of agricultural knowledge after using them for a certain period of time. This is supported by Ngathou *et al.* (2006) who found that farmers' farming experience helps in knowing some sources which are resourceful. In other words, as farmers practice farming activities for a period of time it becomes easy for them to determine sources which are more informative. However, there was a weak negative relationship existing between farming experience and usage of some agricultural knowledge sources. These results indicate that there was a weak negative relationship existing between farming experience and usage of posters (-0.051); trainings/seminars (-0.109); input suppliers (-0.129); buyers (-0.046); farmer's group (-0.085); and village based agricultural advisors (-0.064). This explains that dependency on these agricultural knowledge sources slightly decreased with an increase in farmers' farming experience. This tells that after using these agricultural knowledge sources for a period of time farmers perceived that the sources were not informative enough that some decided to stop using them.

Findings in Table 5.14 on page 167 indicate that there was no relationship existing between farm size and acquiring agricultural knowledge from agricultural extension. This is explained by the fact that among most farmers in Tanzania, an increase in yield was not due to increased usage of good agricultural practices but rather due to increased acreage. For this case, farm size did not relate to either reduced or increased level of usage of agricultural extension services. This is supported by However, there was a weak positive relationship existing between farm size and acquiring agricultural knowledge from fellow farmers (Spearman Correlation Coefficient = 0.057). This tells that as farm size increased farmers dependency on fellow farmers as an agricultural knowledge source slightly increased. This is also explained by the fact that fellow farmers as an agricultural knowledge source was the most used among farmers because of the

social ties and trust among them. However, there was a weak negative relationship existing between farm size and accessing agricultural knowledge from other sources of agricultural knowledge. This tells that dependency on knowledge sources other than fellow farmers and agricultural extension officers slightly decreased with an increase in farm size. This explains that an increase in farm size does not necessarily result into increased usage of agricultural knowledge. In most cases it indicates an increase in human labour rather than usage of agricultural knowledge keeping in mind that by the time this study was undertaken farming was still pre-dominantly hand hoed.

The other variable which influenced usage of agricultural knowledge sources was yield. Table 5.14 on page 167 indicate that there is a weak positive relationship existing between yield and acquiring agricultural knowledge from agricultural extension officers (Spearman Correlation Coefficient = 0.018); fellow farmers (0.062); mobile phones (0.039); farmer's group (0.034) and village based agricultural advisors (0.147). This is explained by the fact that as farmers harvested more they were slightly more motivated to use agricultural knowledge thus consulting some agricultural knowledge sources. This is further explained by the fact that when acquired knowledge helps farmers meet intended outputs, they perceive it positively and they are more likely to use it more frequently. This is supported by Mittal and Mehar (2015) who found that farmers who get more yield are more likely to consult more sources of agricultural knowledge that they may be able to make more rational decisions and get more profits from farming. However, the relationship existing between yield and usage of these agricultural knowledge sources was very weak because very few farmers reported to have better yields. On the other hand, there was a weak negative relationship existing between yield and the usage of rest of other agricultural knowledge sources. This is partly explained by the fact that some agricultural knowledge sources were perceived to have limited useful knowledge.

Among other actors, age and farming experience had more or less similar influence on choice of agricultural knowledge sources. Among actors other than farmers, level of education influenced both the choice of agricultural knowledge sources and usage of agricultural knowledge. Agricultural knowledge sources believed to be more knowledgeable were consulted more than those perceived to have irrelevant knowledge. Income was also found to influence choice of

agricultural knowledge sources. Those with better income managed to consult even fees based sources. This resulted into knowledge divide among actors in AKS.

6.4.4.2.3 Other factors influencing the usage of sources agricultural knowledge

The usage of agricultural knowledge sources was influenced by some other factors shown in Table 5.15 on page 169. For example, results indicate that majority of the farmers (219, 69.7%) did not use agricultural knowledge sources which were not easily accessible. These sources were either not available, were inadequate in number, needed advanced skills to consult them, were not affordable or were hardly accessible. This is supported by Ngathou *et al.* (2006) who reported that agricultural knowledge sources which are more accessible are more likely to be used by more actors in agriculture. Moreover, simple and easy to consult sources are more likely to be used more by farmers. Farmers (88, 28%) did not use some agricultural knowledge sources because such sources were located far away. Consulting agricultural knowledge sources located far away from residential areas consumes both time and financial resources. This is supported by Mtega (2012) who found that farmers use agricultural knowledge sources found around their residential areas because it cost little time to consult them. Low income AKS actors can hardly benefit from these agricultural knowledge sources.

It was found that 67 (21.3%) of the farmers failed to use some agricultural knowledge sources because of language barriers. This is explained by the fact that some contents were written in technical languages while others were in languages not known to farmers and other AKS actors thus limiting them from using such agricultural knowledge sources. This is in line with what was reported by Ugboma (2010) who found that some actors in the agricultural sector were limited from accessing valuable agricultural knowledge sources simply because of language barriers.

It was found that low income limited some AKS actors from using some sources of agricultural knowledge. For example, due to low income 176 (56.1%) farmers failed to consult some agricultural knowledge sources because they did not have money to be paid as fees. AKS actors were supposed to buy ICT tools and pay for mobile phone tariffs, pay for power charges and

subscribe for TV bundles. This made it difficult for most low income actors to use some of the agricultural knowledge sources.

Other farmers, failed to acquire agricultural knowledge from farmers' group because they were not members. Farmers voluntarily joined farmers' groups which were supported by some public or private organizations. Despite being voluntary, few farmers joined these groups. Through groups, members were trained on different agronomic practices. It was explained that only members benefited from services offered by farmers' groups.

Some AKS actors failed to use ICT based sources due to poor signals or limited network coverage. Some locations in villages involved in the study had poor radio signals and limited mobile phone network. This limited some AKS actors from using some ICTs. It was found out that some actors had no access to sources of power (see Table 5.15 on page 169 for details). This is supported Lwoga (2011) who found that some rural areas in Tanzania had poor ICT infrastructure and were not electrified thus limiting actors in the agricultural sector from using ICT based services.

It was found that agricultural radio and TV programmes were aired during odd hours when majority of actors were attending other activities. For example, 123 (39.2%) of the farmers did not acquire some valuable agricultural knowledge because radio and TV agricultural programmes were broadcasted when they were in farms. Similar results are reported by Sife *et al.* (2010) who found that few farmers benefited from radio and TV agricultural programmes because broadcasters presented such programmes when majority of the intended audience were attending other activities.

It was found that illiteracy among AKS actors limited some from using agricultural knowledge sources. Agricultural knowledge seekers were supposed to have certain skills so as to be able to operate or use some sources. For instance, due to illiteracy few farmers (52, 16.6%) failed to acquire agricultural knowledge from sources because they did not have skills needed to consult such sources. However, the number of farmers who mentioned to have failed to use some agricultural knowledge sources because of illiteracy was low. This is explained by the fact that literacy level may have a stronger influence on usage of agricultural knowledge rather than on

usage of agricultural knowledge sources. This argument is supported by Ngathou *et al.* (2006) who also found literacy levels to have stronger influence on usage of knowledge than on usage of knowledge sources. Moreover, most actors in the study area were literate (knew how to read and write).

Other AKS actors did not use some agricultural because they did not trust them. Among the farmers, 126 (40.1%) did not use some agricultural knowledge sources because they believed that those sources were not knowledgeable enough. Actors usually shy away from agricultural knowledge sources believed to have less or no knowledge at all. AKS actors did not use agricultural knowledge sources believed to have irrelevant contents, they usually use sources which are believed to have more relevant contents. This is supported by Mittal and Mehar (2015) who reported that when farmers become dissatisfied with some sources of agricultural knowledge because of being irrelevant they tend to consult other sources so as to meet their agricultural knowledge needs. Thus, sources believed to have more knowledge are likely to be used more.

6.5 Factors hindering and stimulating accessibility of agricultural knowledge among AKS actors

There were several factors identified to influence accessibility of agricultural knowledge among AKS actors. These factors were found to be either be based on AKS actors or agricultural knowledge sources. Sub sections 6.5.1 and 6.5.2 provide detailed descriptions on how several factors limit accessibility of agricultural knowledge while sub section 6.5.3 provides details on factors stimulating agricultural knowledge accessibility.

6.5.1 Factors hindering agricultural knowledge accessibility based on AKS actors

Some characteristics surrounding AKS actors limited them from accessing agricultural knowledge. Among the farmers, 58 (18.5%) did not acquire knowledge because they thought they knew what they wanted to do (see Table 5.16 for details). These farmers relied on their farming experience rather than recommended agricultural knowledge. Moreover, results indicate that 31 (9.9%) of the farmers acquired what they wanted to use. These farmers only accessed

agricultural knowledge needed for decisions they wanted to make. In most cases decision to access agricultural knowledge was influenced by perceived usefulness of agricultural knowledge for specific activities. This is supported by Obidike (2011) and Demiryurek, Erdem, Ceyhan, Atasever and Uysal (2008) who reported that farmers accessed knowledge they considered appropriate for the decisions they want to make. Because of this reason, farmers accessed different categories of agricultural knowledge at each stage of the cropping calendar.

Findings indicate that farmers (54, 17.2%) failed to access some of the needed agricultural knowledge because they did not know where to access it. These farmers were not aware of the possible sources from which they could access agricultural knowledge. As pointed by Benard *et al.* (2014), when farmers or other actors fail to understand where they can access agricultural knowledge they tend to use what they already have.

Findings in Table 5.16 on page 171 indicate that 45 (14.3%) farmers did not access new knowledge because they preferred to use traditional farming techniques. Traditional knowledge was gained through farming experience and skills inherited from their ancestors. These farmers believed that traditional farming techniques preserved soils, were cheap, did not consume time and were easy to employ. The same findings are reported by Hadi, Chaudhry, Ahmed and Khan (2015) who found that some farmers did not like to employ modern farming techniques because they believed traditional farming techniques could lead to better yields.

It was found that some farmers (40, 12.7%) did not access some knowledge because they did not afford to acquire it. This is explained by the fact that not all agricultural knowledge was accessed freely of charge. Actors were supposed to pay a certain amount of money as they consulted some knowledge sources. Unfortunately, some of the public agricultural extension officers were found to be among the expensive sources of agricultural knowledge as some farmers paid some cash in the name of “fare” that agricultural extension officers could pay physical visits to their farms. Farmers who did not have enough funds failed to access useful agricultural knowledge they needed for improving productivity.

It was found that some farmers did not access some categories of agricultural knowledge because it was difficult to get agricultural inputs needed for implementing acquired knowledge. This is

explained by either the inaccessibility of inputs or the high costs associated with buying inputs. Therefore, inaccessibility and high costs of agricultural inputs discouraged farmers from accessing some agricultural knowledge despite being perceived as important. Likewise, 176 (56.1%) farmers failed to acquire some agricultural knowledge because they did not have money for that. These farmers failed to pay some fee for accessing some agricultural knowledge. This is supported by Mtega (2012) who also found that low income farmers failed to access some agricultural knowledge because they did not manage to pay fee for accessing knowledge. Low income also limited farmers and other AKS actors from owning communication tools. Among farmers, 114 (36.3%) failed to own some communication tools because they did not afford to buy.

Findings indicate that AKS actors failed to access some of the agricultural knowledge because of illiteracy. Among farmers, 52 (16.6%) did not acquire some agricultural knowledge because illiteracy. Illiteracy limited farmers from perceiving the importance of agricultural knowledge to productivity. Illiterate actors could not read messages with agricultural contents. This is supported by Lwoga *et al.* (2011a) who found that high illiteracy levels among some farmers limited them from accessing agricultural knowledge.

6.5.2 Factors hindering accessibility of agricultural knowledge based on knowledge sources

There were several factors other than those based on AKS actors which hindered accessibility of agricultural knowledge. Among the farmers, 219 (69.7%) did not acquire some agricultural knowledge because sources were not easily accessible (see Table 5.17 on page 172 for details). This is explained by the fact that some knowledge sources were either too expensive or not available at all that farmers could not consult them. Other farmers (88, 28%) did not acquire agricultural knowledge because sources were located far away from residential areas. Due to the nature of activities of most actors it was difficult to access agricultural knowledge from sources found far away. These findings are supported by Mtega (2012) who reported that regardless of the importance of knowledge carried agricultural knowledge sources found a distant from farmers' residential areas were consulted by few farmers. Libraries and information centres were

among the agricultural knowledge sources found away from most rural areas that only actors located in urban or working in institutes accessed them.

Findings in Table 5.17 on page 172 indicate that few farmers (67, 21.3%) failed to access some agricultural knowledge because of the technical and difficult languages used. This is explained by the fact that some sources presented knowledge in languages which were technical and not familiar to some actors. Galadima (2014) described language barriers to happen if agricultural information carriers were in languages not understandable to intended audience. Most actors were familiar to Kiswahili language, when agricultural knowledge was presented in languages other than Kiswahili, majority of actors failed to access knowledge regardless of its importance. The same findings were reported by Benard *et al.* (2014) and Siyao (2012) who found that some farmers did not manage to acquire knowledge from some sources due to language barriers.

It was found that few farmers (10, 3.2%) did not acquire some agricultural knowledge because sources consulted did not provide feedback. Actors in AKS seek for clarifications when they did not understand the meaning of the previously acquired knowledge. It was explained that most actors requested for clarifications from some of the consulted agricultural knowledge sources but did not get feedback. For this reason, lack of feedback limited those actors from having adequate agricultural knowledge. As described by Galadima (2014), feedback is important for getting clarifications from knowledge sources before deciding to use previously acquired knowledge.

There were some factors limiting usage of ICT tools among AKS actors. Among farmers, 114 (36.3%) did not acquire some knowledge because they did not own communication tools (see Table 5.17 on page 172 for details). Some actors owned computer, mobile phones, radio and TV sets. Ownership of communication tools enhanced usage of these tools for acquiring agricultural knowledge. Those who did not own ICT tools did not use these tools for accessing agricultural knowledge. The same findings were reported by Siyao (2012) who found when the level of possession of ICT tools is low then the level of accessibility of agricultural knowledge becomes low too. Moreover, radio and TV agricultural programmes were broadcasted during odd hours thus limiting majority of AKS actors from accessing most of the broadcasted agricultural contents. It was found for this reason 123 (39.2%) of the farmers did not access radio and TV

agricultural programmes. Most radio and TV agricultural programmes were aired when actors were performing daily key roles. This is supported by Obadike (2011) who urged that if radio and TV agricultural programmes are broadcasted during odd time only few can benefit from such broadcasts.

It was found that lack of sources of power limited some AKS actors from using some ICT based sources for accessing agricultural knowledge. Among the farmers, 125 (39.8%) mentioned to lack sources of power for running ICT tools. Lwoga *et al.* (2011a) reported similar findings that poor electrification in rural areas limited rural farmers from using some ICTs. Moreover, unreliability of power in electrified areas had similar impacts on accessibility of agricultural knowledge. Thus lack or unreliable power supply hindered AKS actors from using ICT tools thus limiting the accessibility of agricultural knowledge.

Poor signals and network coverage of some ICTs limited AKS actors from acquiring some categories of agricultural knowledge. Among the farmers, 26 (8.3%) failed to acquire some categories of agricultural knowledge because of poor mobile phone network coverage. TCRA (2015b) indicated that most villages did not have adequate ICT infrastructure. It was also found that 125 (39.8%) of the farmers did not acquire some agricultural knowledge because of poor radio signals. It was reported that radio signals were poor in some villages. Moreover, even within villages reported to have better radio signals there were some streets with bad radio signals. This is supported by TCRA (2013) who describes that most of the radio stations in Tanzania had limited coverage.

Among the farmers, it was found that 205 (65.3%) did not access some agricultural knowledge because of inadequate or lack of agricultural extension services. It was found that each village had one agricultural extension officer who had to serve thousands of farmers and other actors. This is in line with what was reported by Daniel (2013) who also found that inadequate provision of agricultural extension services in Tanzania was due to low agricultural extension officer to farmers' ratio. Low number of agricultural extension officers limited the accessibility of agricultural extension service hence accessibility of agricultural knowledge.

Actors' perception on the relevancy of agricultural knowledge from some sources affected usage of knowledge sources and hence knowledge accessibility. Among the farmers, it was found that five (1.6%) of them did not to acquire some agricultural knowledge from some sources because they were perceived to have irrelevant content. Irrelevancy of content was determined after determining that the acquired knowledge did not manage to solve practical problems faced. It was explained that some sources contained knowledge for crops not grown in these villages. This is in line with what was reported by Mittal and Mehar (2015) who found that when actors become dissatisfied with sources because of having irrelevant agricultural knowledge they do not consult such sources again.

Villages conducted meetings from time to time. Village meetings involved all villagers, village government including the agricultural extension officer, and other stakeholders implementing interventions in villages. Despite involving many AKS actors limited attention was given to agricultural issues. It was for this reason that 126 (40.1%) of the farmers reported inadequate agricultural issues were discussed during village meetings. AKS actors could use these platforms for sharing experience and challenges. Thus, limiting agricultural related issues during village meetings negatively influenced the accessibility of agricultural knowledge among actors.

Membership in professional networks influenced agricultural knowledge accessibility among AKS actors. Among the farmers, majority (262, 83.4%) failed to access agricultural knowledge because they were not members of farmers' group. Members in professional networks benefited from different knowledge services which non-members could not. Restricting services to members only was set so as to encourage non-members to join such networks. Duveskog (2013) explained that networks were very important among farmers as other AKS actors provided agricultural knowledge to farmers through their networks/groups. Thus, those who were in groups had better access to agricultural knowledge than those who were not.

6.5.3 Factors stimulating accessibility of agricultural knowledge among AKS actors

There were several factors which stimulated the accessibility of agricultural knowledge among AKS actors. Among the farmers, 303 (95%) mentioned that the availability of agricultural

knowledge sources stimulated agricultural knowledge accessibility (see Table 5.18 on page 174 for details). This tells that when actors have access to agricultural knowledge sources they may easily acquire agricultural knowledge. Actors used sources of knowledge which were available and easily accessible. Availability of agricultural knowledge sources was measured by affordability of sources; being found close to residential areas; being user friendly and accessible. This is in line with what was reported by Mtega and Malekani (2009) who found that agricultural information sources found near farmers were consulted more. Likewise, accessibility of agricultural knowledge among AKS actors was stimulated by ownership of communication tools. Those owning communication tools have adequate time for using the tools for acquiring agricultural knowledge. Taking an example of ownership of ICT tools, Sife *et al.* (2010) reported that usage of ICT tools for acquiring agricultural knowledge was higher among owners than among non-owners.

The other factor stimulating accessibility of agricultural knowledge among was affordable mobile phone tariffs. Among the farmers, 206 (65.6%) revealed that affordable mobile phone tariffs stimulated accessibility of agricultural knowledge. In Tanzania, the TCRA monitored how mobile phone tariffs were set. According to TCRA (2011), tariffs set should just, reasonable, cost oriented, and non-discriminatory. When mobile phone tariffs become lower more AKS actors use mobile phones for access agricultural knowledge. This is proved by findings in Table 5.28 on page 185 which indicated that high mobile phone tariffs was among the reasons limiting actors from using mobile phones for acquiring agricultural knowledge.

It was found that a well developed communication infrastructure stimulated the accessibility of agricultural knowledge. Communication infrastructure includes roads, power, ICT and other networks of hardware and software facilitating the dissemination and sharing of agricultural knowledge. TCRA (2015b) indicated that development of communication infrastructure involved both the public and private sector. TCRA (2015b) showed further that ICT infrastructure was not well developed in some rural areas of Tanzania. This limited the accessibility of agricultural knowledge among AKS actors.

It was found that some AKS actors did not access radio and TV agricultural programmes because they were broadcasted during inappropriate time. Among the farmers, 160 (51%) revealed that broadcasting radio and TV agricultural programmes during relevant time stimulated accessibility of agricultural knowledge. If such programmes were broadcasted during appropriate time most AKS actors could have ample accessing them thus acquiring agricultural knowledge. This is supported by Siyao (2012) and Lwoga *et al.* (2011a) who reported that when agricultural programmes are aired after farms activities more farmers may access them.

It was found that being a member of networks and groups stimulated accessibility of agricultural knowledge. Among the farmers, 102 (32.5%) reported that membership in farmers' groups stimulated accessibility of agricultural knowledge. This is explained by the fact that members of groups were provided with several agricultural knowledge services which were not provided to non-members. Moreover Duveskog (2013) reported that providers of agricultural knowledge services found it easy to reach more farmers or other AKS actors when they were in groups than as individuals.

Having adequate agricultural extension services stimulated accessibility of agricultural knowledge among AKS actors. Agricultural extension and advisory services are designed to build and strengthen the capacity of rural farmers and other stakeholders (Mbo'o-Tchouawou1 and Colverson 2014). It is only possible to have adequate provision of agricultural extension services when there are enough providers of these services. Among the farmers, 101 (32%) acknowledged that adequate provision of agricultural extension services was a strong determinant of accessibility of agricultural knowledge. This is in line with Swanson and Rajalahti (2010) who also found that agricultural extension and advisory services enhanced access to knowledge.

Other AKS actors reported that organizational/community culture, continuous creation of knowledge, and top management support strongly stimulated accessibility of agricultural knowledge. Community culture is expressed in terms of leadership, sociability, solidarity, trust, core beliefs, values, norms and social customs (Staplehurst and Ragsdell 2010; Norizah *et al.* 2005; Wahid *et al.* 2003). When all these elements of community culture support the creation

and sharing of knowledge then the level of knowledge accessibility becomes high. Likewise, involvement of different actors in performing agricultural knowledge processes stimulated agricultural knowledge accessibility. Involvement is described in-terms of participation of all actors in relevant AKS roles. This is in line with what was reported by Mangombe and Sabiiti (2013) who found that when important actors from any stage of the knowledge value chain is not involved in then the implementation of agricultural knowledge processes fails.

6.6 Agricultural knowledge sharing process among AKS actors

AKS actors shared acquired agricultural knowledge among themselves and to other actors. Agricultural knowledge was shared mostly from those believed to have more knowledge to those with less and it took place among all AKS actors. Among farmers, agricultural knowledge was shared among themselves and to other AKS actors. Findings from Figure 5.2 indicate that majority of the farmers (289, 92%) shared acquired agricultural knowledge while few (25, 08%) did not. Findings in Table 5.19 on page 175 indicate that farmers (288, 72.6%) shared knowledge on seed selection techniques. Benard *et al.* (2014) and Bachhav (2012) reported that knowledge on seeds selection techniques was considered to be very important among farmers because they linked seed varieties with productivity and marketability. Farmers shared knowledge on seeds because there were many varieties with different properties. Thus, sharing knowledge on seeds enabled farmers make rational decisions before sowing any seed variety. Other farmers (151, 48.1%) mentioned to share knowledge on weather. This is supported by Benard *et al.* (2014) who reported that due to climate change the level of uncertainty has increased that farmers needed knowledge related to weather. This category of knowledge was shared so that other farmers could know when to start preparing farms and choose seeds which were tolerant to drought. Most farmers mentioned to share knowledge on weather to fellow farmers. Majority of farmers shared knowledge on weather more frequently among farmers because agricultural production in Morogoro was predominantly rain-fed.

Other farmers (137, 43.6%) shared knowledge on crop maintenance. They shared knowledge on how to do weeding and apply fertilizers, pesticides and insecticides. This category of agricultural

knowledge was potential for better yields. This is supported by NAFAKA (2012) who reported that farmers who acquired knowledge on crop maintenance had better yields.

Knowledge on farm preparation, seed sowing techniques, post-harvest practices, agricultural marketing and agricultural credits was shared among few farmers. Among farmers, only 26 (8.3%) of them shared knowledge on farm preparation. This is explained by the fact that few farmers adopted recommended land preparation procedures as majority preferred traditional farming systems. Others (84, 26.8%) shared knowledge on seed sowing techniques. Those who shared this category of knowledge mentioned to share knowledge on appropriate spacing during seed sowing and on seed sowing techniques. This category of knowledge was shared among few farmers because majority of farmers reported that recommended seed sowing techniques and methods were tedious, expensive and time consuming. Due to these reasons majority of farmers continued using traditional sowing techniques.

Findings indicate that 60 (19.1%) farmers shared knowledge on post-harvest practices. They shared it to fellow farmers who were in need of it. It was revealed that knowledge on post-harvest practices was shared so as to limit post-harvest losses. However, only few farmers shared this category of knowledge because they preferred using traditional storage techniques. Moreover, with the very low levels of yields among most farmers storage was impractical. It was found that few other farmers (69, 22%) shared knowledge of agricultural marketing. They mentioned to share knowledge on how to set prices and bargaining skills to fellows. Knowledge on agricultural marketing was shared among few because there was no formal agricultural marketing system. Buyers went from one household to the other seeking for farm produce to buy. Moreover, prices of agricultural produce were almost uniform mostly during harvest time when majority of farmers sold farm produce. Furthermore, very few farmers (09, 2.9%) shared knowledge on agricultural credits. As reported by Mtega (2012), farmers did not like credits because farming was very risk mainly due to rainfall unreliability. Most farmers also believed that seeking for credits could lead into loose of assets put as collaterals.

Other AKS actors shared agricultural knowledge relating to their key day to day activities. Depending on core roles, there were some actors who shared all categories of agricultural

knowledge while others shared few. Due to their core roles, agricultural extension officers shared all categories of agricultural knowledge. Agricultural researchers shared different research outputs while input suppliers shared knowledge on agricultural inputs. Village executives shared knowledge on government input subsidies while buyers of agricultural produce/products shared knowledge on prices and qualities of produce/products. NGOs and private companies shared knowledge related to key interventions they involved themselves in. Radio and TV stations disseminated different categories of agricultural knowledge to audience while mobile phone operators shared almost all categories of agricultural knowledge because they provided value added agricultural services to actors.

6.6.1 Recipients of shared agricultural knowledge

Agricultural knowledge was shared with different recipients. One AKS actor could share knowledge to one or more recipients at a given point in time depending much on the channel and environment where knowledge was shared. As found on Table 5.20 on page 176, majority of the farmers (281, 96.2%) shared agricultural knowledge with fellow farmers. This is explained by the fact that most of the farmers (305, 97.1%) acquired agricultural knowledge from fellow farmers (see Table 5.11 on page 160 for details). It was also found that 82 (28.1%) shared agricultural knowledge to agricultural extension officers. Farmers who mentioned sharing agricultural knowledge to agricultural extension officers were among those who acquired such knowledge through agricultural extension officers. These findings are in line with those reported by Stevens and Nta (2011) who found that farmers had to share their challenges to agricultural extension officers because they had adequate skills to solve farm related practical problems. However, the limited number of farmers sharing agricultural knowledge to agricultural extension officers is explained by the poor access to agricultural extension services in most villages due to low agricultural extension officer to farmers' ratio.

Findings indicate that other few farmers (16, 3.8%) reported to share agricultural knowledge with village executives. The low number of farmers sharing agricultural knowledge to village executives is explained by the fact that village executives were not agricultural specialists and that farmers only consulted them to know more on subsidized agricultural inputs. Others (68,

17.5%) shared agricultural knowledge with input suppliers. These farmers believed that attendants of agro-shops had adequate agricultural skills for solving farm related problems. After determining that most agro-shops' attendants had limited agricultural knowledge skills farmers shared their problems to other actors. However, few farmers went to a nearby village for a skilful agro-shop attendant.

There were 74 (25.3%) farmers who shared knowledge with village based agricultural advisors. Village based agricultural advisors were farmers with extra trainings on good agricultural practices, their key responsibility was train other farmers and manage demonstration plots. These farmers mentioned to trust village based agricultural advisors because they knew them and had lived with them in same villages and that they were not ashamed of telling them any agricultural related problem they encountered.

Few farmers (27, 9.2%) shared knowledge with buyers. In most cases these farmers shared knowledge on quantity and quality of their produce. The low number of farmers sharing knowledge to buyers is explained by the fact that the relationship existing between farmers and buyers was not good because buyers bought agricultural produce at very low prices. Moreover, the relationship was poor because buyers used cheating scales so as to get more at a given price. Few other farmers (11, 3.8%) shared agricultural knowledge with agricultural researchers. The low number is explained by the fact that farmers and agricultural researchers were bridged by agricultural extension officers. Mtega (2012) also found that there were few farmers with direct contact with agricultural researchers, these had opportunities to learn and share problems encountered directly to researchers because they lived close to agricultural research institutes.

Among other AKS actors, agricultural knowledge was mainly shared with farmers and colleagues. Agricultural knowledge shared was related to core roles played by AKS actors. Agricultural extension officers shared knowledge to farmers; they also shared knowledge among themselves and sometimes with agricultural researchers. Village executives shared agricultural knowledge mostly with farmers while input suppliers shared agricultural knowledge with farmers and sometimes to fellow input suppliers. Buyers shared agricultural knowledge with fellow buyers, middlemen, warehouse operators and farmers. Owners of private companies

involved in reproducing and distributing seeds shared agricultural knowledge with agricultural researchers, agricultural extension officers and farmers. Through radio/TV agricultural programmes and mobile phones different categories of agricultural knowledge were disseminated to different AKS actors. Finally, NGOs shared agricultural knowledge with beneficiaries, partners and funders.

6.6.2 Channels through which agricultural knowledge was shared

Agricultural knowledge was shared among AKS actors through different channels. Among farmers, agricultural knowledge was mostly shared through face to face oral communication, SMS, voice calls and village meetings. Majority of the farmers (192, 61.1%) shared agricultural knowledge through face to face oral communication (see Table 5.21 on page 177 for details). This is partly explained by the fact that majority of the farmers (305, 97.1%) acquired agricultural knowledge through fellow farmers (see Table 5.11 on page 160 for details) where face to face oral communication was predominant. Moreover, face to face oral communication is believed by most farmers as a cheap and easily accessible channel. Same findings were reported by Lwoga *et al.* (2011a) who found that face to face oral communication was a dominant channel used in sharing agricultural knowledge among actors in the agricultural sector. The channel was more preferred because it was also considered to be traditionally used to pass indigenous knowledge from one generation the other.

Other farmers shared agricultural knowledge through voice calls (110, 35%) and SMS (38, 12.1%). This is because mobile phones were found to be among the highly owned ICTs. However, most farmers preferred to use voice calls to SMS. These findings are in line with those of Wyche and Steinfield (2015) who reported that farmers used voice calls more than SMS because of the risk of sending (and paying for) a text and not knowing whether it would be received and replied. Moreover, farmers preferred voice calls because calls did not involve writing skills which were lacked by some farmers. Other farmers revealed that most SMS sent to a third party were hardly responded. This also discouraged even literate farmers from using SMS. Finally, famers (92, 29.3%) shared agricultural knowledge through village meetings. Village meetings were arranged from time to time where several issues were discussed. These

findings are in line with those of Lwoga *et al.* (2010a) who reported that some farmers shared agricultural knowledge to others through village meetings which were conducted at certain agreed intervals. However, most village meetings put little attention on agricultural issues.

Among other AKS actors agricultural knowledge was shared through both face to face oral communication, mobile phones, internet, print resources, radio and TV sets. They used both mediated and unmediated communication channels during trainings, workshops and seminars. Unmediated face to face oral communication was the mostly used mode of agricultural knowledge sharing among peers found in the same locality. Mediated oral communication used tools which facilitated audio or audio-video meetings for participants from a distant. Skype was commonly used for knowledge sharing among employees in NGOs and with partners and funders found away from where interventions were implemented. Mobile phone calls and SMS were used to share agricultural knowledge to/among farmers' representatives, representatives from private companies, agricultural extension officers, village and ward executives, buyers and input suppliers. Leaflets/brochures, newspapers, radio and TV stations were used to share agricultural knowledge to a wider audience located in different geographical locations. Researchers shared agricultural knowledge through internet and print materials to colleagues, supervisors, policy makers and other local and international researchers. They also shared agricultural knowledge through mobile phones mostly with colleagues and supervisors.

6.6.3 Frequent recipients of shared agricultural knowledge

Different categories of agricultural knowledge were shared among AKS actors. The frequency at which AKS actors shared agricultural knowledge was explained in four levels namely “*very frequently*”; “*frequently*”; “*infrequently*”; and “*not used at all*”. The level was termed as “*very frequently*” if knowledge was shared with a recipient several times per week; and it was “*frequently*” if knowledge was shared with the recipient at least one time per week. Likewise, the level was “*infrequently*” if knowledge was shared very rarely with recipients; and lastly, it was “*not shared at all*” if AKS actors did not share agricultural knowledge with recipients. Among farmers, majority (234, 74.5%) very frequently shared agricultural knowledge with fellow farmers. This is explained by the findings in Table 5.13 on page 164 which indicate that most

farmers (305, 97.1%) acquired agricultural knowledge from fellow farmers. Similar findings were reported by Ballantyne (2010) who found that most farmers acquired knowledge from farmer's long term experience in farming and mainly shared it orally to fellow farmers. Because of the high level of agricultural knowledge exchange among farmers, few mentioned to share it either frequently or infrequently.

Findings in Table 5.22 on page 178 indicate that few farmers (18, 5.7%) very frequently shared agricultural knowledge to agricultural extension officers while 58 (18.5%) shared it frequently. Majority of the farmers (232, 73.9%) did not shared agricultural knowledge with this recipient. This is explained by the fact that one agricultural extension officer had to serve so many farmers from a given village. Daniel (2013) reported that the number of agricultural extension officers was too small compared to number of farmers that it was difficult for farmers to access agricultural extension services. Likewise, most farmers did not share agricultural knowledge with village executives, agricultural researchers, buyers, and farmers' group as more than 87% of farmers did not exchange any agricultural knowledge with them. This is explained by findings in Table 5.11 on page 160 which indicate that such recipients were also not used as sources of agricultural knowledge among most farmers.

In general, there was a strong linkage between some agricultural knowledge sources and recipients of agricultural knowledge. Some of the most used agricultural knowledge sources were found to be the major recipients of agricultural knowledge. Likewise, some of the least used agricultural knowledge sources were found to be the least used recipients of agricultural knowledge.

6.7 Usage of ICTs among AKS actors

AKS actors used computers, internet, mobile phones, radio and TV sets for different purposes. Usage of ICTs among AKS actors was not uniform as farmers used mobile phones, radio and TV sets while others used almost all of the ICTs. Findings in Table 5.23 on page 179 indicate that more (213, 67.8%) of the farmers used radio sets. This is supported by Mtega (2012) and Lwoga *et al.* (2011a) who also found that radio sets were the most used ICTs among farmers in rural areas. High usage of radio sets is explained by the high ownership of these tools among farmers.

Moreover, it is explained by the portability of radio sets and the possibility of accessing radio broadcasts through mobile phones. Farm Radio International (2007) describes radio sets as excellent, cost-effective means of sharing knowledge, building awareness, facilitating informed decision-making and supporting the adoption of new practices by small-scale farmers. Farmers accessed several radio stations while in their villages. This is explained by the wide coverage and increasing number of radio stations with regional, district and community licenses with signals covering most rural areas in the three districts. Moreover, farmers revealed that radio sets were sold at reasonable prices that most households owned (207, 97.2% of those who used radio sets owned them) and used them.

Findings in Table 5.23 on Table 178 indicate that 201 (64%) of the farmers used mobile phones for either acquiring or sharing agricultural knowledge. The high level of usage of mobile phones is explained by increased level of ownership (mainly due to decreasing prices) and the increasing mobile phone infrastructure in most rural areas in Tanzania. This is supported by Sife *at al.* (2010) who reported that increased usage of mobile phones was a result of the developments in mobile phone infrastructure in Tanzania.

Of the three ICT tools used by the farmers TV sets were least used as only 84 (26.8%) of the farmers involved in the study used them. Limited usage of TV sets is explained by low level of ownership; lack of funds to subscribe to bundles of TV channels; lack of sources of power to run them; and poor TV signals. Similar findings were reported by Sife *at al.* (2010) who revealed that usage of TV sets in rural areas was hindered by poor rural electrification and limited ownership of TV sets among farmers.

AKS actors other than farmers used mobile phones, internet, computers, radio and TV sets. Due to nature of their core activities buyers revealed that they used mobile phones, radio and TV sets. Internet was mostly used by AKS actors from NGOs, agricultural research institutes and few agricultural extension officers. Usage of internet was much influenced by user's digital literacy level. Most AKS actors from governmental organizations, NGOs and media were literate, they used internet for either acquiring or sharing agricultural knowledge.

6.7.1 ICT access points

AKS actors accessed ICT tools from different access points. Among farmers, ICT tools were either owned or accessed from a third party. Among those using radio sets, 207 (97.2%) of the farmers owned them while four (1.9%) and two (0.94%) accessed them from relatives and friends respectively. The high level of ownership is explained by the availability and low costs associated with buying radio sets. Likewise, 199 (99%) of those who used mobile phones owned them while two (01%) accessed them from relatives (see Table 5.24 on page 180 for details). Ownership of mobile phones was explained by affordability and the growing mobile phone infrastructure. These findings are supported by Misaki, Apiola and Gaiani (2016) who also reported that ownership of radio sets and mobile phones among farmers in Tanzania was very high that most farmers used these tools for different communication purposes.

It was found that TV sets were least owned by farmers as only 63 (75%) of the users owned the tools (see Table 5.24 for on page 180 details). Results indicate that 15 (17.9%) of those who used TV sets watched TV programmes from relatives, four (4.8%) from friends and two (2.4%) from clubs/kiosks. Limited ownership of TV sets is explained by high costs associated with buying TV sets; it is also explained by the lack of power sources for running TV sets. This is supported by Misaki *et al.* (2016) who reported that TV sets were least owned and used by farmers because it was expensive to buy them and that they needed powerful sources of power to run them. This is also reported by Sife *et al.* (2010) who revealed that limited ownership and usage of TV sets was mainly due to the poor rural electrification and the under developed TV infrastructure in rural areas.

Among other AKS actors, ICT tools were either owned or accessed from offices. Most actors from NGOs, media, some from government organizations and private companies accessed internet and computers from offices. Other tools were mostly individually owned.

6.7.2 Usage of ICT tools in AKS

AKS actors used ICT tools for different agricultural purposes. Among farmers, ICT tools were mainly used for acquiring and sharing agricultural knowledge. As indicated in Table 5.25 on

page 181, majority of those who used ICT tools mentioned to use them for either acquiring or sharing agricultural knowledge. Radio and TV sets were used as sources of agricultural knowledge by 193 (90.6% of 213) and 68 (81% of 84) of the farmers respectively. This is explained by the fact that there were some radio and TV agricultural programmes aired in a week which were accessed by these farmers.

Mobile phones were used for either acquiring or sharing agricultural knowledge. It was found that 159 (79.1%) of the farmers used mobile phones for agricultural knowledge purposes. This is supported by Lwoga *et al.* (2011a) who reported that farmers used mobile phones for communicating with different sources of agricultural knowledge. However, it can be seen that 42 (20.9%) of those who reported to have been using mobile phones did not use the tools for agricultural related activities. These farmers used mobile phones for other communication purposes. Due to limited skills, none of the farmers revealed to use mobile phones for taking photos or accessing internet. Moreover, most farmers reported that most of their mobile phones supported few applications including voice calls, SMS and FM radio.

Among other AKS actors, ICTs were used to perform multiple roles. Agricultural researchers used computers and internet for creating and sharing agricultural knowledge. This is supported by Angello and Wema (2010) who reported that agricultural research institutes had adequate number of computers and basic internet infrastructure for supporting creation and sharing of agricultural knowledge. Computers and internet were also used for similar purposes by employees of NGOs and few public agricultural extension officers. Other AKS actors used smart phones for internet services. Internet, radio and TV sets were used as sources of agricultural knowledge and as channels through which agricultural knowledge was shared or disseminated to intended audience.

6.7.3 Categories of agricultural knowledge acquired and shared through ICT tools

AKS actors acquired and shared different categories of agricultural knowledge through ICT tools. Mobile phones, radio and TV sets were used for acquiring and sharing agricultural knowledge among farmers. Findings in Table 5.26 on page 182 indicate that most farmers acquired knowledge on seed selection techniques and weather through radio and TV sets. Most

radio and TV stations broadcasted weather updates at least one time per day. The high dependency on rain fed agriculture and climate change made it necessary for farmers to use radio and TV sets for acquiring knowledge on weather. Moreover, the availability of different seed varieties made it important for farmers to have adequate seed selection skills. Several seed varieties were reproduced to meet consumer preferences, increase productivity, or cope with climate change. This made it necessary for farmers to listen and watch relevant radio and TV programmes which were mostly sponsored by seed companies. It was also found that more farmers acquired agricultural knowledge on: crop maintenance, post harvest practices, agricultural marketing, and credits through radio sets than through TV sets (see Table 5.26 on page 182 for details). This is explained by the high level of ownership and usage of radio sets among farmers. Moreover, owners of private companies explained that it was too expensive to sponsor TV agricultural programmes than radio programmes. The difference in number of farmers acquiring agricultural programmes through radio and TV sets is also explained by the subscription fees paid for bundles of TV channels, radio channels were aired free of charge.

It was found that voice calls and SMS were used for either acquiring or sharing agricultural knowledge. Findings in Table 5.26 on page 182 indicate that 107 (67.3% of 159) and 110 (69.2% of 159) of the farmers either acquired or shared agricultural knowledge on weather and seed selection techniques through voice calls. It was found that more farmers acquired or shared knowledge on crop maintenance, post harvest practices, agricultural marketing, and credits through voice calls than through SMS (see Table 5.26 for details). Farmers explained that it was easier to acquire or share agricultural knowledge through voice calls than through SMS. Other farmers explained that writing SMS was difficult and time consuming while others mentioned that mobile phone screen sizes were too small for them to easily read and write SMS. This is supported by Martin and Abbott (2010) who reported that illiteracy among farmers resulted into limited usage of SMS mobile phone application. Other farmers did not prefer using SMS for acquiring or sharing agricultural knowledge because they failed to predict when a feedback could be made.

Among other AKS actors, ICT tools were used for creating, acquiring, disseminating or sharing agricultural knowledge related to their involvements in agriculture. NGOs, governmental

organizations and private companies used these tools for disseminating all categories of agricultural knowledge to farmers and to other actors at different stages of the cropping calendar. Mobile phone service providers used mobile phones for disseminating agricultural value added services to different actors in the sector. In general, AKS actors used ICT tools for creating, acquiring and sharing different categories of agricultural knowledge to meet their own knowledge needs and those of farmers.

6.7.4 Time for acquiring agricultural radio and TV programmes

Radio and TV stations had several agricultural programmes broadcasted mainly for farmers. These programmes were funded by the government, NGOs or private companies and were on topical agricultural issues. Findings in Table 5.27 on page 183 indicate that radio and TV agricultural programmes were broadcasted from morning to night. Moreover, several radio and TV stations had agricultural programmes once or twice a week. Findings in Table 5.27 indicate few farmers listened and watched agricultural programmes during nights and early mornings respectively. Moreover, it was found out that 68 (35.2% of 193) of the farmers preferred listening to agricultural programmes during the night while eight (4.1% of 193) preferred listening during early mornings. Likewise, only five (7.4% of 68) farmers mentioned to prefer to watch agricultural programmes during the night. This is explained by the nature of their daily activities, most farmers had early sleep because of being tired due to physical activities they were involved in throughout the day. Moreover, most farms were away from residential areas that farmers had to wake up very early in the morning each day that they could start working on time. Due to these reasons most farmers found it difficult to listen and watch agricultural programmes during nights and early mornings.

There were few farmers who listened and watched agricultural programmes during mornings. Findings in Table 5.27 on page 183 indicate that 72 (37.3% of 193) and 10 (14.7% of 68) of the farmers listened and watched agricultural programmes during the morning respectively. Others, 55 (28.5%) and 18 (26.5%) listened and watched agricultural programmes during afternoon respectively. This is explained by the fact that most farmers started working early in the morning each day and the few who listened to agricultural programmes during early morning were those

who either did not attend farm activities during some days or went to their farms with portable radio sets. However, it was impossible for most farmers to have access to TV broadcasts during morning hours because TV sets were not portable as farmers attend farm activities far away from their homes.

It was found that more than 50% of those who used radio and TV sets as sources of agricultural knowledge preferred to listen and watch agricultural programmes during evenings. They mentioned that this was time when most farmers were at their homes resting after their daily farm activities. Despite being potential time for such programmes, few farmers mentioned to have been accessing agricultural programmes during such time. They mentioned that most stations broadcasted more recreational programmes during evenings while agricultural programmes were either aired during mornings or noon. For farmers to benefit from agricultural broadcasts, radio and TV stations should consider broadcasting these programmes when most farmers can access them.

6.7.5 Factors limiting usage of ICT tools in AKS

It was found that there were several factors which limited the usage of ICT tools among AKS actors. As shown in Table 5.28 on page 185, these factors limited farmers from using ICTs for either acquiring or sharing agricultural knowledge. Few farmers mentioned that usage of mobile phones (04, 2.5%), radio (03, 1.6%) and TV sets (01, 1.5%) was limited by illiteracy. Though most farmers used ICTs particularly mobile phones for acquiring or sharing agricultural knowledge, majority did not enjoy the full potentials of these tools because they only used few applications. This is explained by the limited skills needed for using such applications. Moreover, due to low skills among farmers usage of mobile phones was limited to voice calls and SMS. Nyamba and Mlozi (2012) and Islam and Grönlund (2011) reported that due to illiteracy the number of farmers using SMS was low too. Limited ICT skills limited farmers from acquiring some of the most valuable agricultural services from mobile phones. Moreover, due to illiteracy some farmers did not know the agricultural services which could be acquired through mobile phones. According to Palmer and Pshenichnaya (2015), agricultural value added services provided through mobile phone included agronomic tips; market price information and weather

forecasts. Due to limited skills and awareness of what could be accessed through mobile phones few farmers accessed to these services.

Other farmers who used ICTs for acquiring and sharing agricultural knowledge were limited by poor signals/networks. Findings in Table 5.28 on page 185 indicate that 26 (13.5% of 193) and two (3.0% of 68) of the farmers revealed that poor radio signals limited them from acquiring agricultural knowledge through radio sets. This is explained by the poor reception of some of the radio and TV stations in some areas. This is in line with Islam and Grönlund (2011) who found that poor communication network limited farmers from accessing radio programmes. Moreover, mobile phone network was poor in some of the villages. It was for this reason 34 (21.4%) of those using mobile phones were limited by poor mobile phone network from acquiring and sharing agricultural knowledge. This is supported by Nyamba and Mlozi (2012) and Islam and Grönlund (2011) who also found that poor network coverage has been one of the factors limiting farmers from using ICTs in agriculture.

Usage of radio and TV sets for acquiring agricultural knowledge among 123 (63.7%) and 45 (66.2%) of the farmers respectively was limited by programmes being aired during odd hours. This is explained by the fact that when these programmes were aired most farmers were in farms. This hindered majority of actors accessing agricultural radio and TV programmes. These findings are in line with those of Mtega (2012) and Obidike (2011) who also found that agricultural programmes from radio and television sets were aired during irrelevant hours that few had opportunities to access while majority were in their farms. Moreover, 120 (62.2% of 193) and 49 (72.1% of 68) said that usage of radio and TV sets as sources of agricultural knowledge respectively was limited by lack of awareness on when programmes were to be aired. This was most due to limited promotion aimed at creating awareness on when such programmes could be aired. Moreover, frequently changing time of radio and TV agricultural broadcasts made it difficult for farmers to have access to such programmes.

Findings in Table 5.28 on page 185 indicate that lack of power sources limited farmers from using ICTs for acquiring and sharing agricultural knowledge. It was found 59 (30.6%), 21 (30.9%) and 41 (25.8%) of the farmers revealed that usage of radio sets, TV sets and mobile

phones was limited by lack of sources of power respectively. This is explained by the poor rural electrification in Tanzania. Obidike (2011) and Islam and Grönlund (2011) explained poor rural electrification and constant power interruption in rural areas reduced the level of usage of ICTs. Some farmers using radio sets had to buy dry cells at 500/= Tanzanian Shillings per battery for running radio while those using mobile phones had to recharge their phones at 500/= Tanzanian Shillings whenever it ran out of power. This made it more difficult among low income farmers to access agricultural knowledge through ICTs.

Usage of ICTs for acquiring and sharing agricultural knowledge was also limited by high costs associated with buying ICT tools and tariffs for using them. This is because low income, farmers did not afford to buy ICTs and pay for subscription fees or tariffs for using the tools. The same findings were reported by Nyamba and Mlozi (2012), Obidike (2011) and Islam and Grönlund (2011) who also found that high costs associated with buying ICTs and airtime for mobile phones limited some farmers from using these tools. Further, usage of ICT tools was low because of limited ownership. This is explained by the fact that most farmers did not manage to own such tools due to low income hence not using the tools for acquiring or sharing agricultural knowledge. Similar results were reported by Islam and Grönlund (2011) who urged that most ICTs were sold at prices not easily afforded by some farmers.

Few farmers mentioned that usage of ICTs for acquiring and sharing agricultural knowledge was limited by some irrelevant programmes aired. Less than five percent of those using radio and TV sets for acquiring agricultural knowledge found that some of radio and TV programmes were irrelevant to farmers. This is mainly explained by the fact that farmers were not aware on when agricultural programmes could be broadcasted and that when they had time to access radio and TV programmes they found that contents were irrelevant. This was partly due to low awareness creation made by broadcasters on when such programmes were aired and the frequent changing timing of radio and TV agricultural programmes. It was also found that 100 (62.9%) mobile phone users among farmers mentioned that they accessed more non-agricultural contents through mobile phones. This is explained by the fact that more farmers used mobile phones for social rather than agricultural purposes. Farmers revealed that mobile phone agricultural value added services provided sometimes failed to answer questions or solve problems faced by farmers

because responses given were based on word count from queries rather than meaning of the question.

Among other actors, usage of ICTs was limited by poor ICT signals/networks, programmes being aired during odd hours and lack of awareness on when agricultural programmes were to be aired. Also, ICT usage was limited by lack or unreliable power sources and high costs associated with buying and using some ICTs.

6.8 The role of the Government in enhancing access to and use of agricultural knowledge

The Government of Tanzania has been implementing a number of interventions aiming at enhancing access to and usage of agricultural knowledge among AKS actors. Among other things, the Government has developed the national agricultural policy which rules out the development of the agricultural sector in the country (URT, 2013). The Government had been taking a lead in implementing the national agricultural policy through several interventions. In implementing the national agricultural policy, the Government strengthened the national agricultural research and development system (Beye, 2002). The system was responsible for generating new agricultural knowledge, technologies and developments needed by AKS actors. In implementing the national agricultural policy, the Government put in places an agricultural research and training system which enhanced the creation and dissemination of agricultural knowledge among AKS actors URT (2009). Moreover, the Government had a chain of agricultural training institutes which was made up of universities and colleges mostly run by the government. To involve the participation of private sector in agricultural training and research, the government put conducive environment for the private sector to operate. Through trainings, it was possible to get different professionals who could meet the needs of AKS actors.

The Government established an agricultural marketing system with different actors. It formed boards for governing production and trade of different crops. As started by URT (2009), boards were formed for supporting agricultural research; extension services to growers and other actors; enhancing access to inputs; promotion of production, marketing, processing and storage; and agricultural knowledge dissemination related to crops. These boards also supported the

technological advancements of various crops and the provision of assistance in formation of farmers' associations. Among others, agricultural boards enhanced access to agricultural knowledge and skills needed by AKS actors.

Access to agricultural knowledge among AKS actors required a well developed knowledge infrastructure. It was the role of the Government to create conducive environment for public private partnership in developing relevant communication infrastructure. According to Weber (2011), the knowledge infrastructure needed for enhancing access to agricultural knowledge included railroads, telephone wires, paved roads, textual protocols, and networked technologies. Knowledge workers formed an important component of the knowledge infrastructure too. For years, the government of Tanzania has been working closely with the private sector in developing this important infrastructure. There were some interventions which had been done by the government alone (investing in roads and railroads) while others have been done collaboratively with both the private and public sector. These efforts had made it possible to have a chain of radio and TV stations and a fast growing mobile phone infrastructure in both rural and urban areas. TCRA (2015b) supported this by reporting that by the year 2015 Tanzania had 123 radio stations; 30 television stations; 44 postal and courier operators. Moreover, the country had seven mobile phone operators with more 35,920.090 subscribers. The level of subscription to mobile phone services was reported to be increasing tremendously among both rural and urban population that a need to further develop such infrastructure was inevitable. Moreover, most mobile phone service providers came out with agricultural value added services for farmers and other AKS actors. Through these services, knowledge on agronomic practices, marketing and weather was provided via mobile phones.

Through TCRA, the government regulated the operations of the ICT sub-sector in the country. It controlled tariffs settings for mobile phone services. As reported by TCRA (2011), tariffs set were to be just, reasonable, cost oriented, and non-discriminatory. Moreover, the government through TCRA set import and excise dues for ICTs. It also managed the quality of imported ICT tools. Generally, the government had to ensure that a fair play ground was set among all ICT service providers in the country.

The government also enhanced access to power through electrification projects. Though by the time the current study was being undertaken most farmers did not have access to electricity, there were several rural electrification projects being implemented in most rural areas. Moreover, through public private partnership the private sector enhanced access to cheap solar panels. As reported by the African Development Bank (2015), solar power was mostly used by people from rural areas in Tanzania because the national grid was limited to urban areas. Farmers used solar power for lighting during nights, running some ICTs (radio and TV sets) and for recharging mobile phones.

To make sure that farmers use what they had been taught by different AKS actors, the government set regulations which enhanced access to agricultural inputs. Among such regulations was subsidizing the cost of some agricultural inputs that they were sold at affordable prices. Moreover, the Government established an institute for certifying all reproduced seeds before they were distributed to farmers. Through these strategies, the number of farmers who used recommended agricultural inputs increased from time to time.

Lastly, the Government created a favourable environment for the involvement of the private sector in creation and sharing of agricultural knowledge. Through this initiative several local and international NGOs and private companies were involved in agricultural research and provision of agricultural extension services. The government through DAICO coordinated the involvement of the private sector in projects aiming at providing knowledge on good agricultural practices through trainings to AKS actors in districts. The Government coordinated other activities related to agricultural research, seed multiplication, post-harvest handling and agricultural marketing and trade.

6.9 Variables influencing AKS usage among actors

There were several variables with significant influence on AKS usage. These variables were related to AKS actors, type of AKS being used, agricultural knowledge management or environment surrounding AKS. They have either direct or indirect influence on AKS usage. The following sub sections give explanations on how each variable influenced AKS usage.

6.9.1 How type of AKS influenced usage

Actors in agriculture used three types of AKS namely human based system, paper based and ICT based system. The level of usage of these types of AKS was found to be different. Findings in Table 5.29 on page 191 indicate most farmers used human based system. This is explained by the fact that this type of AKS was the most available among AKS actors. As reported by Lwoga *et al.* (2011a), this human based system involved human experience for knowledge creation and acquisition; human memory for knowledge storage; and face to face oral communication for knowledge sharing. This type of AKS was cheap and simple.

ICT based system followed in level of usage. The usage of ICT based system depended on the availability of ICT networks, accessibility of ICT tools, skills needed to operate tools, and power to run such tools (see Tables 5.28 on page 185 and 5.29 on page 191 for details). For this case, ICT tools which were easily available, had wider network coverage and did not require advanced skills to operate them were used by most AKS actors. Due to these facts, mobile phones, radio and TV sets were used by more AKS actors than computers and internet which were used by few. Moreover, not all ICT applications were used uniformly by both AKS actors as some were mentioned to require more skills than others (see Table 5.26 on page 182 for details).

Paper based system were least used by actors. It was found that the level of usage of paper based system differed among users because few farmers preferred to use them. High illiteracy levels among some actors resulted into limited usage of this type of AKS. Moreover, the limited availability and accessibility of print materials also resulted into low level of usage of paper based system.

Generally, the level of usage of AKS depended on easy of usage of AKS components, availability of components making up the AKS, and the level of complexity of AKS. AKS which was affordable, required limited skills to operate, had complete set of components which could be used to meet actor's needs at a given time were used more.

6.9.2 How behavioural intention influences usage of AKS

Behavioral intention is either directly or indirectly influenced by level of education, age, sex, experience and income. These individual characteristics influence the perceived ease of use and usefulness of a system. These individual characteristics may help individuals understand what they may achieve and the level of efforts they have exerted so as to achieve what they want (see Tables 5.29 on page 191 and 5.30 on page 193 for details). The best system is the one found to have high performance expectancy (usefulness) and little effort expectancy (ease of use). It was for this reason sex of actors had a very limited influence on usage of some types of AKS. However, when sex of an actor had some influence on AKS usage, then it was more likely that the difference in usage of a system was influenced by sex based division of labour. It was because of this reason more male farmers (125, 81.7% of 153) used ICT based system than females (107, 66.5% of 161).

Age, farming experience and level of education influenced usage of AKS in certain ways. The influence of age was more like that of farming experience. Findings in Table 5.30 on page 193 indicate that usage of AKS increased with age and farming experience. The influence of age on usage of human based and ICT based was lower than that on paper based system (see Table 5.30 for details). These findings indicate that usage of paper based system increased more with an increased in age than was the usage of ICT based system. This is explained by techno-phobia among most adult AKS actors. Hutchby and Moran-Ellis (2013) describe technophobia as fear to usage of some technologies. Moreover, usage of paper based system slightly increased with farming experience as somehow more experienced actors used this AKS than younger ones (see Table 5.29 on page 191 for details). Level of education influenced usage of some types of AKS. Findings on Table 5.29 indicate that usage of ICT based system increased with an increase in level of education of actors. This is explained by the complexity of some AKS which needed more skills for operating them. This is supported by Lwoga *et al.* (2011a) who reported that people need some skills so as to use some ICT tools.

6.9.3 How perceived usefulness of knowledge influenced AKS usage

Some categories of agricultural knowledge were perceived to be more useful to AKS actors than others. AKS actors acquired agricultural knowledge perceived to be important to what they were doing. For this reason, actors consulted AKS so as to acquire knowledge to meet their needs. In the current study, perceived usefulness of agricultural knowledge was determined by the frequency of acquiring some categories of agricultural knowledge (see Table 5.8 on page 154 for details). Moreover, findings in Table 5.32 on page 196 indicate that usefulness of agricultural knowledge was measured by user's belief on knowledge's contribution to final output. It is explained that knowledge usefulness is not only measured by acquisition but also level of usage of acquired knowledge. It is for this reason some farmers acquired and used some categories of agricultural knowledge while other categories of agricultural knowledge were acquired but not put into use because actors did not perceive such knowledge as important (see Figure 5.1 on page 157 for details).

6.9.4 The influence of accessibility of agricultural knowledge sources on AKS usage

Table 5.15 on page 169 indicates that there were some agricultural knowledge sources used by AKS actors. It was found that some of the agricultural knowledge sources were used more than others. One of the reasons which influenced the level of agricultural knowledge sources was the availability of agricultural knowledge sources. Agricultural knowledge sources which were available were used more by most AKS actors. Availability of agricultural knowledge sources within AKS was explained by accessibility; provision of a two way communication traffic; awareness of the existence of the source; appropriateness of time for accessing the source; and ownership of communication tools (see Tables 5.11 on page 161 and 5.15 on page 169 for details). Availability of agricultural knowledge sources was also explained by the presence of power to run ICT tools and strength of signals or network coverage (see Table 5.28 on page 185).

Due to accessibility, fellow farmers were more used as sources of agricultural knowledge than agricultural extension officers (see Table 5.11 on page 160 for details). Moreover, due to

uncertainty in receiving a feedback, voice calls were more preferred than SMS (see Table 5.26 on page 182 for details). Since availability of knowledge sources was also explained by ownership, actors who owned ICTs used them more frequently for accessing knowledge than no-owners.

6.9.5 How ease of use influence AKS usage

In order to acquire and share agricultural knowledge, actors had to exert some efforts which were in different forms. Efforts exerted were in forms of cash spent and skills needed for acquiring and sharing knowledge. Moreover, it was in the form of ability to own and manage communication tools. Findings in Tables 5.15 on page 169 and 5.16 on page 171 showed that some actors failed to use AKS because they did not afford to buy communication tools. Others failed to use AKS because of high tariffs. As indicated on Table 5.34, Phi value of -0.029 indicates that there was a negative association between high mobile phone tariffs and using mobile phones for acquiring agricultural knowledge. Thus, those who did not have enough funds failed to own/access and use communication tools. Furthermore, using some agricultural knowledge sources required some level of skills. As shown in Tables 5.14 on page 167 and 5.28 on page 185, actors needed some skills so as to consult sources which were found to be somehow complex.

6.9.6 How availability of agricultural knowledge influence AKS usage

When agricultural knowledge is available AKS actors can easily acquire it and when it is not available actors get discouraged and in most cases rely on what they already know. As shown in Table 5.12 on page 162 and 5.17 on page 172, agricultural knowledge availability was determined by awareness on the presence of knowledge; frequency of usage of some knowledge sources; and usage of newly created agricultural knowledge. Usually actors consulted AKS if they believed they could acquire agricultural knowledge they needed. When actors knew that nothing can be acquired from AKS, they continued conducting activities in normal ways. Moreover, the influence of availability of agricultural knowledge was measured by the accessibility of radio and TV agricultural programmes. As indicated in Table 5.36, when

agricultural programmes were broadcasted at farmers' preferred time more farmers could have access to such broadcasts than when aired at stations' preferred time.

6.9.7 How AKS usage is affected by social influence

Social influence induced change on how AKS actors performed certain activities due to interactions with peers, colleagues or supervisors. As reported by scholars (Moussaï'd, Ka'mmer, Analytis and Neth 2013), social influence works under the expert effect (induced by the presence of a highly confident individual in the group) and the majority effect (caused by the presence of a critical mass of laypeople sharing similar opinions). Findings in Table 5.11 on page 160 and Table 5.20 on page 176 indicate that farmers acquired agricultural knowledge from some sources and shared to certain recipients (see Table 5.20). Moreover, it is found in Figure 5.1 on page 157 and Figure 5.2 on page 175 showed that farmers shared and used acquired agricultural knowledge. Acquiring, sharing and using agricultural knowledge was influenced by both expert and majority effects. Among agricultural extension officers, expert effects were exerted by supervisors mainly from DAICO. Among the farmers, majority effects were exerted by fellow farmers and by colleagues and peers among other AKS actors. Such exerted effects had strong positive impacts on usage of AKS.

6.9.8 The influence of actors' participation on AKS usage

Involvement of all actors in AKS is important for their effectiveness. Actors conduct several agricultural knowledge processes at each stage of the commodity value chain. Involvement of actors is important because they create, organize, share, disseminate or use agricultural knowledge in their daily agricultural activities. Actors' participation is expressed by how each group of actors is involved in performing these activities. As shown in Tables 5.16 on page 161 and 5.17 on page 172, when some actors do not perform their tasks correctly, access to agricultural knowledge becomes poor. This is supported by Mangombe and Sabiiti (2013) who found that when important actors from any stage of the knowledge value chain is not involved in then the implementation of agricultural knowledge processes fails. Thus, participation of actors from each stage of a commodity value chain in agricultural knowledge processes has a direct influence on the efficiency of AKS.

6.9.9 How ownership of communication tools influences AKS usage

Findings in Table 5.24 on page 180 indicate that actors either owned or accessed some communication tools from a third part. Those who did not own communication tools accessed them from friends, relatives or kiosks. Communication tools particularly ICTs enhanced the creation, sharing, storage and dissemination of agricultural knowledge. Those who owned these tools were at a better position to use them for agricultural knowledge purposes. This argumentation is supported several empirical studies (Mtega, 2012; Sife *et al.*, 2010; Mtega and Malekani, 2009) which found that those who owned communication tools were at a better position of using them more frequently for different agricultural knowledge purposes.

6.9.10 How community culture influences AKS usage

Effective implementation of agricultural knowledge processes depends on the culture of communities. Culture shapes the way people live and how they interact. Community culture is expressed in terms of leadership, sociability, solidarity, trust, core beliefs, values, norms and social customs (Staplehurst and Ragsdell 2010; Norizah *et al.* 2005; Wahid *et al.* 2003). In this study, preference of agricultural knowledge sources was much influenced by social ties, sociability, experience, sex, literacy, core beliefs and trust among AKS actors. As shown in Tables 5.11 on page 160, 5.12 on page 162 and 5.24 on page 180, culture had a strong influence on where an actor had to access agricultural knowledge and to whom agricultural knowledge was to be shared.

6.9.11 How communication infrastructure influences AKS usage

Findings in Tables 5.15 - 18 on pages 169 to 174 outlined several factors influencing accessibility of agricultural knowledge and agricultural knowledge sources. It was found that most rural areas in Tanzania had poor communication, ICT power, and road infrastructure. These infrastructures limited actors to perform different knowledge processes. Electricity, telecommunication, roads and transportation enhance access to knowledge (Kamba 2009). Investment in infrastructure and access to infrastructure has a positive influence on usage of AKS.

6.9.12 How individual factors influence usage of AKS

The level of AKS usage depends on individual factors which may either motivate or discourage actors from using the system. Individual factors influence directly some independent variables which in turn have direct impacts on system usage. Important factors identified to influence usage of AKS were literacy, income, experience and membership in organizations and sex (see Table 5.14 on page 167, and Tables 5.29, 5.30 and 5.31 on pages 191 to 193 for details). These factors influence directly usage of AKS and ultimately the level of usage of agricultural knowledge.

6.10 Chapter summary

The current chapter interpreted and discussed the findings presented in Chapter Five. The chapter provided key observations from the interpretation and discussion of the research findings regarding how AKS can be strengthened for improved rural livelihoods in Tanzania. Respondents involved in the study were differentiated with respect to their major roles in agriculture, level of education, age, sex, farming experience, major crops they grew, average acreage, and level of yield. These individual demographic characteristics had moderating effects on AKS usage.

The study found that the public sector through agricultural research and extension services, ward and village executives, and councillors played important roles in AKS. Actors from the private sector included farmers, input suppliers, buyers, media operators, and mobile phone service providers. Others were warehouse operators, NGOs and private companies. Among actors, the government was the main actors in the agricultural sector with the major role of ensuring food security and improved livelihoods of farmers in the country. The private sector supported the government in ensuring this through implementing various interventions.

The study revealed that human based, paper based and ICT based system were used by actors in the agricultural sector. Among farmers, the study revealed that human based system was used by majority of the farmers (310, 98.7%) followed by ICT based system which was used by 231 (73.6%) of the farmers. Paper based system was least used as only 39 (12.4%) used it. Among other actors, all of the three types of AKS were used. AKS actors were supposed to be linked

together because of the interdependency among them. However, actors were weakly linked together thus reducing the effectiveness and efficiency of AKS.

Findings revealed that actors needed knowledge related to weather, farm preparation, seed selection techniques, seed sowing techniques and crop maintenance. Agricultural knowledge was acquired through human, ICT and paper based sources. Among farmers, majority acquired knowledge from human based system and mostly from fellow farmers. Acquisition of agricultural knowledge was influenced by perceived usefulness of knowledge in accomplishing tasks. Due to this reason, majority of farmers acquired knowledge on seed selection techniques and weather while few acquired agricultural knowledge on agricultural credits. Due to the same reason, other actors acquired knowledge categories related to their key involvements in AKS. Moreover, agricultural knowledge needs varied from time to time within the cropping calendar. Despite acquiring needed agricultural knowledge, not all AKS actors used all of the acquired knowledge. Among farmers, only 61 (19.43%) of the farmers used all of the acquired knowledge. Majority did not use acquired knowledge because either knowledge or inputs were either delivered lately or farmers themselves did not realize the importance acquired of knowledge.

Factors limiting acquisition of agricultural knowledge were related to either AKS actors themselves or agricultural knowledge sources. Among those related to actors, illiteracy and low income were mentioned to limit acquisition of agricultural knowledge. Factors related to agricultural knowledge sources limiting accessibility of agricultural knowledge included: inaccessibility of sources; language barriers; limited ownership of communication tools; and poor signals/networks hindered acquisition of agricultural knowledge. Other factors limiting accessibility of agricultural knowledge were: airing agricultural programmes during odd hours; lack of sources of power; not being members of some groups/networks; inadequate agricultural extension services; and irrelevant agricultural contents from some sources.

Actors shared agricultural knowledge to either fellows, peers, colleagues or supervisors. Among the farmers, majority (289, 92%) shared acquired agricultural knowledge while minority (25, 08%) did not. Perceived usefulness of agricultural knowledge influenced the knowledge sharing

process among AKS actors. Among the farmers, majority (288, 72.6%) shared knowledge on seed selection techniques because more farmers needed it. Among other AKS actors, knowledge related to their day to day involvement in AKS was mostly shared. Among farmers, agricultural knowledge was shared through face to face oral communication, SMS, voice calls and village meetings. Other AKS actors used both face to face oral communication, paper based channels and ICTs in sharing agricultural knowledge.

It was found that actors used computers, internet, mobile phones radio and TV sets for different purposes. Farmers used mobile phones, radio and TV sets mainly for either acquiring or sharing agricultural knowledge. Among farmers, radio sets and mobile phones were most used because they were owned by the majority. Other actors used ICTs for acquiring, sharing, organizing and disseminating agricultural knowledge. ICT tools were either owned or accessed from another party. Farmers who did not own ICTs tools accessed them from neighbors, relatives, friends or clubs/kiosks. Other AKS actors either owned or accessed ICTs from offices. Usage of ICTs in AKS was limited by illiteracy, poor ICT signals/networks, programmes being aired during odd hours and lack of awareness on when programmes were aired. Other factors limiting usage of ICTs included lack of sources of power and high expenses or tariffs for buying or running ICTs.

The Government played different roles in AKS. The major roles played by the government were strengthening agricultural research and development; establishing and running agricultural training institutes; and provisions of agricultural extension services. The Government also created suitable environment for development of reliable communication infrastructure, enhanced access to agricultural inputs and created suitable and favourable environment for involvement of private sector in creation and sharing of agricultural knowledge.

Significant variables which directly influenced AKS usage included behavioral intention to use AKS, fitness of technology to AKS usage and perceived usefulness of knowledge. Others were efforts exerted to acquire and share knowledge, availability of agricultural knowledge, social influence, self-efficacy, communication and power infrastructure, system quality, ownership of communication tools, community culture and actors' participation in AKS. Variables with moderating impacts were demographic characteristics, awareness on knowledge sources,

availability of a feedback mechanism and community culture. The following chapter presents the overall summary, conclusions and recommendations of the study.

CHAPTER SEVEN

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This Thesis presents and discusses findings of the investigation on how AKS can be strengthened for improved rural livelihoods in Tanzania. The background to the study providing the general introduction and definition of the research problem was presented in Chapter One. Chapter Two of the Thesis discussed and formulated the conceptual framework to guide this study. Chapter Three presented the review of literature related to this study. The research methodology detailing sampling procedures, data collection methods and statistical procedures employed by the study was presented in Chapter Four of this Thesis. Chapter Five focused on the presentation of research findings. Interpretation and discussion of research findings was given in Chapter Six of the Thesis. This chapter presents summaries, conclusions and recommendations of the study. Suggestions for areas for further research are also presented at the end of this chapter.

7.2 Overall summary of the study

The overall objective of this study was to investigate how AKS can be strengthened for improved rural livelihoods in Tanzania so as to recommend a model for enhancing access to agricultural knowledge among actors. The study was motivated by the notable problems associated with very limited access to and usage of important agricultural knowledge needed for production and post-harvest activities leading to dismal growth of agricultural sector and prevalence of poverty among households whose livelihoods relied solely on agriculture. To achieve the overall objective of the study, seven specific objectives outlined in Section 1.5.1 of Chapter One were formulated. To keep the study in focus, seven major research questions outlined in Section 1.5.2 of Chapter One were formulated. The research model for the study was modified from the Botha *et al.* (2008) Knowledge Management Process Model. The model shows how different knowledge processes overlap and interact to create a knowledge rich zone and how human and technology focus influence knowledge creation, organizing and sharing.

Farmers formed the most important unit for the study because they were mostly affected by AKS performance. Other actors were involved because they had important tasks in AKS. In selecting the study area and respondents, the study adopted both probability and non-probability sampling techniques. The study adopted survey, interviews and document review as main methods for data gathering. The survey questionnaire, key informant interview checklist and the focus group discussion guide were the main tools used for data collection. The survey questionnaire targeted 362 farmers selected through simple random sampling from a population of 25,193 farmers from nine villages from the three districts of Morogoro Region of Tanzania. A total of 314 farmers responded to the questionnaire making 87% response rate. Of the 314 respondents, 161(51.3%) were females and 153 (48.7%) were males. In-depth interviews and focus group discussions complemented the main questionnaire survey. Key informant interviews targeted 12 agricultural extension officers, three agricultural researchers, six other agricultural information providers, nine input suppliers, nine village executives, nine councillors, and nine buyers. Moreover, 24 farmers (eight farmers from one village of each district) were involved in focus group discussions which were used to complement data collected through other data collection techniques.

The study also carried out review of documents; this involved a literature review and structured records review. The literature review provided the researcher with a general understanding of the research problem and was used as a benchmark for comparing and contrasting the research results. The structured records review involved going through reports accessed mainly from libraries and government offices at village, ward, district, region and ministry level. Other reports were accessed from research institutes, NGOs and TCRA. Reviewing structured records was important because it helped in determining the involvement of other actors in AKS and complemented data acquired through key informant interviews. All collected data was analyzed by relevant tools. The classical content and constant comparison analysis were used in analyzing qualitative data. All data accessed from structured records review were analyzed through content analysis. SPSS was used to analyze quantitative data, descriptive and inferential statistics were employed in providing descriptions and associations existing between quantified data.

Among the farmers, 22 (7.0%) were aged between 15 and 25 years; 79 (25.2%) between 26 and 35 years; 80 (25.5%) between 36 and 45 years; 42 (13.4%) between 46 and 55 years; and 91 (28.9%) between 56 and 65 years. With respect to level of education of the farmers, majority (70.1% of 314) had primary education; others (13.4% of 314) had secondary education; while others (12.1% of 314) had informal education; and a few (4.5% of 314) had adult education. With respect to farming experience, 60 (19.1%) farmers had one to five years in agriculture; 60 (19.1%) had between six and ten years; 40 (12.7%) had between 11 and 15 years; 40 (12.7%) had between 16 and 20 years; 27 (8.6%) had between 21 and 25 years; 30 (9.6%) had between 26 and 30 years; and 57 (18.2%) had more than thirty years in agriculture. The yield per acre for maize and paddy ranged from one to 30 bags of 100 kilograms.

The following sub-sections present the summary of the key results on the basis of the seven specific objectives and seven major questions of this study.

7.2.1 Identification of key AKS actors and their roles

Broadly, AKS actors were categorized into farmers, Government and the private sector. Farmers were found as individuals or in groups. AKS actors from the Government included village executives; agricultural extension officers; councillors; agricultural researchers; and the district agriculture, irrigation and cooperatives officer. Actors from the private sector included input suppliers; buyers of agricultural produce; radio and TV stations; mobile phone operators; local and international NGOs; private companies; warehouse operators; and millers.

7.2.1.1 AKS used in the study area

Actors in the study area used three types of AKS namely human based, paper based and ICT based system. Majority of farmers (310, 98.7%) used human based system, 231 (73.6%) used ICT based while few (39, 12.4%) farmers used paper based system while other actors used all types of AKS.

7.2.1.2 Roles of different actors in AKS

Village executives coordinated all developmental activities including enhancing access to subsidized agricultural inputs in villages. Agricultural extension officers provided agricultural extension services to farmers while councillors represented farmers in district councils. Agricultural researchers created new knowledge, developments and technologies while the DAICO maintained good public private partnership with the private sector involved in agriculture and coordinated all issues related to agriculture (crops), irrigation and cooperatives. Input suppliers sold agricultural inputs; each agro-shop had attendant selling inputs. Other actors included buyers who bought agricultural produce; warehouse operators who stored harvests; and radio and TV stations which broadcasted some agricultural programmes. Others were mobile phone operators who provided mobile phone services including value added agricultural services; NGOs which provided agricultural extension and education services and mobilized farmers to form groups while some private companies multiplied and sold seeds.

7.2.1.3 Determining how AKS actors were linked together

Farmers were linked to agricultural research institutes through agricultural extension officers. Due very low agricultural extension officer to farmers' ratio, very few farmers had access to agricultural extension services. Moreover, there were no structured agricultural markets; this led to limited access to agricultural markets information among actors. Furthermore, most agricultural programmes broadcasted through radio and TV sets were during odd hours. Moreover, there was a late delivery of agricultural inputs which made it difficult for farmers to use all of the acquired agricultural knowledge. These factors limited the linked among actors in AKS.

7.2.2 Categorizing agricultural knowledge needs of AKS actors

It was found that actors acquired agricultural knowledge related to weather; farm preparation; seed selection techniques, seed sowing techniques, crop maintenance, post-harvest practices, agricultural marketing and agricultural credits. Among the farmers, majority (281, 89.5%) acquired knowledge on seed selection techniques, weather (213, 67.8%) and (211, 67.2%) crop

maintenance. Few farmers (38, 12.1%) acquired agricultural knowledge on agricultural credits. Other actors acquired agricultural knowledge related to their key involvements in AKS.

7.2.2.1 Frequency of acquisition of agricultural knowledge among AKS actors

Among the farmers, majority (147, 46.8%) frequently acquired knowledge on weather, seed selection techniques (131, 41.7%); and crop maintenance (105, 33.4%). Moreover, most farmers did not acquire knowledge on agricultural credits (271, 86.3%), farm preparation (231, 73.6%), seed sowing techniques (231, 73.6%), post-harvest practices (200, 63.7%) and agricultural marketing (201, 64%). It was found further that each category of agricultural knowledge was acquired during specific time of a cropping calendar. Actors other than farmers acquired knowledge related to key activities taking place during a specific time of the cropping calendar.

7.2.2.2 Factors limiting usage of acquired agricultural knowledge among AKS actors

Among the farmers, only 61 (19.43%) used all of the acquired agricultural knowledge while majority (253, 80.57%) did not put into use some of the acquired agricultural knowledge. Moreover, some actors did not manage to acquire what they needed. Those who did not put into use acquired agricultural knowledge were limited by unavailability or late delivery of agricultural inputs; lately acquired agricultural knowledge; taking too long in acquiring some agricultural knowledge; and the perception that acquired agricultural knowledge was useless.

7.2.2.3 Determining sources of agricultural knowledge preferred by AKS actors

AKS actors used different sources of agricultural knowledge. Among human based sources, more farmers (305, 97.1%) acquired knowledge from fellow farmers while few acquired it from churches/mosques (03, 1.0%). Among ICT based sources, 193 (61.5%) farmers used radio sets; 152 (48.4%) used mobile phones and 68 (81%) used TV sets. Among paper based sources, posters were used by more farmers (33, 10.5%) than other sources. Among other actors, all the human, paper and ICT based sources were used.

7.2.2.4 Level of usage of agricultural knowledge sources among AKS actors

The frequency of usage of knowledge sources differed among AKS actors. Among human based sources, majority of farmers (241, 76.8%) used very frequently fellow farmers as knowledge. Among ICT based sources, mobile phones were used very frequently by more farmers (128, 40.8%) while majority of the farmers (175, 55.7%) did not use TV sets at all for acquiring agricultural knowledge. Paper based knowledge sources were used very frequently by few farmers. Among other actors, both human, paper and ICT based sources were frequently used depending on what categories of agricultural knowledge was to be acquired.

7.2.2.5 Factors influencing usage of sources of agricultural knowledge among actors

Among the farmers, sex, age, level of education, farming experience and yield influenced usage of agricultural knowledge sources. Factors limiting usage of some agricultural knowledge sources included: some sources being not easily accessible (126, 40.1%), being not a member of a farmers' group (262, 83.4%), inadequate provision of agricultural extension services (205, 65.3%), high expense for accessing and using some sources (176, 56.1%) and limited agricultural related issues being discussed during village meetings (219; 69.7%). It was found that the same factors were found to influence choice of sources of agricultural knowledge among other AKS actors.

7.2.3 Determining factors hindering access to agricultural knowledge among actors

Accessibility of agricultural knowledge was hindered by poor perception on the importance of knowledge, limited awareness on new knowledge availability, illiteracy, low income among actors, limited awareness on knowledge sources and low ownership of some communication tools. Other factors hindering knowledge accessibility include difficult languages used in some knowledge carriers; knowledge sources being found far away; not being a member of farmers' group, lack of power sources, radio and TV programmes being aired during odd hours and inadequate provision of agricultural extension services.

7.2.4 Determining factors stimulating access to agricultural knowledge among actors

It was found that agricultural knowledge accessibility was stimulated by the accessibility of agricultural knowledge sources, ownership of communication tools, affordability of mobile phone tariffs and well developed ICT infrastructure. Others were reliable sources of power, broadcasting radio and TV agricultural programmes during relevant time, membership in farmers' groups and adequate agricultural extension services. It was also stimulated by top management support and involvement of different actors in AKS.

7.2.5 Investigating how agricultural knowledge sharing processes take place

Among the farmers, 289 (92%) shared acquired agricultural knowledge while only 25 (8%) did not. All of the non-farmer actors shared acquired agricultural knowledge too. Among the farmers, knowledge on seed selection techniques was shared by the majority (228, 72.6%) while knowledge on agricultural credits was shared by very few (09, 2.9%). Other actors mentioned to share agricultural knowledge related to their key involvements in AKS.

7.2.5.1 Recipients of shared agricultural knowledge

Among farmers, majority (281, 96.2%) shared agricultural knowledge with fellow farmers while a few (11, 3.8%) to agricultural researchers. Other recipients of agricultural knowledge were agricultural extension officers, village executives, input suppliers, buyers, farmers' group and village based agricultural advisors. Among other AKS actors, farmers were the major recipients of knowledge. However, they mentioned to share knowledge with colleagues and supervisors.

7.2.5.2 Channels used by actors in sharing agricultural knowledge

It was found that 192 (61.1%) of the farmers shared agricultural knowledge through face to face oral communication; 38 (12.1%) through SMS, 110 (35%) through voice calls and 92 (29.3%) through village meetings. Non-farmer AKS actors shared knowledge through face to face communication, mobile phones, radio and TV broadcasts, leaflets/brochures and notes and internet.

7.2.6 ICTs in supporting agricultural knowledge management and AKS

Among the farmers, majority (213, 67.8%) used radio sets, 201 (64%) farmers used mobile phones while 84 (26.8%) farmers used TV sets. Among other actors, internet and computers were commonly used among workers in NGOs, agricultural extension services and agricultural research institutes. Other non-farmers actors used mobile phones, radio and TV sets.

7.2.6.1 Points used to access ICT tools

Among the farmers, majority (199, 99%) owned mobile phones, others (207, 97.2%) owned radio sets while few (63, 75%) owned TV sets. A few farmers access these ICTs from relatives, neighbours, or kiosks. Non-farmers actors either owned or accessed ICT tools from their offices.

7.2.6.2 ICT tools in agricultural knowledge management

Among the farmers, majority used ICTs to access agricultural knowledge. Among the 201 farmers who used radio sets, 193 (90.6%) used them as sources of agricultural knowledge. Likewise, 68 (81%) farmers used TV sets as source of agricultural knowledge. Among the 199 farmers who owned mobile phones, 159 (79.1%) acquired and shared agricultural knowledge through these tools and few of the non-owners used the tools for either acquiring or sharing agricultural knowledge. Other AKS actors used ICTs for acquiring, sharing, disseminating, storing or creating agricultural knowledge.

7.2.6.3 Categories of agricultural knowledge acquired by AKS actors through ICT tools

Among farmers, ICTs were used for accessing agricultural knowledge. Majority (134, 69.4%) acquired knowledge on seed selection techniques while others (127, 65.8%) acquired knowledge on weather through radio sets respectively. Others, 52 (76.5%) and 48 (70.6%) accessed knowledge on weather and seed selection techniques through TV sets respectively. Similarly, 110 (69.2%) and 107 (67.3%) acquired knowledge on seed selection techniques and weather through voice calls respectively. Most of other actors acquired and shared different categories of agricultural knowledge through mobile phones. Some used computers for creating and storing

knowledge while internet, radio and TV sets were used for sharing or disseminating different categories of agricultural knowledge to intended audience.

7.2.6.4 Broadcasting time for radio and TV agricultural programmes

Most agricultural radio and TV programmes were broadcasted during morning hours. Majority of the actors preferred to listen to radio programmes and/or watch TV programmes during the evening.

7.2.6.5 Factors limiting the usage of ICTs for agricultural knowledge purposes

Usage of ICTs in performing agricultural knowledge processes was limited by airing radio and TV programmes during odd hours, high expense/tariffs for some services, irrelevant contents accessed through some tools and lack or unreliable power sources. Other factors limiting usage of ICTs were poor signals/networks, illiteracy on using some ICT applications, poor ownership of some tools and illiteracy.

7.2.7 The government in enhancing access to and use of agricultural knowledge

The government implemented several interventions aiming at enhancing access to agricultural knowledge among actors. The Government set and implemented policies which aimed at improving the agricultural sector as whole in the country. Other key functions of the Government included: creating favourable environment for involvement of private sector in creation and sharing of agricultural knowledge, providing agricultural training and extension services, enhancing access to agricultural inputs, creating suitable environment for development of reliable communication infrastructure and strengthening agricultural research and development.

7.2.8 Significant variables influencing AKS usage among actors

Significant variables influencing usage of AKS among actors included: type of AKS used, behavioral intention, task to technology fit, knowledge usefulness, accessibility of agricultural knowledge sources and effort exerted to acquire and share knowledge. Others included availability of agricultural knowledge, social influence, ownership of communication tools,

knowledge infrastructure, system quality, community culture and actors' involvement. Moderating variables influencing independent variables were community culture which moderated actors' involvement, demographic characteristics, awareness, feedback and availability of sources.

7.3 Conclusions

Sections 7.1 and 7.2 summarized key findings from this study. The current section provides key conclusions as guided by the themes drawn from the research questions of the study.

7.3.1 AKS actors and their key tasks

AKS actors used human based, paper and ICT based system while majority used human and ICT based system. This was mainly due to the accessibility and ease of use of the two types of AKS. Farmers, village executives, agricultural extension officers, councillors, agricultural researchers, input suppliers, buyers and radio and TV stations were the major actors in AKS. Others were mobile phone operators, local and international NGOs, private companies, warehouse operators and millers. Most actors provided services aiming at transforming the agricultural sector and improving the livelihoods of rural farmers. These services enhanced access to agricultural knowledge, agricultural inputs, agricultural markets and storage facilities. However, there was a poor linkage among actors in AKS. It is concluded that due to poor linkage among actors, AKS has failed to enhance increased access and usage of agricultural knowledge among actors.

7.3.2 Categories of agricultural knowledge needed by AKS actors

AKS actors needed agricultural knowledge related to weather, farm preparation, seed selection techniques, seed sowing techniques, crop maintenance, post-harvest practices, agricultural marketing and agricultural credits. They frequently needed and acquired agricultural knowledge categories related to what they were doing a specific time. Generally, agricultural knowledge perceived to be more useful was mostly acquired. However, some AKS actors did not manage to acquire what they needed while those who acquired what they needed failed to use all of the acquired agricultural knowledge. Limited usage of agricultural knowledge was mainly due to the

unavailability or late delivery of agricultural inputs, acquiring knowledge lately and illiteracy among AKS actors. Thus, knowledge perceived to be important was acquired and used by AKS actors.

It was found that most AKS actors used human and ICT based sources while few used paper based sources. Usage of agricultural knowledge sources was limited by illiteracy, lack agricultural extension services, not being a member of a group or network, sources being too expensive to consult and limited agricultural contents in meetings. Thus, sources which were available and easily consulted were used more.

7.3.3 Factors hindering and stimulating access to agricultural knowledge

Not all AKS actors managed to acquire all of the needed categories of agricultural knowledge. Acquisition of some categories of agricultural knowledge was limited by inaccessibility of knowledge sources, illiteracy, un-affordability of some agricultural knowledge, high fees for consulting knowledge sources, low ownership of some communication tools, difficult languages used and inadequate provision of agricultural extension services. Limited access to agricultural knowledge was also due to lack of power sources and airing agricultural radio and TV programmes during odd hours. On the other hand, accessibility of agricultural knowledge was stimulated by the availability of agricultural knowledge sources; ownership of communication tools; affordable mobile phone tariffs, well developed communication infrastructure and broadcasting agricultural radio and TV programmes during relevant time. Other factors stimulating the accessibility of agricultural knowledge were: being a member of a network and a group; adequate provision of agricultural extension services, organizational/community culture, continuous creation of knowledge and top management support. Generally, factors influencing agricultural knowledge accessibility were based on either actors themselves or sources of agricultural knowledge.

7.3.4 Agricultural knowledge sharing processes among actors in AKS

Majority of AKS actors shared agricultural knowledge acquired from different sources. Farmers shared agricultural knowledge on seed selection techniques and weather while knowledge on

agricultural credits was least shared. Other AKS actors shared agricultural knowledge related to their key involvements in AKS. Farmers shared agricultural knowledge with fellow farmers, agricultural extension officers, village executives, input suppliers, buyers, farmers' group and village based agricultural advisors. Few farmers shared agricultural knowledge with agricultural researchers. Among other AKS actors, agricultural knowledge was mainly shared to farmers, colleagues/peers and supervisors. It was found that most farmers shared agricultural knowledge through face oral communication. Other farmers shared agricultural knowledge through SMS, voice calls and village meetings. Actors other than farmers shared agricultural knowledge through face to face communication, mobile phones, radio and TV broadcasts, leaflets/brochures/publications and internet. Generally, most actors shared agricultural knowledge, face to face oral communication was the main channel used by most actors.

7.3.5 How ICTs supported agricultural knowledge management and AKS

AKS actors used computers, internet, mobile phones, radio and TV sets. Among the farmers, majority owned and used mobile phones and radio sets while few owned and used TV sets. Those who did not own ICT tools accessed them from relatives, neighbours, or club/kiosks. Majority of those owning radio and TV sets used them as agricultural knowledge sources. Those owning mobile phones used them for acquiring and sharing agricultural knowledge. Only a few among the farmers who did not own ICTs used these tools for acquiring or sharing agricultural knowledge. Among other actors, ICTs were either owned or accessed from their offices. They used ICTs for acquiring, creating, sharing, disseminating, or storing agricultural knowledge. Among the farmers, knowledge on seed selection techniques and weather were either acquired or shared mainly through mobile phones, radio and TV sets. Among other AKS actors, different categories of agricultural knowledge were mainly acquired or shared through mobile phones. Majority of the actors preferred to listen and watch radio and TV agricultural programmes during evenings. However, usage of ICTs among actors for performing agricultural knowledge processes was affected by high tariffs, illiteracy, limited ownership of ICT tools, lack or unreliability of power sources and poor signals/networks for some ICTs. Usage was also limited by lack of awareness on when radio and TV programmes were aired, irrelevant contents from some tools and airing radio and TV programmes during odd hours. Generally, despite the

importance of ICT tools to enhancing access to agricultural knowledge accessibility, the level of usage of ICTs among most actors was still low.

7.3.6 How the Government enhanced accessibility and usage of agricultural knowledge

The Government enhanced access to and usage of agricultural knowledge among AKS actors directly or indirectly. It set and implemented policies which aimed at improving the agricultural sector as whole in the country. The Government created favourable environment for involvement of private sector in creation and sharing agricultural knowledge. It was directly involved in creation and sharing of agricultural knowledge through providing agricultural training; establishing agricultural research institutes; and providing agricultural extension services. The Government also enhanced access to agricultural inputs and created suitable environment for development of reliable communication infrastructure which is important for knowledge transfer. Generally, the Government was the main actor in enhancing access to, sharing and usage of agricultural knowledge among AKS actors.

7.3.7 Variables influencing AKS usage among actors

There were several significant variables found to influence usage of AKS among actors. These were type of AKS, behavioral intention, task to technology fit, knowledge usefulness, accessibility of agricultural knowledge sources and effort exerted to acquire and share knowledge. Others were availability of agricultural knowledge, social influence, ownership of communication tools, communication infrastructure, system quality, community culture and actors' involvement. Moderating variables influencing independent variables were demographic characteristics of AKS actors, accessibility of sources of knowledge, awareness, and feedback mechanism. Community culture also had a moderating influence to actors' involvement. These variables influenced usage of AKS positively or negatively.

7.3.8 The overall contribution of the research findings

The key findings from this study and the proposed model for strengthening AKS provide valuable information for understanding how AKS can be strengthened to enhance increased access to and usage of agricultural knowledge among actors in the agricultural sector. These findings are also important among implementers of agricultural projects aiming at improving usage of good agricultural practices, increasing yield and profitability from agriculture. Additionally, findings from this study have increased the knowledge base in the field of Information Science.

7.4 Recommendations

This section presents the author's views regarding what should be done in order to improve the situation in the study areas and beyond. The section makes recommendations to address the issues identified in order to improve usage of AKS and enhance access to and use of agricultural knowledge among actors. The recommendations made are based on research questions found in Section 1.5.2 of Chapter One.

7.4.1 Identifying AKS actors and their roles

Findings indicate that actors used three types of AKS namely human, paper and ICT based. Among the three types of AKS, human based system was the most used followed by ICT based. Usage of paper based system was hindered by limited access to print resources and illiteracy among AKS actors. It is recommended that rural resource centres should be established that farmers and other actors may have access to knowledge. Moreover, adult education programmes should be implemented as was during the 1980s. It is also recommended that the coverage of ICT infrastructure should be widened that all AKS actors can have access to and use of ICT tools. Additionally, the Government should subsidize the cost of basic ICT (mobile phones, radio and TV sets) tools for increased ownership and usage. Furthermore, since most actors relied on human based system it is important to empower supervisors, experts and influential/progressive farmers through trainings, seminars, workshops and conferences so as to broaden their agricultural knowledge base.

Findings indicate that actors had different key tasks in AKS. However, it was found that AKS actors were not well linked together. It is recommended that the linkage among AKS actors should be strengthened that different categories of agricultural knowledge can be made available for usage among all actors. Moreover, it is recommended that all key AKS actors should be involved in their respective tasks in AKS. Farmers who were considered by most other actors as recipients of knowledge had a lot of knowledge not known to other actors. It is recommended that other AKS actors should consider farmers as creators of agricultural knowledge too as they have a lot to offer through their experience in farming.

Moreover, as farmers visited agro-shops to buy agricultural inputs they consulted agro-shops' attendants on how to put into use agricultural inputs. Unfortunately, it was found that most attendants of agro-shops had no agricultural backgrounds. It is recommended that appropriate regulations should be set to enforce owners of agro-shops to employ attendants with adequate agricultural skills.

7.4.2 Categorizing agricultural knowledge needs of actors of AKS

Findings revealed that AKS actors needed almost all categories of agricultural knowledge. They needed knowledge on weather, farm preparation, seed selection techniques, seed sowing techniques and crop maintenance. They also needed agricultural knowledge related to post-harvest practices, agricultural marketing and agricultural credits. However, actors acquired agricultural knowledge they perceived to be useful for what they were doing at a given point in time. It was for this reason some categories of agricultural knowledge were acquired more frequently than others. Among farmers, few used all of the acquired agricultural knowledge. Most actors did not use acquired agricultural knowledge either because they did not afford to acquire some of the inputs, found some knowledge to be useless, acquired some agricultural knowledge lately, or agricultural inputs were either not available or delivered lately. It is recommended that basic agricultural knowledge should be made freely available among actors and should be provided on time. The Government should set strategies aiming at a timely delivery of agricultural inputs as most acquired knowledge provided skills on how to use inputs or perform some procedures for improved productivity. Farmers on the other had should be

ready and willing to use all acquired and recommended agricultural knowledge for increased productivity and improved livelihoods.

Findings indicate that actors used different sources of agricultural knowledge. Few agricultural knowledge sources were used more while some were least used. Factors which limited usage of agricultural knowledge sources included illiteracy among actors, inaccessibility of some agricultural knowledge sources, poor signals/networks of some ICTs, low income among actors, low number of agricultural extension officers and airing TV and radio programmes during odd hours. It is recommended that AKS actors should be willing to learn on how to use most ICT applications while illiterate actors should learn how to read and write. It is recommended further that multiple sources of agricultural knowledge should be made available to rural areas. Moreover, the number of agricultural extension officers should be increased and they should be given working tools including transport facilities that they may be able to pay physical visits to farms. The government in collaboration with the private sector should invest in rural ICT and communication infrastructure that more rural people can be able to use ICT based agricultural knowledge sources. Furthermore, TCRA should regulate tariffs because AKS actors failed to use mobile phones for acquiring or sharing agricultural knowledge because of high tariffs.

7.4.3 Determining factors influencing access to agricultural knowledge

Findings indicate that access to agricultural knowledge was limited by factors related to either AKS actors or sources of agricultural knowledge. Factors related to AKS actors included lack of awareness on where to access knowledge, illiteracy, lack of awareness on new knowledge, unaffordability of some agricultural knowledge and limited ownership of communication tools. It is recommended that AKS actors from both the public and private sector should make awareness campaign about where agricultural knowledge can be accessed. On the other hand, farmers should be educated on the importance of using recommended good agricultural practices. Moreover, providers of agricultural knowledge should adopt open access strategies that more AKS actors get access to knowledge. The Government and the private sector should cover costs associated with creation and dissemination of agricultural knowledge.

Factors limiting accessibility to agricultural knowledge which were based on sources of agricultural knowledge included poor ICT infrastructure, lack of agricultural extension services, inaccessibility of agricultural knowledge sources and lack or late delivery of feedback from some sources. Others were poor ICT networks, limited agricultural contents discussed during village meetings and few relevant contents from radio and TV programmes. It is recommended that the private sector should be involved in the provision of agricultural extension services so as to complement efforts made by the government. AKS actors providing agricultural knowledge services should enhance timely feedback whenever clarifications are needed. Moreover, radio and TV stations should increase the number of agricultural programmes because majority of Tanzanians are farmers. Local governments should set laws to enforce village executives to include agricultural related issues during village meetings.

Accessibility to agricultural knowledge was stimulated by availability of agricultural knowledge sources, ownership of communication tools, affordable mobile phone tariffs and adequate provision of agricultural extension services. It was also stimulated by organizational/community culture, continuous creation of knowledge, top management support and well developed communication infrastructure. It is recommended that all factors that may stimulate access to agricultural knowledge should be considered when planning to provide agricultural knowledge services to actors in agriculture.

7.4.4 Investigation of the agricultural knowledge sharing processes among actors in AKS

Majority of the AKS actors shared agricultural knowledge with fellows, peers, colleagues or supervisors. AKS actors shared agricultural knowledge perceived to be useful by recipients. Among farmers, agricultural knowledge was mostly shared with fellow farmers while less than 30% of farmers shared agricultural knowledge with other recipients. Since most farmers shared agricultural knowledge with fellow farmers, it is recommended that influential and progressive farmers should be empowered so as to broaden their agricultural knowledge base.

Other AKS actors shared agricultural knowledge with farmers, colleagues, peers and supervisors. However, findings indicate that the linkage among some AKS actors was broken. It is

recommended that all AKS actors should be linked together for effective agricultural knowledge sharing process. Since all AKS actors are not found in all places, investing in rural mobile phone and broadband infrastructure and reducing tariffs may ultimately enhance effective acquisition and sharing of agricultural knowledge. Moreover, developing good agricultural policies and implementing them accordingly is important for linking actors together. Moreover, setting enough budgets for agricultural knowledge creating and sharing is also important for bringing actors together.

Among the farmers, agricultural knowledge was mainly shared through face to face oral communication, SMS, voice calls, and village meetings. However, majority shared agricultural knowledge through unmediated face to face oral communication. This tells that farmers must be in same location for them share agricultural knowledge among themselves. It is recommended that agricultural information providers should adopt the interactive voice response service (IVRS) in disseminating agricultural knowledge. Moreover, investing in rural frequency modulation (FM) radio also can enhance access to agricultural knowledge. Furthermore, farmers may learn how to use other mobile phone based applications which may be effective in knowledge sharing.

Among other AKS actors, agricultural knowledge was shared through face to face oral communication during trainings and seminars. However, agricultural extension officers mentioned to lack trainings, seminars, workshops or platforms for sharing experience. It is recommended that seminars and training opportunities should be made available to actors that they may share experience and acquire new knowledge. Moreover, it is recommended that actors working on similar agricultural issues should create platforms for sharing and updating themselves on topical issues.

Other AKS actors shared agricultural knowledge through internet, print materials, radio and TV broadcasts. Despite the power of radio and TV programmes in reaching many people at a time, it was mentioned that there were few agricultural programmes and among the few most were aired when farmers were attending farm activities. It is recommended that the number of radio and TV agricultural programmes should be increased. The Government should motivate radio and TV

stations hosting agricultural programmes by reducing some taxes and dues supposed to be paid by such stations. Radio and TV stations should broadcast such programmes during suitable time that majority of the intended recipients may access them.

7.4.5 How ICTs support agricultural knowledge management and AKS

Findings indicate that AKS actors used computers, internet, mobile phones, radio and TV sets. Majority of the farmers who used ICTs for either acquiring or sharing agricultural knowledge mentioned to use radio sets and mobile phones while very few used TV sets. Limited usage of some ICTs was mainly due to lack of power, poor signals for radio and TV sets, low ownership and poor network coverage for mobile phones. As already recommended above, the government should involve the private sector in investing in rural power and ICT infrastructure. Due to the large size of the country and the limited resources, involvement of the private sector in providing most communication services can complement what has already been done by the government. Moreover, the government should improve internet connectivity in most public offices. It was also found that usage of ICTs was limited by illiteracy. It is recommended that ICT based agricultural knowledge sharing and information literacy training sessions should be organized and implemented among AKS actors.

7.4.6 Role of the Government in enhancing access to and use of agricultural knowledge

The major role of the Government is to set and implement policies for enhancing agricultural development in the country. Implementation of this key role was through creating favourable environment for the involvement of the private sector in creation and sharing of agricultural knowledge. The involvement of private sector in agriculture has been increasing; in most cases these organizations have been working in rural areas where they could easily meet set goals and usually they shied away from most difficult and unreachable areas. Due to this, similar projects were being implemented by different partners in same villages. It is recommended that the government should work very closely with these organizations and suggest areas where interventions are really needed.

The Government provided agricultural training and extension services. Despite training personnel for providing agricultural extension services, the number of agricultural extension officers was found to be very low. The ratio of agricultural extension officer to farmers was very low. It is recommended that agricultural extension section of the MALF should promote the usage of radio and TV programmes in providing agricultural extension services to farmers. Moreover, it is recommended that the Government should set regulations to register individuals who can provide agricultural extension services to farmers. Farmers on the other hand should be willing to pay for agricultural extension services from private agricultural extension services providers. Since findings indicate that public agricultural extension officers did not have access to refresher courses, it is recommended that such courses should be provided that they can update their skills.

The other important role of the Government is to strengthen agricultural research and development in the country. Agricultural research institutes in Tanzania created a lot of useful technologies, developments and skills. Most of these important outputs were left shelved without reaching intended audience. It is recommended that the Government should strengthen and support agricultural research institutes' outreach sections through investment in ICTs. With ICTs research outputs can easily be disseminated to intended audience. Moreover, the government should subsidize most agricultural inputs that farmers may put into use all of the acquired agricultural knowledge.

The government also created suitable environment for development of reliable communication and power infrastructure. Despite these initiatives, most rural roads are still poor, some villages were not electrified, and some are without mobile phone infrastructure. As already recommended, these infrastructures should be developed for improved agricultural development.

7.4.7 Significant variables that influence AKS usage

There were some significant variables which directly influenced AKS usage. These variables included: type of AKS, behavioral intention, perceived usefulness of knowledge and the accessibility of agricultural knowledge sources. Others were ease of use of acquiring, sharing and using knowledge, availability of agricultural knowledge, ownership of communication tools,

social influence, communication and power infrastructure, individual factors and actors' involvement in AKS. These variables may affect AKS usage positively or negatively. It is recommended to take into considerations all these factors when planning to disseminate agricultural knowledge to actors in agriculture.

7.4.8 Proposed framework for strengthening AKS usage

The study proposes a model for strengthening AKS usage hence increased usage of agricultural knowledge among actors. This model considers the influence of different variables on agricultural knowledge processes. There are several knowledge processes involved in any knowledge system. Such processes involve creating, acquiring/capturing, organizing, storing, retrieving, sharing, using and reusing agricultural knowledge (Civelek *et al.* 2015; Fai, Chin, Fu, and Bun 2005). The proposed model is meant to strengthen usage of AKS hence improving the performance of different agricultural knowledge processes. It is based on seven independent and two dependent variables. The independent variables are knowledge factors, type of AKS, involvement of actors, individual, institutional, agricultural production and communication factors. AKS usage and performing agricultural knowledge processes are the dependent variables of the proposed model. Both dependent and independent variables are described from sections 7.4.8.1 to 7.4.8.9 while the model is illustrated in Figure 7.1.

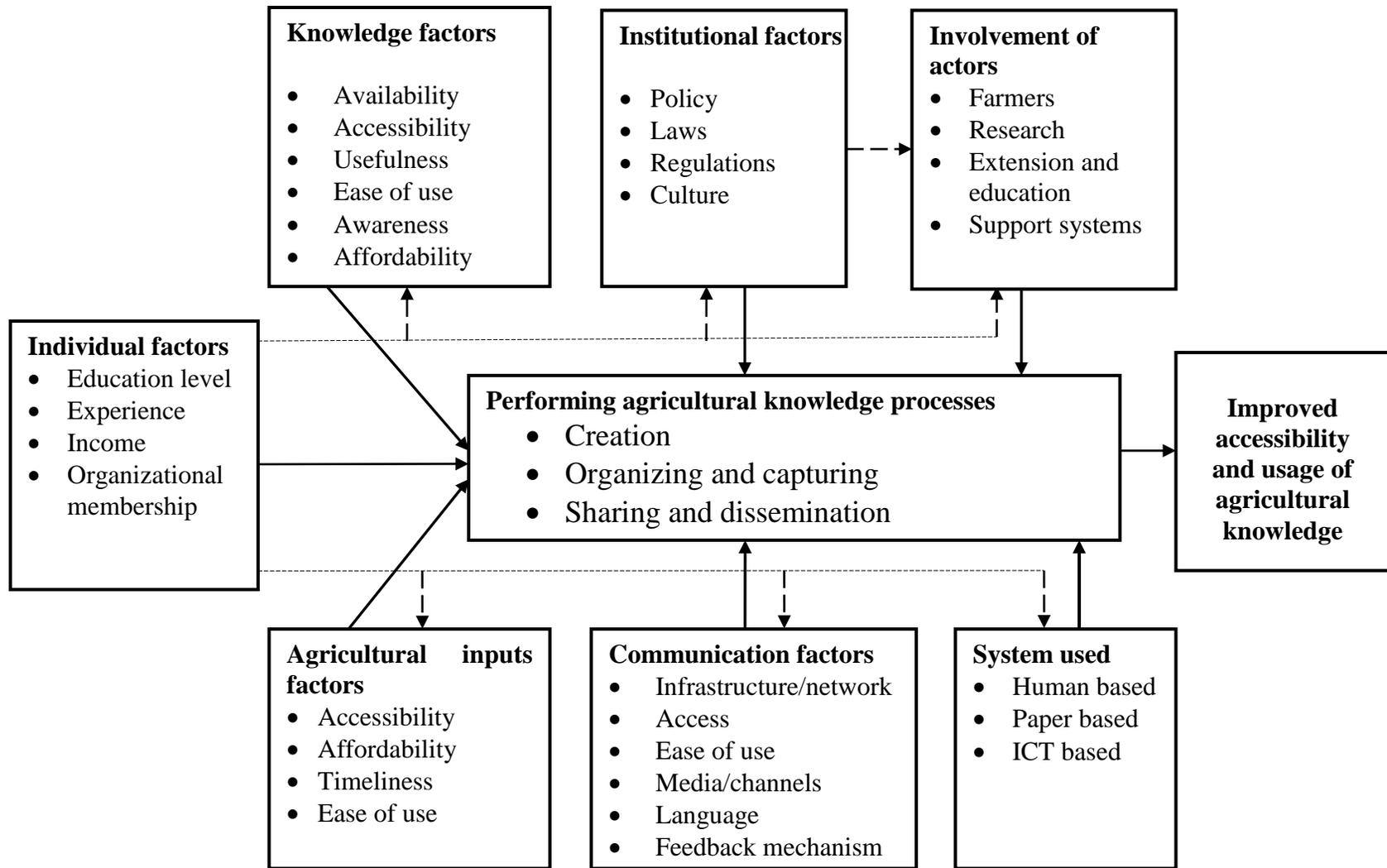


Figure 7.1: Proposed model for strengthening AKS usage

7.4.8.1 Knowledge factors

Knowledge factors influence the usage of AKS and hence influencing the usage of agricultural knowledge among actors. These factors are more related to knowledge as an item actors are willing to use. They include knowledge usefulness, availability, accessibility and ease of use. Others are awareness on knowledge, affordability in accessing knowledge and timeliness in accessing it. Details on how each factor influences AKS usage are given in the following paragraphs.

Before using agricultural knowledge one must perceive the importance of knowledge. Perceived usefulness of agricultural knowledge is determined in terms of expressed agricultural knowledge needs, relevancy of agricultural knowledge to purpose, acquiring and using acquired agricultural knowledge. According to Tong and Ayres (2009), knowledge needs can be simply defined as people's personal needs for knowledge. Tong and Ayres describe further that each individual owns knowledge in his/her sense which is known as direct knowledge (people's knowledge in the ordinary sense). It is only when direct knowledge fails to solve a given problem one's knowledge needs arise and it is expressed as a knowledge gap. After identifying the knowledge gap, one has to take relevant steps in order to fill the gap. According to Wickremasinghe, Kuruvilla, Mays and Avan (2016), after perceiving the knowledge gap the actor eagerly acquires knowledge and uses it for filling the knowledge gap. In the current study, perceived usefulness of knowledge was revealed by acquiring and using agricultural knowledge (see Table 5.7 on page 152 and Figure 5.1 on page 157 for details). It was also explained by the frequency of acquiring the same category of agricultural knowledge from time to time (see Table 5.8 for details).

Perceived usefulness of agricultural knowledge is influenced by individual's level of education (see Tables 5.15 – 17 on pages 169 to 172 for details). Ngathou *et al.* (2006) describe that individual's level of education influences how a person perceives on the usefulness of knowledge in improving the quality and quantity of intended outputs. Ngathou *et al.* (2006) point further that education has a strong influence in usage of any knowledge perceived to be important (Figure 5.1 for details). Age and farming experience have impacts related to literacy as

most actors in agriculture learn through experience. Thus, perceived usefulness of knowledge has a directly influence on knowledge creation, sharing and usage.

Usage of AKS directly depends on availability of agricultural knowledge. Vaseegaran (2014) points out that usage of knowledge depends much on its availability. The effectiveness of performing knowledge processes (finding, capturing, creating, storing, organizing, retrieving, using, sharing and reusing knowledge) depends on knowledge availability. Civelek *et al.* (2015) support this by reporting that the success of firms depends on the availability of knowledge which is needed for creating values. Knowledge availability is expressed by the accessibility of knowledge sources, availability of a feedback mechanism, awareness of the existence of the knowledge sources and awareness on the availability of knowledge. it is also expressed by awareness on when source can be accessed; and usage of acquired agricultural knowledge (see Tables 5.11 and 5.12 on pages 160 and 162 and Tables 5.15, 5.16 and 5.27 on pages 169, 171 and 172 respectively for details). When actors believe the system has the needed knowledge they tend to use it more. Thus, knowledge availability has a direct influence on AKS usage.

Actors use AKS and agricultural knowledge only if they can access agricultural knowledge. Findings in Table 5.18 indicate that accessibility of agricultural knowledge is stimulated by the accessibility of agricultural knowledge sources, ownership of communication tools, affordability of mobile phone tariffs and well developed ICT infrastructure. Other factors stimulating accessibility of agricultural knowledge are reliable sources of power, broadcasting radio and TV agricultural programmes during relevant time, membership in farmers' groups and adequate agricultural extension services. It is also stimulated by top management support and involvement of different actors in AKS. On the other hand, accessibility of agricultural knowledge is limited by limited awareness on new knowledge availability, illiteracy, low income among actors, limited awareness on knowledge sources and low ownership of some communication tools (see Table 5.17 on page 172 for details). Agricultural knowledge accessibility is also limited by difficult languages used in some knowledge carriers; knowledge sources being far away from residential areas; not being a member of farmers' group, lack of power sources, radio and TV programmes being aired during odd hours and inadequate provision of agricultural extension services. Therefore, knowledge accessibility influences AKS and agricultural knowledge usage among actors in the agricultural sector.

Usage of agricultural knowledge depends much on easiness on using it. Ease of use of acquired agricultural knowledge influenced usage among those who used acquired agricultural knowledge. Findings in Table 5.10 on page 158 indicate that farmers do not use knowledge if using it is difficult or takes too long time to use it. Ease of use of knowledge is influenced by individual factors (level of education and farming experience).

Usage of AKS hence agricultural knowledge is influenced by awareness on the availability of agricultural knowledge. Findings in Table 5.17 on page 172 indicate that some actors were hinders from using AKS simply because there were not aware that the needed knowledge was available. Awareness of agricultural knowledge is influenced by level of education, experience and membership in agricultural related groups (individual factors).

Some categories of agricultural knowledge involve fees for acquiring them. Others are from sources which must be consulted at a given fee. Moreover, there are other communication tools used for acquiring agricultural knowledge requiring tariffs before being put into use. Findings in Table 5.17 on page 172 indicate that high costs associated with acquiring some agricultural knowledge limited usage of AKS and agricultural knowledge among actors. Findings in Table 5.18 on page 174 indicate that affordable mobile phone tariffs stimulate the accessibility of agricultural knowledge hence AKS usage and increased usage of knowledge. Therefore, affordability influences both AKS and agricultural knowledge usage. It is influenced by individual level of income (individual factor).

Timeliness in acquisition/availability of agricultural knowledge influences AKS and agricultural knowledge usage. When knowledge is made available on time more actors can consult AKS for different agricultural knowledge processes. Findings in Table 5.10 on page 158 indicate that when the availability of agricultural knowledge is late then more actors fail to perform different agricultural knowledge processes including using it. Moreover, findings in Table 5.18 on page 174 further indicate that broadcasting radio and TV agricultural programmes during relevant time stimulate the accessibility of agricultural knowledge. Thus, more actors can acquire agricultural knowledge when it is made available on time (see also Tables 5.27 on page 183 for details).

7.4.8.2 Individual factors

Individuals have factors which influence AKS usage. These factors include level of education, experience, income, occupation and organizational membership. These factors may directly influence AKS usage or indirectly through knowledge, communication, agricultural inputs and institutional factors. Likewise, individual factors may indirectly influence usage of AKS through involvement actors in AKS processes. The influence of each factor is given below.

Level education influences individual perception, decision making and ability to use technologies. Findings in Tables 5.15, 5.16 and 5.17 on pages 169 to 162 indicate level of education influences the perceived usefulness of agricultural knowledge. Moreover, findings in Table 5.29 on page 191 indicate that level of education influences the usage of ICT based system. This means that level of education influences individual ability to use some ICT applications. Findings in Table 5.2 on page 144 indicate that farmers involved in the study had informal to secondary level of education. The level of education of other AKS actors ranged from informal to tertiary education. Level of education can directly influence AKS usage or through perceived usefulness and ease of use of knowledge, ability to use communication tools and ability to understand languages. Moreover, level of education may have an indirect influence on AKS usage through one's involvement in AKS and ease of use of agricultural inputs (agricultural inputs factors).

One's experience in agricultural activities influences usage of AKS. Experience in agriculture is measured by number of years one has been involved in farming. It tells about actor's agricultural knowledge behavioral built over time. Findings in Table 5.14 on page 167 indicate farmers' farming experience influenced choice of agricultural knowledge sources. Moreover, findings in Table 5.16 on page 171 indicate that some actors did not acquire some categories of agricultural knowledge because they relied on their experience. Furthermore, farming experience is one of the methods through which new agricultural knowledge is created. Likewise, involvement in creating new agricultural knowledge was found to be higher among experienced agricultural researchers than juniors. Therefore, experience in agricultural activities influences performance of most of the agricultural knowledge processes. It can directly influence AKS usage but also

indirectly through knowledge, communication and agricultural inputs factors, through choice of type of AKS and through involvement of actors.

Level of income influences AKS usage. It is through income communication infrastructure can be developed, used and maintained. Likewise, usage of AKS depends on acquiring agricultural inputs which depends on individual income (see Table 5.10 on page 158 for details). Moreover, accessing knowledge sources and using some communication channels may require some fees. Findings in Tables 5.15 and 5.16 on pages 169 and 171 respectively indicate that usage of AKS among farmers is limited by fees paid for accessing knowledge from some knowledge sources. Moreover, findings in Table 5.17 on page 172 indicate that some farmers failed to access some agricultural knowledge due to high tariffs. As found in Table 5.18 on page 174, affordable mobile phone tariffs stimulate agricultural knowledge accessibility. Likewise, ownership of communication tools (which is influenced by income) has a strong impact on AKS usage. Therefore, income can directly influence AKS usage and/or indirectly through communication, knowledge and agricultural inputs factors.

Actors in AKS may form agricultural networks or be members of agricultural associations/groups/organizations. Findings in Table 5.15 on page 169 indicate that farmers' associations/groups were important sources of agricultural knowledge. Likewise, other actors had their umbrella organizations facilitating knowledge exchange. Thus, membership in professional organizations/groups/networks influences AKS usage.

7.4.8.3 Involvement of actors in AKS

The efficiency of AKS depends much on how each actor is involved in performing agricultural knowledge processes. Findings from this study indicate that the public sector, private sector and farmers are the actors in agriculture. In the public sector sub-category are the village and ward agricultural extension officers, village and ward executives, councilors and agricultural research institutes. The private sector sub-category has more actors including: input suppliers, buyers of agricultural produce, media (radio TV stations), mobile phone operators, local and international NGOs and private companies implementing several agricultural interventions. Others are warehouse operators and millers. Farmers are either found as individual farmers, in farmers'

groups or in farmers' associations. Some villages had farmers who received intensive trainings that they may train fellow farmers.

Traditionally, AKS involved a collection of actors, such as researchers, advisors and educators, working primarily in agricultural knowledge institutes (EU SCAR (2012)). Farmers were considered to be consumers of knowledge created by other actors. However, effective AKSs involve all actors in performing different agricultural knowledge processes. As explained by Lee and Yang (2000), at each stage of the knowledge value chain there are people involved in creating, sharing/disseminating, using, organizing, or storing knowledge. When some of the actors lack or are not/not actively involved then the entire knowledge value chain becomes ineffective (Mangombe and Sabiiti, 2013). This is important because roles performed by actors are interrelated and linked to each other. Due to this fact, the involvement of all AKS actors in agricultural knowledge value chain is inevitable for an effective AKS. Social influence (expert and majority effect) influence how actors interact in AKS. Thus, involvement of all actors influences the performance of AKS. Actors' involvement is shaped by individual and institutional factors.

7.4.8.4 Institutional factors

Institutional factors play important roles in enhancing AKS and agricultural knowledge usage. These factors include the agricultural policy, laws, regulations and culture. They have direct influence on AKS usage and an indirect influence through involvement of actors. Findings from this study indicate that the Government develops the agricultural policy and sets laws and regulations to be followed by actors in AKS. Among issues insisted in Tanzania National Agricultural Policy is usage of agricultural knowledge for improving agricultural productivity. To implement the agricultural policy, laws and regulations are set and put into action that agricultural knowledge is created, disseminated and used for improved agricultural production. Therefore, good agricultural policies, laws and regulations are important for effective AKS.

Likewise, organizations and communities have culture shaping how people live. Community culture is expressed in terms of leadership, sociability, solidarity, trust, core beliefs, values, norms and social customs (Staplehurst and Ragsdell 2010; Norizah *et al.* 2005; Wahid *et al.*

2003). Due to community culture informal and formal communication networks and platforms are formed (Eshlaghy and Yusefvand 2011; Heaidari *et al.* 2011). Findings from this study indicate that due to community culture (strong sociability, solidarity and trust) more actors acquired agricultural knowledge from some sources (see Table 5.11 on page 160 and Figure 5.2 on page 175) and shared with some recipients (see Table 5.20 on page 176 for details).

Generally, agricultural policies, laws and regulations related to AKS govern how actors have to interact so as to enhance access to agricultural knowledge. They stipulate roles to be played by each actor. On the other hand, community/organizational culture shape how actors to behave in terms of customs and norms related to agricultural knowledge processes in a specific locality. Therefore, institutional factors have a direct influence on AKS usage and an indirect influence through involvement of actors. Individual factors (level of education and experience) moderate the influence of institutional factors on AKS usage.

7.4.8.5 Agricultural inputs factors

Agricultural inputs factors influence the level of usage of AKS and agricultural knowledge among actors in the sector. Inputs factors are expressed in terms of inputs accessibility, affordability, ease of use and delivery time. Findings in Table 5.10 on page 158 indicate that if actors do not afford to buy agricultural inputs then they do not acquire knowledge related to usage of such inputs. Likewise, findings indicate that actors do not put into use some of the acquired agricultural knowledge when some agricultural inputs are not available or delivered lately. Therefore, when some types of agricultural inputs are not available actors do not look for knowledge on how to use such inputs. Likewise, if usage of some agricultural inputs requires more skills/knowledge then only few actors will tend acquire such inputs and associated knowledge (see Table 5.10 for details). Therefore, timely access to affordable agricultural inputs may influence usage of agricultural knowledge. Individual factors (level of education, income, experience and organizational membership) moderate the influence of agricultural inputs factors on AKS usage.

7.4.8.6 Type of AKS used

Actors use human based system, paper based and ICT based system. Findings in Table 5.29 on page 191 indicate most farmers used human based system followed by ICT based system while paper based is least. Human based system is traditional and in most cases involves face to face communication. Lwoga *et al.* (2011a) describes human based system to involve human experience for knowledge creation and acquisition; human memory for knowledge storage; and face to face oral communication for knowledge sharing. It is cheap and simple when compared to the other two types. On the other hand, usage of ICT based system depends on availability of ICT networks, accessibility of ICT tools, skills needed to operate tools, and power to run such tools (see Tables 5.28 on page 185 and 5.29 on page 191 for details). Likewise, usage of paper based system depends on the availability of print materials and literacy level of AKS actors. Therefore, the type of AKS available for use influences the level of usage of the system. It has a direct influence on level of usage of system. Individual factors (age, level of education and income) moderate its influence on AKS usage.

7.4.8.7 Communication factors

Communication factors have a strong impact on AKS usage. These factors include the communication infrastructure (ICT networks, power supply, and road networks), accessibility of tools/network, ease of use, media/channels, language and feedback mechanism. Electricity, telecommunication, roads and transportation enhance access to knowledge (Kamba 2009). Roads enhance rural-urban linkages (Narayanamoorthy and Hanjra 2006), in knowledge management road infrastructure enhance the transportation of print resources from publishers/printers to destinations. Access to ICT networks and power infrastructure enhance the usage of ICT tools. Results in Table 5.28 on page 185 indicate that poor ICT networks and power supply limit usage of ICTs. Therefore, infrastructure directly influences the usage of AKS.

The usefulness of the ICT networks is influenced by the accessibility of ICT tools (communication tools) and the ease of use of such tools. Communication tools particularly ICTs enhanced the creation, sharing, storage and dissemination of agricultural knowledge. Findings in Table 5.24 indicate that actors either own or access communication tools from a third part. More

access to these tools increases the level of performing agricultural knowledge processes (Mtega, 2012; Sife *et al*, 2010; Mtega and Malekani, 2009). Moreover, ease of use of communication tools has a strong influence on usage and performance of agricultural knowledge processes. Ease of use is the perceived easiness that an individual thinks of when using the system (Kasim 2015). In AKS usage, ease of use is expressed in terms of efforts exerted in implementing agricultural knowledge processes and can be in the form of level of affordability to fees or skills needed to operate the system or tools making up a system (see Tables 5.14 on page 167, 5.28 on page 185 and 5.34 on page 198 for details).

Channels/media are important for effective communication. They are used as outlets or tools for delivering messages to intended audience. Findings in Table 5.21 on page 177 indicate that actors access and share knowledge through face to face oral communication; SMS, voice calls village meetings. Findings from agricultural actors not directly involved in farming access and share knowledge through face to face communication, mobile phones, radio and TV broadcasts, leaflets/brochures and notes and internet. Ease of use communication channels influence the level of usage of AKS. Moreover, channels which facilitate immediate feedback are considered to be more effective. It is for this reason more farmers prefer to use voice calls to SMS (see Table 5.21 for details).

Language plays an important role in a communication process. It is a means through which meaning is communicated to audience. Effective communication involves a simple and understandable language. Findings in Tables 5.15 on page 169 and 5.17 on page 172 indicate that technical and difficult languages are barriers to communication among some AKS actors.

Generally, communication factors play a very important role in increasing usage of AKS. They may have a direct influence on the level of usage of AKS or act through behaviour intention through the influence of ease of use of communication tools or channels. Individual factors moderate the influence of communication factors on AKS usage.

7.4.8.8 Performing agricultural knowledge processes

AKS usage is a dependent variable influenced by knowledge factors, type of AKS, involvement of actors, individual, institutional, agricultural production and communication factors. Individual

factors influence the usage of AKS and moderate the influence of other independent variables on AKS usage. Institutional factors shape and have to monitor how actors involve themselves in AKS. Generally, the efficiency of AKS depends on how all seven factors are set to enhance improved performance of the agricultural sector.

The performance of different agricultural knowledge processes depends on the level of usage of AKS. The more AKS is used the more the performance of agricultural knowledge processes (acquiring, capturing, creating, storing, organizing, retrieving, using, sharing and reusing agricultural knowledge). As agricultural knowledge processes take place different variables of the AKS model can be re-involved thus increasing AKS usage and the level of performance of agricultural knowledge processes. Thus, for effective performance of agricultural knowledge using and reusing AKS is inevitable.

7.4.8.9 Increased accessibility and usage of agricultural knowledge

Increased performance of agricultural knowledge processes leads to accessibility and usage of agricultural knowledge among AKS actors. Studies (Lwoga, Stilwell and Ngulube 2011b; Kremp and Mairesse, 2004) indicate that access to and usage of relevant information and knowledge is very important for improved agricultural productivity and livelihoods. Therefore, accessibility and usage of agricultural knowledge is one of the important factors of production.

7.5 Suggestions for further research

The scope and limitations presented in Section 1.7 of Chapter One of this study showed what has been covered by the study. For widening the scope and understanding in the field of Information Science, what was not covered by this study can be done by future studies. However, there are a number of issues which have been identified by this study requiring further investigation in order to provide a better understanding of the topic and more practical solutions to other issues involved. This section highlights eight areas that require further investigation.

7.5.1 Linkage between agricultural research institutes and farmers

Findings revealed that farmers were linked to agricultural research institutes through agricultural extension officers. This mode of linking the two key AKS actors have failed because findings indicate that few farmers had access to agricultural extension services and very few had contacts with agricultural researchers despite living near these institutes. Moreover, agricultural research institutes have been conducting research activities resulting into valuable knowledge, technologies and development which in most cases are left shelved in agricultural research institutes. This study proposes for an investigation on best modalities to link farmers and agricultural research institutes. The study can include issues related to how and which ICTs can facilitate linkage between farmers and agricultural research institutes.

7.5.2 Linking agricultural knowledge accessibility and usage to yield and profitability

Findings indicate that few among farmers who acquired agricultural knowledge put it into use. Some mentioned to have not used acquired agricultural knowledge because they did not know that it was useful. This study proposes for an investigation on how usage of agricultural knowledge is linked to increased yield and profitability. The proposed study may identify other factors perceived by farmers to influence yield and profitability. Such factors may be very useful when addressing issues related to agricultural knowledge services.

7.5.3 Usage of agricultural knowledge among actors

Findings revealed that the usage of acquired agricultural knowledge was very low. However, it is only through usage of agricultural knowledge yields can be improved. This study proposes for an investigation to find best ways to promote usage of recommended agricultural knowledge among AKS actors. The proposed study should determine the level of involvement of key actors in improving the level of usage of agricultural knowledge among them.

7.5.4 Usage of agricultural extension services among farmers

Despite its importance to agricultural productivity, the level of usage of agricultural extension services was low throughout the study area regardless of the presence of one agricultural extension officer in each village. It is proposed to have a study to determine factors influencing usage of agricultural extension services among farmers.

7.5.5 Usage of mobile phone agricultural value added services among AKS actors

Findings revealed that mobile phone service providers had specific agricultural value added services for AKS actors. It is proposed that an intensive investigation should be conducted to determine factors influencing usage of mobile phone agricultural value added services among actors. The investigation should assess the friendliness of platforms and other issues influencing usage of these services.

7.5.6 Agricultural radio and TV programmes

Despite airing few agricultural programmes, findings revealed that radio and TV sets were among the most used ICTs. Due to the wide coverage and being accessed by more audience at the same, these tools have great potential in enhancing agricultural knowledge accessibility. This study proposes for a study to determine how to promote and attain full potentials of radio and TV agricultural programmes. The investigation should also determine how to enhance access to agricultural broadcasts among more AKS actors.

7.5.7 Sustaining agricultural knowledge services provided by NGOs

Findings revealed that the government was the key actor in providing agricultural knowledge services. Results indicate further that through some projects NGOs were also directly involved in providing agricultural extension services. However, services provided by these organizations ended with the project life cycle. This study proposes for an investigation on how agricultural knowledge services provided by the private sector can be sustained beyond their life cycle.

7.5.8 Validation of the proposed model for strengthening AKS

This study ended by proposing a model for strengthening AKS usage. It is thus proposed that other researchers may validate the proposed model and assess its validity before being put into use.

7.6 Chapter summary

This chapter summarized the key research findings of the study as guided by the research questions from Section 1.5.2 of Chapter One. This chapter has also addressed the conclusions of the study as well as recommendations and suggestions of areas for further research.

The study revealed that human, ICT and paper based system were used by actors but the linkage among actors was poor. The study found further that actors needed different categories of agricultural knowledge. They also acquired most of the agricultural knowledge they needed but few of the acquired agricultural knowledge was put into use. Acquisition and usage of agricultural knowledge was mainly influenced by the perceived usefulness of knowledge. Results revealed further that accessibility of agricultural knowledge among actors was influenced by factors based on actors and agricultural knowledge sources. It was also found that most AKS actors shared agricultural knowledge mainly to fellows, peers, colleagues, or supervisors. Findings revealed further that computer; internet; mobile phones; radio; and TV sets were the ICTs used by AKS actors for acquiring, sharing, organizing or disseminating agricultural knowledge. Furthermore, it was found that the government was the key actor in enhancing access to agricultural knowledge services to other actors. The private sector was involved so as to complement government efforts in agricultural development. It was also found that there were significant variables influencing AKS usage. This chapter recommended for a framework for strengthening AKS usage in the agricultural sector. The chapter also recommended that in order to improve usage of AKs the following measures should be taken:

- Empower agricultural extension officers and influential farmers through trainings;
- Improve the linkage among AKS actors;
- Timely delivery of agricultural knowledge;
- More investment in rural ICT infrastructure;

- More involvement of the private sector in provision of agricultural knowledge services;
- Increase usage of ICTs in provision of agricultural knowledge services and;
- Consideration of all significant variables identified to influence AKS usage.

The chapter was concluded by suggesting the following eight areas for further research as a follow up to the current study:

- Determining best modalities to link farmers and agricultural research institutes;
- Determining how to sustain agricultural knowledge services provided through projects implemented by NGOs and private companies;
- Determine how to promote radio and TV agricultural programmes;
- Investigating factors influencing usage of mobile phone agricultural value added services;
- Determining best ways to promote usage of recommended agricultural knowledge among actors;
- Investigating factors influencing usage of mobile phone agricultural value added services among AKS actors
- Investigating the linkage between agricultural knowledge accessibility and usage to yield and profitability and;
- Validation of the proposed framework for strengthening AKS usage.

7.7 Overall conclusion

The study found that actors used human, paper and ICT based system. It was found that there was limited access and usage of agricultural knowledge among AKS actors. AKS actors failed to acquire and use some agricultural knowledge because of unavailability/late delivery of both agricultural knowledge and inputs. Actors shared acquired agricultural knowledge through face to face oral communication, SMS, voice calls, internet, and meetings. Agricultural knowledge was shared to fellows, peers or supervisors. Results revealed that radio sets and mobile phones were mostly used by the farmers while other AKS used computers, internet, mobile phones, radio and TV sets. ICTs were used for creating, organizing, storing, sharing or disseminating agricultural knowledge. The Government was found to play major roles in enhancing access to

and usage of agricultural knowledge. The study found some significant variables influenced usage of AKS. To strengthen the usage of AKS, a number of recommendations based on the findings were presented. Furthermore, a framework for strengthening AKS usage among actors was proposed. The chapter ended by identifying areas for further research.

REFERENCE

- Abalu, G. 2001. *Education in the political economy of African agricultural knowledge systems: staying abreast of the changing environment*. http://www.ciea.ch/documents/s01_sout_abalu.pdf (Accessed 20 May 2015).
- Abbas, F., Rasheed, A., Habiba, RA. & Shahzad, I. 2013. Factors promoting knowledge sharing and knowledge creation in banking sector of Pakistan. *Management science letters*, Vol. 3 (2), 405–414.
- Abdullah MS., Benest, I., Evans, A. & Kimble, C. 2002. Knowledge modelling techniques for developing knowledge management systems http://www.chris-kimble.com/Publications/Documents/Abdullah_2002.pdf (Accessed 20 April 2013).
- Abu-Nahleh, I., Hamdan, MA., Abu, HM. & Taha, SA. 2010. Developing a theoretical framework for knowledge acquisition. *European, Mediterranean & Middle Eastern Conference on Information Systems 2010 (EMCIS2010)*, April 12-13 2010, Abu Dhabi, UAE.
- Ackoff, RL. 1989. From data to wisdom. *Journal of Applied Systems Analysis*, 16, 3–9
- Adams, JD. 1990. Fundamental Stocks of Knowledge and Productivity Growth. *Journal of political economy*, Vol. 98 (4), 673-702.
- AEO. 2013. *Tanzania*. <http://www.africaneconomicoutlook.org/en/countries/east-africa/tanzania/> (Accessed 24 April 2015).
- African Development Bank. 2015. Renewable energy in Africa: Tanzania country profile. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/Renewable_Energy_in_Africa_-_Tanzania.pdf (Accessed 15 May 2015).
- Agwu, AE. & Adeniran, AA. 2009. Sources of agricultural information used by arable crop farmers in Isale Osun farm settlement, Osogbo Local Government Area of Osun State. *Journal of agricultural extension*, Vol. 13 (1).
- Ahmad AR. & Idris MTM. 2008. *Managing knowledge management through strategic management perspectives*. http://eprints.uthm.edu.my/332/1/abd_rahman_ahmad%2Cmohammad_talha.pdf (Accessed 5 May 2013).

- Ahsan, S. & Shah, A. 2006. Data, information, knowledge, wisdom: a doubly linked chain? <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.89.5378&rep=rep1&type=pdf> (Accessed 12 October 2014).
- Ajzen, I. & Fishbein, M. 1980. *Understanding attitudes and predicting social behavior*. New Jersey: Prentice-Hall.
- Ajzen, I. 2005. *Attitudes, Personality and Behaviour*. Ontario: McGraw-Hill Education.
- Aker, J. 2011. *Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries*. http://www.cgdev.org/sites/default/files/1425497_file_Aker_A_for_Agriculture_FINAL.pdf (Accessed 10 May 2015).
- Akpalu, DA. 2013. Agriculture extension service delivery in a semiarid rural area in South Africa: The case study of Thorndale in the Limpopo province. *African journal of food, agriculture, nutrition and development*, Vol. 13 (4), 8034–8057.
- Aktharsha, US. 2010. A theory of knowledge management. <http://www.psgim.ac.in/journals/index.php/jcrm/article/viewFile/118/125> (Accessed 20 May 2015).
- Akyoo, EP. 2008. Opportunities and Challenges of a partnership approach: the case of the income generating activities project, Morogoro Region Tanzania. M Dissertation, Larenstein University of Applied Sciences, Leeuwarden.
- Alam, GM., Hoque, KE. Khalifa, TB. Siraj, SB. & Ghani, MFBA. 2009. *The role of agriculture education and training on agriculture economics and national development of Bangladesh*. http://www.academicjournals.org/article/article1380809999_Alam%20et%20al.pdf (Accessed 20 May 2015).
- Alavi, M. & Leidner, D. 1999. *Knowledge management and knowledge management systems: conceptual foundations and research issues*. https://flora.insead.edu/fichiersti_wp/inseadwp_1999/99-34.pdf (Accessed 11 March 2015).
- Allameh, M., Zamani, M. & Davoodi, SMR. 2011. The relationship between organizational culture and knowledge management: a case study: Isfahan University. *Procedia computer science*, Vol. 3, 1224–1236.
- Allan, J. 2005. Interdisciplinary differences in attitudes towards deposit in institutional repositories. Masters dissertation, Manchester Metropolitan University. Manchester.

- Al-Shayaa, MS., Al Shenifi, MS. S AL Abdu Al Hadi, HS. 2011. Constraints to use computers among agricultural extension workers in Riyadh and Qaseem Regions of Saudi Arabia. *The journal of animal and plant sciences*, Vol. 21 (2), 264-268.
- Alston, JM. & Pardey, PG. 2008. *Public Funding for Research into Specialty Crops*. <http://hortsci.ashspublications.org/content/43/5/1461.full> (Accessed 08 May 2014).
- Altnöz, M. 2008. An overall approach to the communication of organizations in conventional and virtual offices. *World academy of science, engineering and technology*, Vol. 2, 05-20.
- Anaeto FC., Asiabaka CC., Nnadi FN, Ajaero JO., Ugwoke FO., Ukpongson MU. & Onweagba, AE. 2012. The role of extension officers and extension services in the development of agriculture in Nigeria. *Wudpecker, journal of agriculture research*, Vol. 1(6), 180-185.
- Andersen, O. 1992. *On the internationalization process of firms: a critical analysis*. http://jpkc.swufe.edu.cn/up_files/File/cankaowenxian/yingwen/ON%20THE%20INTERNATIONALIZATION%20PROCESS%20OF%20FIRMS.pdf (Accessed 20 May 2015).
- Aranganathan, P. & Lakshmi, J. 2010. Knowledge management in Indian information technology (IT) organizations. http://www.indianmba.com/Faculty_Column/FC1137/fc1137.html (Accessed 05 March 2014).
- Argote L. & Ingram P. 2000. Knowledge transfer: a basis for competitive advantage in firms. *Organizational behavior and human decision processes*, Vol. 82 (1), 150–169.
- Arnon, I. 1968. *Organization and administration and agricultural research*. Amstadam: Elsevier Publishing Company LTD.
- Arokoyo T 2003. ICT's for agriculture extension transformation: proceeding of ICTs transforming agriculture extension? http://repository.ruforum.org/sites/default/files/Case_study_Nigeria.pdf (Accessed 10 June 2016).
- Ary, D., Jacobs, LC. & Razavieh, A. 1985. *Introduction to research in education*. New York: Holt Rinehart and Winston.
- Aryal, D. 2009. *Oral tradition and communication*. <http://www.nepjol.info/index.php/BOHDI/article/viewArticle/2813> (Accessed 10 February 2013).
- Asenso-Okyere, K. & Mekonnen, DA. 2012. *The importance of icts in the provision of information for improving agricultural productivity and rural incomes in Africa*. <http://www.undp.org/content/dam/rba/docs/Working%20Papers/ICT%20Productivity.pdf> (Accessed 30 May 2015).

- Asenso-Okyere, K., Davis, K. & Ared, D. 2008. *Advancing agriculture in developing countries through knowledge and innovation*. <http://www.ifpri.org/sites/default/files/publications/oc59.pdf> (Accessed 21 March 2014)
- Asiedu-Darko, E. 2014. A Study of farmers seed selection methods in the Kpandai district of the northern region of Ghana. *International journal of agriculture, forestry and fisheries*. Vol. 2 (6), 86-90.
- Aslam, H. 2013. *Social Capital and Knowledge Sharing as Determinants of Academic Performance*. <http://cgr.umt.edu.pk/icobm2013/papers/Papers/IC3-Dec-2012-092.pdf> (Accessed 10 March 2014).
- Assefa, A., Waters-Bayer, A., Fincham, R. & Mudahara, M. 2009. Comparison of Frameworks for Studying Grassroots Innovation: Agricultural Innovation Systems and Agricultural Knowledge and Information Systems. In: Sanginga, P.C., Waters-Bayer, A., Kaaria, S., Njuki, J. & C. Wettasinha (eds), *Innovation Africa: Enriching farmers' livelihoods*. Oxford: Routledge.
- Azudin, N., Ismail, M.N. & Taherali, Z. 2009. Knowledge sharing among workers: a study on their contribution through informal communication in Cyberjaya, Malaysia. *Knowledge Management & e-learning: an international journal*, Vol. 1 (2), 139-62.
- Bacharach, SB. 1989. Organizational theories: some criteria for evaluation. <http://amr.aom.org/content/14/4/496.full.pdf+html> (Accessed 20 January 2013).
- Bachhav, NB. 2012. *Information needs of the rural farmers: a study from Maharashtra, India: a survey*. <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2043&context=libphilprac> (Accessed 13 March 2013).
- Bakhari IM. & Zawiyah MY. 2008. *Factors affecting knowledge sharing in public organizations in malaysia*. <http://www.kmice.cms.net.my/ProcKMICE/KMICE2008/Pdf/165-171-CR96.pdf> (Accessed 15 June 2014).
- Balaban, I., Mu, E., & Divjak, B. 2013. Development of an electronic portfolio system success model: An information systems approach. *Computers & education*, Vol. 60 (1), 396-411.
- Balama, C., Augustino, S., Eriksen, S., Makonda, FSB. & Amanzi, N. 2013. Climate change adaptation strategies by local farmers in Kilombero district, Tanzania. *Ethiopian Journal of Environmental Studies and Management*, Vol. 6, 724 – 736.

- Ballantyne, P. 2010. Agricultural information and knowledge sharing: promising opportunities for agricultural information specialists. *Agricultural information worldwide*, Vol. 3 (1), 4-9.
- Banerjee, A. and Chaudhury, S. 2010. Statistics without tears: populations and samples. *Industrial psychiatry journal*, Vol. 19 (1): 60–65.
- Baraka, HA., Baraka, HA. & EL-Gamily, IH. 2013. Assessing call centers' success: A validation of the DeLone and McLean model for information system. *Egyptian informatics journal*, Vol. 14 (2), 99-108.
- Beegle, K. Deweerdt, K. & Dercon, S. 2011. Migration and economic mobility in Tanzania: evidence from a tracking survey. *The review of economics and statistics*, Vol. 93 (3), 1010-1033.
- Behi, R. & Nolan, M. 1995. Ethical issues in research. *British journal of nursing*, Vol. 4 (12), 712-716.
- Benard, R. Dulle, F. & Ngalapa, H. 2014. *Assessment of information needs of rice farmers in Tanzania; a case study of Kilombero District, Morogoro.* <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=2666&context=libphilprac> (Accessed 30 June 2015).
- Berg, KE. & Latin, RW. 2008. *Essentials of research methods in health, physical education, exercise science, and recreation*. Sydney: Lippincott Williams and Wilkins.
- Bergh, D. D., Hanke, R., Balkundi, P., Brown, M., & Chen, C. 2004. An assessment of research designs in strategic management research: The frequency of threats to internal validity. In D. J. Ketchen & D. D. Bergh (Eds.), *Research methodology in strategy and management*. Oxford: Elsevier.
- Berman, J. 2013. Utility of a conceptual framework within doctoral study: a researcher's reflections. *Issues in educational research*, Vol. 23 (1), 1-18.
- Bertolini, R. 2004. Making information and communication work for food security in Africa. 2020. *Africa Conference Brief 11*. International Food Policy Research Institute: Washington DC.
- Beye, G. 2002. *Impact of foreign assistance on institutional development of national agricultural research systems in Sub-Saharan Africa*. FAO Research and Technology Paper No 10. Rome: FAO.
- Bhattacharyya, DK. 2009. *Research methodology*. New Delhi, Excel Books India.

- Bhattacharjee, A. 2012. *Social science research: principles, methods, and practices*. Florida: CreateSpace.
- Bhojaraju, G. 2005. Knowledge management: why do we need it for corporates? *Malaysian Journal of library & information science*, Vol. 10 (2), 37-50.
- Bickel, PJ. & Lehmann, EL. 2012. Descriptive statistics for nonparametric models 1: introduction. *The annals of statistics*, Vol. 3 (5), 1038-1044.
- Bihani, P. & Patil, ST. 2014. A comparative study of data analysis techniques. *International journal of emerging trends & technology in computer science*, Vol. 3 (2), 95-101.
- Bitso, C. & Fourie, I. 2012. An investigation of information-seeking behaviour of geography teachers for an information service intervention: the case of Lesotho. <http://www.informationr.net/ir/17-4/paper549.html#.V3I8qhLOeVc> (Accessed 25 January 2016).
- Biygautane, M. & Al-Yahya, K. 2011. *Enablers and barriers to effective knowledge management: the case of dubai's public sector*. https://www.academia.edu/1049537/Enablers_and_Barriers_to_Effective_Knowledge_Management_The_Case_of_Dubais_Public_Sector1 (Accessed 01 June 2014).
- Booch, G., Rumbaugh, J. & Jacobson, I. 1999. *The unified modelling language user guide*, Massachusetts: Addison Wesley.
- Borthakur, A. & Singh, P. 2012. Agricultural research in India: an exploratory study. *International journal of social science & interdisciplinary research*, Vol. 1 (9), 59-74.
- Boslaugh, S. 2007. *Secondary data sources for public health: a practical guide (Practical Guides to Biostatistics and Epidemiology)*. Cambridge: Cambridge University Press
- Botha A, Kourie D, and Snyman R. 2008. *Coping with continuous change in the business environment, knowledge management and knowledge management technology*. London: Chandice Publishing Ltd.
- Bourguignon, F. & Pleskovic, B. 2008. *Rethinking Infrastructure for Development*. Annual World Bank Conference on Development Economics—Global, 2007. Washington, DC: The World Bank.
- Bracht, GH. & Glass, GV. 1968. The external validity of experiments. *American educational research journal*, Vol. 5 (4), 437-474.

- Braman, S. 2011. *Defining information policy*. <http://jip.vmhost.psu.edu/ojs/index.php/jip/article/download/19/14> (Accessed 09 July 2014).
- Brand A. 1998. Knowledge management and innovation at 3M. *Journal of knowledge management*, Vol. 2 (1): 17-22.
- Brüntrup-Seidemann, S. 2011. Actual and Potential Roles of Local NGOs in Agricultural Development in Sub-Saharan Africa. *Quarterly journal of international agriculture*, Vol. 50 (1), 65-78.
- Bryman, A. 2004. *Social research methods*. 2nd ed. Oxford: Oxford University Press.
- Burgess, R. 1984. *In the Field: An Introduction to Field Research*. London: Unwin Hyman
- Byerlee, D. 1998. The search for a new paradigm for the development of national agricultural research systems. *World development*, Vol. 26 (6), 1049-1055.
- Byrne, G. 2007. A statistical primer: Understanding descriptive and inferential statistics. *Evidence based library and information practice*, Vol. 2 (1), 32-47.
- Cabrera, EF. Cabrera, A., 2005. Fostering knowledge sharing through people management practices. *International Journal of human resource management*, Vol. 16 (5), 720-735.
- Carneiro, A. 2001. The Role of Intelligent Resources in Knowledge Management. *Journal of knowledge management*, Vol. 5 (4), 358–367.
- Carr, MKV. Ndamugoba, DM. Burgess, PJ. & Myinga, GR. 1992. *An overview of tea research in Tanzania - with special reference to the Southern Highlands*. <https://dspace.lib.cranfield.ac.uk/bitstream/1826/1397/1/Carr%20Ndamugoba%20Burgess%20Myingal-TeaResearch-SouthHigh%201992.pdf> (Accessed 6 May 2013).
- Case, DO. 2002. *Looking for information: a survey of research on information seeking, needs and behaviour*. Amsterdam: Elsevier.
- Cash, DW. Clark, WC. Alcock, F. Dickson, NM. Eckley, N., Guston, DH., Jager, J. & Mitchell, RB. 2003. *Knowledge systems for sustainable development*. <http://www.pnas.org/content/100/14/8086.full.pdf> (Accessed 16 September 2014).
- Castillo, JJ. 2009. *Research population*. <http://www.experiment-resources.com/research-population.html> (Accessed 10 August 2015).
- Castro, FG., Kellison, JG., Boyd, SJ. & Kopak, A. 2010. A methodology for conducting integrative mixed methods research and data analyses. *Juornal of mix research methods*, Vol. 4 (4), 342–360.

- Chambers, R. and Conway, G. 1992. *Sustainable rural livelihoods: practical concepts for the 21st century*. Brighton: Insitutte of Development Studies.
- Chen, CP., Liu, PL. & Tsai, CH. 2008. A study of the influence of organizational knowledge ability and knowledge absorptive capacity on organizational performance in Taiwan's hi-tech enterprises. *Journal of applied sciences*, Vol. 8 (1), 1138 -48.
- Chilimo, W. 2010. Information and Communication Technologies and sustainable livelihoods: a case of selected rural areas of Tanzania. D Inf. Studies, University of KwaZulu-Natal, KwaZulu-Natal.
- Choo, CW. & Neto, RCDA. 2010. Beyond the ba: managing enabling contexts in knowledge organizations. *Journal of knowledge management*, Vol. 14 (4), 592-610.
- Chota, E. 1986. Agricultural research in Tanzania. Doctoral Thesis, Michigan University, Michigan.
- Chou, SW. and He, MY. 2003. Knowledge management: the distinctive roles of knowledge assets in facilitating knowledge creation. *Journal of information science*, Vol. 30 (2), 146–164.
- Chow WS. & Chan LS. 2008. Social network and shared goals in organizational knowledge sharing. *Information management*, Vol. 45 (7), 24–30.
- Chowdhury, MF. 2014. Interpretivism in aiding our understanding of the contemporary social world. http://file.scirp.org/Html/20-1650412_48986.htm (Accessed 27 May 2015).
- Christensen, PH. 2003. Knowledge management: perspectives and pitfalls. Copenhagen: Copenhagen Business School Press.
- Chronic Research Poverty Centre. 2005. *Methods toolbox*. <http://www.chronicpoverty.org/page/toolbox> (Accessed 14 October 2013).
- Chua, A. 2001. *Relationship between the types of knowledge shared and types of communication channels used*. <http://www.tlainc.com/articl26.htm> (Accessed 03 June 2014).
- Chunjuan, LI. 2013. Research on architecture of knowledge system of emergency management. *Science and technology management research*, Iss. 16, 241-245.
- Civelek, M.E., Çemberci, M., Artar, O.K. & Uca, N., 2015. *Key factors of sustainable firm performance*. Nebraska: Zea Books.
- Cohen, L., Manion, L. & Morrison K. 2007. *Research methods in education* (6th Edition). London: Routledge Falmer.

- Collins, C., Smith, K. G. & Stevens, C. K. 2001. *Human resource practices, knowledge-creation capability and performance in high technology firms*. <http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1064&context=cahrswp> (Accessed 13 November 2014).
- Collins, H. 2010. *Creative research: the theory and practice of research for the creative industries*. New York: Ava Publishing.
- Connelly, CE. Zweig, D. Webster, J. and Trougakos, JP. 2012. Knowledge hiding in organizations. *Journal of organizational behavior*, Vol. 33, 64–88.
- Contento, IR. 2008. Nutrition education: linking research, theory, and practice. *Asia Pacific journal of clinical nutrition*, Vol. 17, 176–179.
- Coulson, A. and Diyamett, B. 2012. *Improving the contribution of agricultural research to economic growth: policy implications of a scoping study in Tanzania*. <http://www.theigc.org/sites/default/files/Coulson%20and%20Diyamett%20final%20paper.pdf> (Accessed 14 November 2014).
- Cramer, KM. 2013. Six Criteria of a Viable Theory: Putting Reversal Theory to the Test. *Journal of Motivation, Emotion, and personality*, Vol. 1 (1), 9–16.
- Creswell, J. 2009. *Research design: Qualitative, quantitative, and mixed methods approaches*. London: SAGE Publications.
- Crossan, F. 2003. Research philosophy: Towards an understanding. *Nurse researcher*, Vol. 11(1), 46-55.
- Crousillat E. Hamilton R. & Antmann P. 2010. *Addressing the electricity access gap*. Background paper for the World Bank Group Energy Sector Strategy. http://siteresources.worldbank.org/EXTESC/Resources/Addressing_the_Electricity_Access_Gap.pdf (Accessed on 12 May 2013)
- CTA. 2008. *Assessment of agricultural information needs in African, Caribbean and Pacific (ACP) States Eastern Africa Country study: Tanzania*. Wageningen: CTA.
- Cummings JL. & Teng B-S. 2003. Transferring R&D knowledge: the key factors affecting knowledge transfer success. *Journal of engineering and technology management*, Vol. 20, 39-68.

- CUTS International. 2011. *Extension services in Tanzania: better reaching remote areas*. http://www.cuts-geneva.org/pdf/Action-Alert-Extension_Services_Tanzania.pdf (Accessed 10 June 2013).
- Dalkir, K. 2013. *Knowledge management in theory and practice*. Oxford: Routledge.
- D'Ambra, J., Wilson, C. & Akter, S. 2013. Application of the task-technology fit model to structure and evaluate the adoption of E-books by academics. *Journal of the American society for information science and technology*, Vol. 64 (1), 48-64.
- Daniel, E. 2013. *Assessment of agricultural extension services in Tanzania. a case study of Kyela, Songea Rural, and Morogoro Rural Districts*. <http://www.parasite-project.org/wp-content/uploads/2013/12/Elifadhili-2013-Internship-report-final.pdf> (Accessed 19 November 2016).
- Darroch, J., & McNaughton, R. 2002. Examining the link between knowledge management practices and types of innovation. *Journal of intellectual capital*, Vol. 3 (3), 210-22.
- Das, AK. & Dutta, C. 2004. *Strengthening rural information infrastructure through e-choupals*. http://eprints.rclis.org/bitstream/10760/7210/1/Das_Dutta_XXI_IASLIC_Seminar_2004.pdf (Accessed 19 April 2014)
- Daudu, S., Chado, SS. & Igbashal, AA. 2009. Agricultural information sources utilized by farmers in Benue State, Nigeria. <http://patnsukjournal.net/Vol5No1/p5.pdf> (Accessed 05 April 2014).
- Davenport TH. & Prusak L. 1998. *Working knowledge: how organizations manage what they know*. Havard: Harvard Business School Press.
- Davenport, T., De Long, D. & Beers, M. 1998. Successful knowledge management projects. *Sloan management review*, Vol. 39 (2), 43–57.
- Davenport, TH. & Volpel, SC. 2001. The rise of knowledge towards attention management. *Journal of knowledge management*, Vol. 5 (3), 212-21.
- Davis, B. & Riggs, B. 1999. Knowledge management: get smart. *Information week*, 40–46.
- Davis, FD., Bagozzi, RP. & Warshaw, PR. 1992. Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of applied social psychology*, Vol. 22 (14), 1111-1132.
- Davis, K. Babu, SC. & Blom, S. 2014. *The role of extension and advisory services in building resilience of smallholder farmers*. <http://www.ifpri.org/sites/default/files/publications/2020resilienceconfbr13.pdf> (Accessed 02 May 2015).

- De Long, DW. & Fahey, L. 2000. Diagnosing cultural barriers to knowledge management. *Academy of management executive*. Vol. 14 (4).
- Demiryurek, K., Erdem, H., Ceyhan, V, Atasever, S. & Uysal, O. 2008. Agricultural information systems and communication networks: the case of dairy farmers in the Samsin province of Turkey. <http://www.informationr.net/ir/13-2/paper343.html> (Accessed 20 April 2014).
- Denzin, NK. & Lincoln, YS. (Eds.). 2000. *Handbook of qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.
- Derso, D., Mamo, Y. & Haji, J. 2014. Analyzing socio-economic factors affecting the use of information and communication technologies among farmers in central highlands of Ethiopia. *African journal of agricultural science and technology*, Vol. 2 (8), 163-171.
- Desouza, KC. 2003. Barriers to effective use of knowledge management systems in software engineering. *Communications of the ACM*, Vol. 46 (1), 99–101.
- Diyamett, B., Mutambala, M. & Daniel, L. 2012. Improving Agricultural Extension and Advisory Services in Africa South of the Sahara using ICTs: A Report of a Scoping Study for Tanzania. *IFPRI Workshop* 13-14 December, 2012 Addis Ababa, Ethiopia.
- Dongre AR., Deshmukh PR., Kalaiselvan G. & Upadhyaya S. 2009. Application of qualitative methods in health research: an overview. *Online journal of health and allied science*, Vol. 8 (4).
- Driscoll, DL., Appiah-Yeboah, A. Salib, P. and Rupert, DJ. 2007. *Merging qualitative and quantitative data in mixed methods research: how to and why not*. <http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1012&context=icwdmeea> (Accessed 02 July 2016)
- Droppelmann, K. Mapila, MATJ., Mazunda, J., Thangata, J. & Yauney, J. 2013. *Who talks to whom in african agricultural research information networks?* <http://www.ifpri.org/sites/default/files/publications/ifpridp01264.pdf> (Accessed 8 June 2013).
- Drost, EA. 2011. Validity and Reliability in Social Science Research. *Education research and perspectives*, Vol.38 (1).
- Du J. & Liu, L. 2011. Knowledge management for product development: a review. *12th International Conference on Computer-Aided Design and Computer Graphics, CAD/Graphics 2011*, Jinan, China, September 15-17, 2011. Jinan Computer Society: 38–43.

- Dunleavy, P. 2003. *Authoring a PhD: how to plan, draft, write and finish a doctoral thesis or dissertation*. New York: Palgrave Macmillan.
- Durrheim, K. 2006. Research design. In: Terre Blanche, M., K. Durrheim and D. Painter (eds). *Research in practice: applied methods for the social sciences*. Cape Town: University of Cape Town.
- Duveskog, D. 2013. *Farmer Field Schools as a transformative learning space in the rural African setting*. PhD Thesis, Swedish: University of Agricultural Sciences, Uppsala.
- Dvorak, KA. 1992. Technical Paper 6: Socio-Economic Data Collection Methods. In *The AFNETA alley farming training manual - Volume 2: Source book for alley farming research*. The Alley Farming Network for Tropical Africa (AFNETA).
- Dwivedi, R. S. 1997. *Research methods in behavioural sciences*. New Delhi: Macmillan.
- Eisenhardt, KM. 1989. Building theories from case study research. *Academy of management review*, Vol. 14 (4), 532-550.
- Eshlaghy, AT. & Yusefvand, AA. 2011. Identifying and prioritizing critical success factors (CSFs) in practicing knowledge management in small and medium firms using decision making techniques. *European journal of economics, finance and administrative sciences*, Iss. 40.
- EU SCAR 2012. *Agricultural knowledge and innovation systems in transition – a reflection paper*, Brussels. http://ec.europa.eu/research/bioeconomy/pdf/ki3211999enc_002.pdf (Accessed 17 March 2014).
- Fai, CF., Chin, KK., Fu, CK. & Bun, LW. 2005. *Systematic knowledge auditing with applications*. <http://www.tlinc.com/articl97.htm> (Accessed 03 August 2014).
- FAO 2006. *Food security information for action: reporting food security information stakeholders' analysis*. http://www.fao.org/elearning/course/f6/en/pdf/trainerresources/annex0140_01.pdf (Accessed 04 July 2014).
- FAO 2008. *Global review of good agricultural extension and advisory service practices*. <http://www.fao.org/3/a-i0261e.pdf> (Accessed 12 March 2013).
- FAO 1972. *Training for agriculture: annual review of selected developments*. <http://files.eric.ed.gov/fulltext/ED075670.pdf> (Accessed 12 March 2014).
- FAO 1996. *Training for agriculture and rural development*. FAO: Rome.

- FAO 2003. *Enhancing support for sustainable rural livelihoods*. <http://www.fao.org/docrep/meeting/006/y8349e.htm> (Accessed 29 October 2014).
- Farm Radio International, 2011. The new age of radio: how ICTs are changing rural radio in Africa. *African farm radio research initiative 2011*. <http://www.farmradio.org/wp-content/uploads/farmradioictreport2011.pdf> (Accessed 20 May 2016).
- Fassnacht, M. & Koese, I. 2006. Quality of electronic services: conceptualizing and testing a hierarchical model. *Journal of service research*, Vol. 9 (19), 19-37.
- Fawcett, J. & Downs, F.S. 1986. *The relationship of theory and research*. Norwalk, CT: Appleton-Century-Crofts.
- Federer, WT. 1991. *Statistics and society: data collection and interpretation*. London: CRC Press.
- Ferroni, M. & Castle, P. 2011. Public-private partnerships and sustainable agricultural development. *Sustainability*, Vol. 3, 1064-1073.
- Fife-Schaw, C., (Ed.) 2006. *Research Methods in Psychology*, London; Sage Kimberlin, CL and Winterstein, AG. 2008. Validity and reliability of measurement instruments used in research. *American journal of health-system pharmacy*, Vol. 65 (23), 2276-84.
- Fourie, I. 2012. Understanding information behaviour in palliative care: arguing for exploring diverse and multiple overlapping contexts. *Information research*, Vol.17 (4).
- Frické, M. 2007. The knowledge pyramid: a Critique of the DIKW hierarchy. *Journal of informations*, Vol. 20 (10), 1-13.
- Furuholt, B. & Matotay, E. 2011. The developmental contribution from mobile phones across the agricultural value chain in rural Africa, *The electronic journal on information systems in developing countries*, Vol. 48 (7), 1-16.
- Gagne, M. 2009. A model of knowledge-sharing motivation. *Human resource management*, Vol. 48 (4), 571–589.
- Galadima. M. 2014. Constraints on farmers access to agricultural information delivery: a survey of rural farmers in Yobe state, Nigeria. *IOSR journal of agriculture and veterinary science*, Vol. 7 (9), 18 – 22.
- Gelard, P. Emamisaleh, K. Hassanabadi, M. & Rad, MS. 2013. Looking into knowledge management from organizational structure perspective. *International review of management and business research*, Vol. 2 (2).

- Gelb E. & Voet, E. 2009. *ICT adoption trends in agriculture: a summary of the EFITA ICT adoption questionnaires (1999–2009)*. <http://departments.agri.huji.ac.il/economics/voet-gelb.pdf> (Accessed 22 May 2014).
- Gillespie, DF. 1995. *Ethical issues in research*. http://www.uncp.edu/home/marson/ethical_issue_s.html (Accessed 21 March 2015).
- Glanz, K., Rimer, B. K. & Viswanath, K. 2008. *Health behavior and health education: theory, research, and practice*. San Francisco: John Wiley & Sons, Inc.
- Glatstein, E. 2002. What is Research? <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.611.4381&rep=rep1&type=pdf> (Accessed 08 April 2015).
- Godtland, E., Sadoulet, E., deJanvry, A., Murgai, R., Ortiz, O. 2004. The impact of farmer field schools on knowledge and productivity: A study of potato farmers in the Peruvian Andes. *Economic development and cultural change*, Vol. 53 (1), 63–92.
- Goel, V., Gold, B., Kapur S. & Houle, S. 1997. The seats of reason? An imaging study of deductive and inductive reasoning. <http://www.yorku.ca/vgoel/reprints/goel.neuroreport.97.pdf> (Accessed 08 April 2014).
- Golafshani, N. 2003. Understanding Reliability and Validity in Qualitative Research. *The qualitative report*, Vol. 8 (4).
- Goldkuhl, G. 2004. *Meanings of Pragmatism: Ways to conduct information systems research*. Proceedings of the 2nd International Conference on Action in Language, Organisations and Information Systems (ALOIS 2004), 17-18 March 2004. Linköping, Sweden.
- Goodhue, DL. & Thompson, RL. 1995. Task-Technology Fit and Individual Performance. *Management information systems quarterly*, Vol. 19 (2), 213-236.
- Gottschal, P. 2007. Knowledge management systems: value shop creation. Hershey: IGI
- Goyal, A. 2011. *ICT in Agriculture Sourcebook: Connecting Smallholders to Knowledge, Networks, and Institutions*. <https://openknowledge.worldbank.org/bitstream/handle/10986/12613/646050ESWOP11801ture0e0Sourcebook12.pdf?sequence=1&isAllowed=y> (Accessed 8 May 2013).
- Gregor, S. 2002. *A theory of theories in information systems*. In S. Gregor and D. Hart (Eds.), *Information Systems Foundations: Building the Theoretical Base*. Australian National University, Canberra, 1-20.

- Gregor, S. 2006. The nature of theory in information systems. *Management information systems quarterly*, Vol. 30 (3), 611-642.
- Gwivaha, FA. 2015. Factors that impact agricultural extension training programs for smallholder women farmers in Njombe District, Tanzania. M Thesis, Iowa State University, Iowa.
- Hadi, SA., Chaudhry, AG., Ahmed, A. & Khan, SE., 2015. Perception, approaches and practices of local farming and development: an anthropological approach. *Pakistan journal of agricultural research*, Vol, 28 (1).
- Hall, A., Mytelka, L. & Oyeyinka, B. 2005. *Innovation systems: implications for agricultural policy and practice*. https://cgspace.cgiar.org/bitstream/handle/10568/70179/ILAC_Brief02_Innovation.pdf?sequence=1&isAllowed=y (Accessed 8 June 2015).
- Hartini A. Normala S. & Sobry, A. 2006. *Knowledge sharing behavior in the public sector: the business process management perspectives*. <http://www.kmice.cms.net.my/ProcKMICe/KMICe2006/Pdf/435.pdf> (Accessed 22 May 2013).
- Hartwich, F., Pérez, MM. Ramos, LA. & Soto, JL. 2007. Knowledge management for agricultural innovation: lessons from networking efforts in the Bolivian Agricultural Technology System. *Knowledge Management for Development Journal*, Vol. 3(2), 21-37.
- Haslinda, A. & Sarinah, A. 2009. *A review of knowledge management models*. http://www.sosyalarastirmalar.com/cilt2/sayi9pdf/haslinda_sarinah.pdf (Accessed 22 June 2013).
- Havlíček, J. Hron, J. & Tichá, I. 2006. *Knowledge based higher education*. <http://www.agriculturejournals.cz/publicFiles/58002.pdf> (Accessed 08 May 2013).
- He, W. & Wei, KK., 2009. What drives continued knowledge sharing? An investigation of knowledge-contribution and seeking beliefs. *Decision support systems*, Vol. 46 (4), 826–838.
- Heaidari, M., Moghimi, MH. & Khanifar, H. 2011. The critical success factors in implementing knowledge management: agricultural organization in Islamic Republic of Iran. *British journal of science*, Vol. 1 (2).
- Heinström, J. 2003. Five personality dimensions and their influence on information behaviour. *Information research*, Vol. 9 (1).

- Hemsley, J., & Mason, RM. 2012. The nature of knowledge in the social media age: implications for knowledge management models. *Proceedings of HICSS 45*, 3928-3937.
- Hendriks, P., 1999, Why share knowledge? the influence of ICT on the motivation for knowledge sharing. *Knowledge and process management*, Vol. 6 (2), 91-100.
- Hermans, F., Klerkx, L. & Roep, D. 2010. *Comparative analysis and synthesis report*. http://www.solinsa.org/fileadmin/Files/deliverables/D3_1a_Comparative_analysis_and_synthesis_report_final_Nov_2011.pdf (Accessed 10 July 2013).
- Herschel, RT., Nemati, H. & Steiger, D. 2001. *Tacit to explicit knowledge conversion: knowledge exchange protocols*. http://e_p_w2.tripod.com/tacit_to_explicit_-_herschel.pdf (Accessed 13 November 2013).
- Hess, CG. 2006. *Knowledge management and knowledge systems for rural development*. http://www.fao.org/nr/com/gtzworkshop/Knowledge_Management_and_Systems.pdf (Accessed 15 May 2013).
- Hislop, D. (2003). Linking human resource management and knowledge management via commitment: a review and research agenda. *Employee relations*, Vol. 25 (2), 182-202.
- Holsapple, CW. & Joshi, KD. 2000. An investigation of factors that influence the management of knowledge in organizations. *Journal of strategic information systems*, Vol. 9 (2-3), 235-261.
- Hooff van den, B., Elving, W., Meeuwsen, J. M. & Dumoulin, C. 2003. *Knowledge sharing in knowledge communities*. In Huysman, M., Wenger, E. and Wulf, V. *Communities and technologies*. Dordrecht: Kluwer Academic Publishers.
- Howitt, D. & Cramer, D. 2008. *Introduction to research methods in psychology*. New Jersey: Prentice Hall.
- Hsiao, C. 2005. Invited eminent paper series: Why panel data? *The Singapore Economic Review*, Vol. 50 (2), 143-154.
- Huang, CC. & Lin TC. 2007. *Understanding knowledge management system usage antecedents: an integration of social cognitive theory and task technology fit*. http://iceb.nccu.edu.tw/proceedings/APDSI/2007/papers/Final_36.pdf (Accessed 19 July 2014).
- Hubbard, DW. 2010. *How to measure anything: finding the value of intangibles in business*. New Jersey: John Wiley and Sons.

- Hussein, K. 2001. *Farmers' organisations and agricultural technology: institutions that give farmers a voice*. London: SAGE Publications.
- Husted, MS. Minbaeva, DB. & Pedersen, T. 2011. Knowledge sharing hostility and governance mechanisms: an empirical test. *Journal of knowledge management*, Vol.16 (5), 754–773.
- Hutchby, I. & Moran-Ellis, J. 2013. *Children, technology and culture: the impacts of technologies in children's everyday lives*. Oxford: Routledge.
- IMF. 2011. Tanzania: Poverty reduction strategy paper. *IMF country report no. 11/17*. IMF: Washing DC.
- Inkpen, AC. & Tsang, EWK. 2005. Social capital, networks, and knowledge transfer. *Academic management review*, Vol. 30 (1), 146–165.
- Islam, F. 2010. *Institutionalization of agricultural knowledge management system for digital marginalized rural farming community*. <http://hal.archives-ouvertes.fr/docs/00/51/64/58/PDF/Faisal-Institutionalization.pdf> (Accessed 20 May 2013).
- Islam, SM. & Grönlund, Å. 2011. Factors influencing the adoption of mobile phones among the farmers in Bangladesh: theories and practices. *International journal on advances in ICT for emerging regions*, Vol. 4 (01), 4–14.
- Jaggi, S. 2003. Descriptive statistics and exploratory data analysis. http://www.iasri.res.in/ebook/EB_SMAR/e-book_pdf%20files/Manual%20II/1-Descriptive%20Statistics.pdf (Accessed 14 January 2014).
- Jamaluddin H. & Alias AN. 1997. *Quality in student support: a learner's perspective*. 11th Annual Conference on Quality Assurance in Distance and Open Learning. Kuala Lumpur
- Järvinen, P. 2011. On recent advances in research methods. 2nd Scandinavian Conference on Information Systems & the 34th Information Systems Research Seminar (IRIS), August 2011, 16-19.
- Jelenic, D. 2011. *The importance of knowledge management in organizations – with emphasis on the balanced scorecard learning and growth perspective*. <http://www.issbs.si/press/ISBN/978-961-92486-3-8/papers/ML11-1.pdf> (Accessed 14 January 2014).
- Jennex, M.E. 2009. Re-visiting the knowledge pyramid. 2009. *HICSS'09. 42nd Hawaii International Conference on system sciences*, 1-7.

- Jennex, ME. 2007. *Knowledge management in modern organizations*. New York: Idea Group Inc (IGI).
- Jewels, T., Underwood, A. & de Pablos, C. 2003. The Role of Informal Networks and Knowledge sharing. <http://is2.lse.ac.uk/asp/aspecis/20030070.pdf> (Accessed 14 January 2014)
- Jha, AS. 2014. *Social research methods*. New Delhi: McGraw Hill Education (India) Pvt Ltd.
- John, KC. 1997. Farmers' participation in agricultural research and extension systems. New Delhi: Concept Publishing Company.
- Johnson J. 1996. Promoting interaction among students in distant education. *Education and media international journal of knowledge management practice*, Vol. 9 (3), 18-25.
- Jowell, R., 1986. The Codification of Statistical Ethics. *Journal of official statistics*, Vol.2 (3), 217-53.
- Kahreh, MS. 2011. *Economics of strategic knowledge management: a new model for assessment*. <http://www.ijtef.org/papers/113-F541.pdf> (Accessed 19 February 2014).
- Kajembe, GC. Silayo, DA. Mwakalobo, ABS. & Mutabazi, K. 2013. *The Kilosa District REDD+ pilot project, Tanzania: a socio-economic baseline study*. London: IIED.
- Kamba, M. A. 2009. *Access to information: the dilemma for rural community development in Africa*. http://globelics2009dakar.merit.unu.edu/papers/1238296264_MA.pdf (Accessed 29 May 2016).
- Kapange, B. 2004. *ICTs and national agricultural research systems: the case of Tanzania*. <http://www.tzonline.org/pdf/ictsandnationalagriculturalresearchsystems.pdf> (Accessed 02 May 2013).
- Kasim, HA. 2015. Factors affecting knowledge sharing using virtual platforms – a validation of unified Theory of acceptance and use of technology (UTAUT). <http://airccse.org/journal/mpict/papers/6215ijmpict01.pdf> (Accessed 02 June 2016).
- Kawa, I. & Kaitira, LM. 2007. Enhancing smallholder farmers' market competitiveness in Tanzania. In: Per Pinstруп-Andersen and Fuzhi Cheng (editors). *Food policy for developing countries: case studies*. <http://cip.cornell.edu/dns.gfs/1200428177> (Accessed 15 May 2016).

- Kenny, C. Navas-Sabater, J. & Qiang, C. 2001. Information and Communication Technologies and poverty. <http://repository.mdp.ac.id/ebook/library-ref-ind/ref-ind-1/application/poverty-reduction/prsp/SourceBook/ict0409.pdf> (Accessed 20 January 2014).
- Khodamoradi, S. & Abedi, M. 2011. The importance of Information and Communication Technologies (ICT) in agriculture development in developing countries. *Journal of American science*, Vol. 7 (3).
- Kijazi, A., Chang'a, L. Liwenga, E., Kanemba, A. & Nindi, S. 2013. The use of indigenous knowledge in weather and climate prediction in Mahenge and Ismani wards, Tanzania. *Journal of geography and regional planning*, Vol. 6 (7), 274-280.
- Kimaro W.H, Mukandiwa L and Mario E.Z.J (Eds), 2010. Towards improving agricultural extension service delivery in the SADC Region. Proceedings of the Workshop on Information Sharing among Extension Players in the SADC Region, 26-28 July 2010, Dar es Salaam, Tanzania
- Kimberlin, CL. & Winterstein, AG. 2008. Validity and reliability of measurement instruments used in research. *American journal of health system pharmacists*, Vol. 65 (23), 2276-2284.
- King, RN. & Rollins, TJ. 1999. An evaluation of an agricultural innovation: Justification for participatory assistance. *Journal of extension*, Vol. 37 (4).
- King, WR. 2009. *Knowledge Management and Organizational Learning*. Springer, New York, USA.
- Kiplangat, NE. 2013. Analysis of existing agricultural information Systems for post-harvest management among Smallholder farmers in Bomet County. M Inf dissertation, University of Nairobi, Nairobi.
- Kitzinger J. 1994. Focus groups: method or madness? In Boulton M, ed. *Challenge and innovation: methodological advances in social research on HIV/AIDS*. London: Taylor and Francis.
- Kitzinger J. 1995. *Introducing focus groups*. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2550365/pdf/bmj00603-0031.pdf> (Accessed 05 June 2015).
- Klenke, K. 2008. *Qualitative research in the study of leadership*. Bingley: Emerald Group Publishing.

- Klerkx, L. & Leeuwis, C. 2008. Balancing multiple interests: embedding innovation intermediation in the agricultural knowledge infrastructure. *Technovation*, Vol. 28 (6), 364-378.
- Knezevic, SZ., Evans, SP. & Mainz, M. 2003. Row spacing influences the critical timing for weed removal in soybean (glycine max). *Weed technology*, Vol. 17 (4), 666-673.
- Koda, B. 2000. Understanding local knowledge systems for agricultural and rural development: research needs for Tanzania in Mascarenhas, A (ed.). *Gender, biodiversity and local knowledge systems to strengthen agricultural and rural development: the Tanzanian context*. Rome: FAO.
- Kora, G. 2006. *Building knowledge management strategies for effective rural development in east africa. viability of commercial rural ict centers: the case of Tanzania*. <http://www.share4dev.info/kb/documents/4242.pdf> (Accessed 12 April 2013).
- Kothari, CR. 2004. *Research methodology: methods and techniques*. 2nd edition, New Delhi: New Age International (P) LTD Publishers
- Koutsoumpos, L. 2007. *The switch of ethics and the reflective architect: in-between practice and theory*. Dundee: University of Dundee.
- Kramer, WJ. Jenkins, B. & Katz, RS. 2007. *The role of Information and Communications Technology sector in expanding economic opportunity*. http://www.hks.harvard.edu/m-rcbg/CSRI/publications/report_22_EO%20ICT%20Final.pdf (Accessed 19 January 2014).
- Krauss, SE. 2005. Research paradigms and meaning making: a primer. *The qualitative report*, Vol. 10 (4), 758-770.
- Krejcie, RV. & Morgan, DW. 1970. Determining sample size for research activities. *Educational and psychological measurement*, Vol. 30, 607-610.
- Kremer, M. & Zwane, AP. 2005. Encouraging Private Sector Research for Tropical Agriculture. *World development*, Vol. 33 (1), 87–105.
- Kremp, E. & Mairesse, J. 2004. Knowledge management, innovation and productivity: a firm level exploration based on French manufacturing CIS3 data. <http://www.nber.org/papers/w10237.pdf> (Accessed 20 February 2017).
- Kripanont, N. 2006. Using technology acceptance model to investigate academic acceptance of the Internet. *Journal of business systems, governance, and ethics*, Vol. 1 (2), 13-28.

- Kripanont, N. 2007. Examining a technology acceptance model of Internet usage by academics within Thai Business Schools. D Inf Sys thesis, Victoria University, Melbourne.
- Krishnaswami, OR. 2002. *Methodology of research in social sciences*. New Delhi: Himalaya Pub
- Kuhn, T. 1962. *The structure of scientific revolutions*. Chicago: The University of Chicago Press.
- Kumar, KK. Jain, KK. & Tiwary, RR. 2013. Leadership activities and their impact on creating knowledge in organizations. *International journal of leadership studies*, Vol. 8 (1).
- La Ferrara, E., 2010. Family and kinship ties in development: an economist's perspective in Platteau, JP (ed.). *culture, institutions and development*. Abingdon: Routledge.
- Labaree, R. 2014. *LibGuides: Organizing your social sciences research paper: the literature review*. <http://libguides.usc.edu/content.php?pid=83009&sid=615851> (Accessed 22 April 2014).
- Laoubi, KH. Boudi M. & Yamao M. 2010. Citrus farming in Algeria: farmers' behavior. *African journal of agricultural research*, Vol. 5 (15), 1993-2001.
- Laszlo, A., & Krippner, S. 1998. Systems theories: Their origins, foundations and development. In J. Scott Jordan (Ed.), *Systems theories and a priori aspects of perception*. Amsterdam: Elsevier.
- Lee, C. C. & Yang, J. 2000. Knowledge value chain. *Journal of management development*; Vol. 19 (9), 783-793.
- Lee, CY. 2010. Factors affecting knowledge transfer and absorptive capacity in multinational corporations. *The journal of international management studies*, Vol. 5 (2), 118-126.
- Lee, H. & Choi, B. 2003. Knowledge management enablers, processes, and organizational performance: an integrative view and empirical examination. *Journal of management information systems*, Vol. 20 (1), 179-228.
- Lee, KP. & Lee, SJ. 2003. *Understanding the relationship between research and practice in design from industrial point of view in Korea*. http://www.designresearchsociety.org/docs-procs/ded3/d_final_paper/d_03.pdf (Accessed 16 June 2015).
- Leech, NL. & Onwuegbuzie, AJ. 2008. Qualitative data analysis: a compendium of techniques for school psychology research and beyond. *School psychology quarterly*, Vol. 23 (4), 587-604.

- Lehner, F. & Haas, N. 2010. Knowledge management success factors – proposal of an empirical research. *Electronic journal of knowledge management*, Vol. 8 (1),79-90.
- Lema, NM. & Kapange, BW. 2006. *Farmers' Organizations and Agricultural Innovation in Tanzania: The Sector Policy for Real Farmer Empowerment*. In Wennink, B. and Heemskerk, W. (eds). *Farmers' Organizations and Agricultural Innovation: Case Studies from Benin, Rwanda and Tanzania*. Amsterdam: Royal Tropical Institute..
- Lemma, M. & Hoffman, V. 2007. *The agricultural knowledge system in ethiopia insights from a study in the Tigray region*. <http://www.tropentag.de/2005/abstracts/full/49.pdf> (Accessed 09 May 2014).
- Lengale Consulting Company Ltd. 2013. *Documentation of the lessons and the best practices for climate smart small-scale agriculture*. Dar es Salaam: Tanzania Forest Conservation Group.
- Lin, Y-C. and Lin, L-K. 2006. *Critical success factors for knowledge management: studies in construction*. http://www.iaarc.org/publications/fulltext/isarc2006-00022_200606061325.pdf (Accessed 25 May 2014).
- Lincoln, YS., and Guba, EG. 2000. *Paradigmatic controversies, contradictions, and emerging confluences* in Denzin, NK. and Lincoln, YS. (Eds.), *Handbook of qualitative research* Thousand Oaks: Sage.
- Littlejohn, A. & Margarayn, A. 2011. Collective learning in the workplace: Important knowledge sharing behaviours. *International journal of advanced corporate learning*, Vol. 4 (4), 26-31.
- Louis, C., Manion, L. & Morrison, K. 2007. *Research methods in education*. New York: Routledge.
- Lowder, SK., Skoet, J. & Singh, S. 2014. *What do we really know about the number and distribution of farms and family farms worldwide?* <http://www.fao.org/docrep/019/i3729e/i3729e.pdf> (Accessed 25 May 2014).
- Lwoga, E. 2009. Application of knowledge management approaches and information and communication technologies to manage indigenous knowledge in the agricultural sector in selected districts of Tanzania. D Inf thesis, Kwazul Natal University, Kwazul Natal.
- Lwoga, ET. 2011. Knowledge management approaches in managing agricultural indigenous and exogenous knowledge in Tanzania. *Journal of documentation*, Vol. 67 (3).
- Lwoga, ET., Ngulube, P. & Stilwell, C. 2010a. *The management of indigenous knowledge with other knowledge systems for agricultural development: challenges and opportunities for*

- developing countries*. International Association of Agricultural Information Specialists (IAALD), 13th World Congress, April 2010, Montpellier, France.
- Lwoga, ET., Ngulube, P. & Stilwell, C. 2010b. Understanding indigenous knowledge: bridging the knowledge gap through a knowledge creation model for agricultural development. *South African journal of information management*, Vol. 12 (1).
- Lwoga, ET., Stilwell, C. a& Ngulube, P. 2011a. Challenges of managing indigenous knowledge with other knowledge systems for agricultural growth in sub-Saharan Africa. *Libri*, Vol. 61, 226-238.
- Lwoga, ET., Stilwell, C., & Ngulube, P. 2011b. Access and use of agricultural information and knowledge in Tanzania. *Library review*, Vol. 60 (5), 383-395.
- Lwoga. ET. 2010. Bridging the agricultural knowledge and information divide: the case of selected telecenters and rural radio in Tanzania. *The electronic journal on information systems in developing countries*, Vol. 43 (6), 1-14.
- Lyatuu, PM. 2013. *Effect of land access on livelihood strategies in rural densely populated areas of Tanzania*. www.repoa.or.tz/documents_storage/GD2.pdf (Accessed 23 March 2014).
- Mackenzie, N. & Knipe, S. 2006. Research dilemmas: paradigms, methods and methodology. <http://www.iier.org.au/iier16/mackenzie.html> (Accessed 20th May 2015).
- Mamman, DH. & Nansoh, S. 2014. The role of agricultural research institute libraries in consolidating research and development of agriculturalists in Kaduna State, Nigeria. *American international journal of research in humanities, arts and social sciences*, Vol. 7 (1), 52-58.
- Mangombe, AW. & Sabiiti, EN. 2013. *Agricultural knowledge systems in the EAC region: lessons from the past 50 years and prospects for the future*. International Symposium and Exhibition on Agricultural Development in the EAC Partner States. 4-8 November, Kampala, Uganda
- Martin, B & Abbott, E. 2010. *Development calling: the use of mobile phones in agriculture development in Uganda*. <http://mak.ac.ug/documents/IFIP/DevelopmentCalling.pdf> (Accessed 15 May 2016).
- Martin, BL.& Abbott, E. 2011. Mobile phones and rural livelihoods: diffusion, uses, and perceived impacts among farmers in rural Uganda. *Information technologies & international development*, Vol. 7 (4), 17–34.

- Marzanah, A.J., Salfarina, A., Abdul Azim, AG. & Rusli, A. 2012. Barriers surrounding knowledge transfer in non-located software architectures development. *International journal of advance studies in computer, science & engineering*, Vol. 1 (3).
- Mbo'o-Tchouawou, M. and Colverson, KE. 2014. Increasing access to agricultural extension and advisory services: How effective are new approaches in reaching women farmers in rural areas? ILRI Project Report. Nairobi, Kenya: ILRI.
- Mboera, LEG., Rumisha, SF., Senkoro, KP., Mayala, BK., Shayo, EH. & Kisinza, WN. 2007. Knowledge and Health Information Communication in Tanzania. *East African journal of public health*, Vol. 4 (1).
- McCullough EB. & Matson PA. 2011. Evolution of the knowledge system for agricultural development in the Yaqui Valley, Sonora, Mexico. *Proceedings of the National Academy of Sciences* (2011).
- Mchombu, KJ. 1995. Researching rural information provision: a case study. *Conference on information provision to rural communities in Africa*, 22 - 25 June, Gaborone, Botswana.
- Mekonnen, F., Sehai, E., & Hoekstra, D. 2012. *Innovative approaches of knowledge management in agriculture: the case of IPMS, Ethiopia*. http://www.ipms-ethiopia.org/content/files/Documents/publications/Proceedings/INNOVATIVE_APPROACHES_KM.pdf (Accessed 20 March 2013).
- Miller, B. & Atkinson, RD. 2014. *Digital drag: ranking 125 nations by taxes and tariffs on ICT goods and services*. <http://www2.itif.org/2014-ict-taxes-tariffs.pdf> (Accessed 23 February 2015).
- Miller, PG., Strang, J. & Miller, PM. (Eds.). 2010. *Addiction research methods*. Hoboken: John Wiley & Sons.
- Miniwatts Marketing Group. 2012. *Tanzania: internet usage and marketing report*. <http://www.internetworldstats.com/af/tz.htm> (Accessed 12 March 2013).
- Misaki, E., Apiola, M. & Gaiani, S. 2016. Technology for small scale farmers in Tanzania: a design science research approach. *African journal of environmental science and technology*, Vol. 74 (4), 1-15.
- Mitra, J. and Abubakar, YA. & Sagagi, M. 2011. Knowledge creation and human capital for development: the role of graduate entrepreneurship. *Education and training*, Vol. 53 (5), 462-479.

- Mittal, S. & Mehar, M. 2015. *Agricultural information networks, information needs and risk management strategies: A survey of farmers in Indo-Gangetic Plains of India*. <http://libcatalog.cimmyt.org/download/cim/98167.pdf> (Accessed 29 June 2014).
- Miyakado, B. 2012. Gender and education opportunities in Tanzania: do we bridge the gap of equality. *Academic research international*, Vol. 3 (3), 246-255.
- Mongi, H., Majule, AE. and Lyimo, JG. 2010. Vulnerability assessment of rainfed agriculture to climate change and variability in semi-arid Tanzania. *African journal of environmental science and technology*, Vol. 4 (6), 371-381.
- Moumouni, I. & Labarthe, P. 2012. *Institutionalization of knowledge sharing platforms in the last three decades in Francophone Sub Saharan Africa*. http://www.ifsa2012.dk/downloads/WS1_1/Moumounif_Labarthe.pdf (Accessed 29 June 2014).
- Moussai'd M, Ka'mmer JE, Analytis PP. & Neth H. 2013. Social influence and the collective dynamics of opinion formation. *PLoS ONE*, Vol. 8 (11).
- Movarej, M., Hashemi, SMK, Hosseini, SM. & Rezvanfar, A. 2012. Facilitating sustainable agriculture: integrating indigenous knowledge in current agricultural knowledge and information systems. *Cercetări Agronomice în Moldova*, Vol. 45 (1/149).
- Mtega, W.P. & Malekani, A.W. (2009) Analysing the Usage Patterns and Challenges of Telecenters among Rural Communities: Experience from Four Selected Telecentres in Tanzania. *International Journal of Education and Development using Information and Communication Technology*, Vol. 5 (2), 68-87.
- Mtega, WP. & Benard, R. 2013. The state of rural information and communication services in Tanzania: a meta-analysis. *International journal of information and communication technology research*, Vol. 3 (2).
- Mtega, WP. & Msungu, AC. 2013. Using Information and Communication Technologies for enhancing the accessibility of agricultural information for improved agricultural production in Tanzania. *The electronic journal of information systems in developing countries*, Vol. 56 (1), 1-14.
- Mtega, WP. 2012. Access to and usage of information among rural communities: a case study of Kilosa District Morogoro region in Tanzania. *Partnership: The canadian journal of library and information practice and research*, Vol 7 (1).

- Mtega, WP., Dulle, F., & Benard, R. 2013. Understanding the knowledge sharing process among rural communities in Tanzania: A review of selected studies. *Knowledge management & e-learning*, Vol. 5 (2), 205–217.
- Mukama, B. and Yongolo, SC. 2005. Development of s & t system and experience of Tanzania on S&T data collection. *Presentation at the Regional Workshop on Science and Technology Statistics* 17–22 September, Entebbe, Uganda.
- Mundree, S. 2016. *Sugarcane-based Biofuels and Bioproducts*. Sussex: John Wiley & Sons.
- Munyua, H. & Stiwell, C. 2009. *A mixed qualitative–quantitative–participatory methodology: a study of the agricultural knowledge and information system (AKIS) of small-scale farmers in Kirinyaga district, Kenya*. International conference on qualitative and quantitative methods in libraries. 26- 29 May, Crete, Greece.
- Munyua, H., Adera, E. & Jensen, M. 2008. Emerging ICTs and their potential in revitalizing small scale agriculture in Africa. *International journal of commerce and business management*, Vol. 6 (1), 118-12.
- Murray, R. 2011. *How to write a thesis*. Maidenhead: Open University Press.
- Murthy, G. 2011. *Tanzanian media environment: current access, potential for growth and strategies for information dissemination*. http://audiencescapes.org/sites/default/files/Tanzania%20Media%20Environment_0.pdf (Accessed 10 March 2013).
- Murthy, SN. & Bhojanna, U. 2009. *Business research methods*. New Delhi: Excel Books.
- Mwalukasa, N. 2013. Agricultural information sources used for climate change adaptation in Tanzania. *Library review*, Vol. 62 (4/5) 266–292.
- Mwanje, JI. 2001. *Issues in social science research*. Social science research methodology series, module 1. Addis Ababa: OSSREA Africa.
- Mwaura, F., Muwanika, F R. & Okoboi, G. 2010. Willingness to pay for extension services in uganda among farmers involved in crop and animal husbandry. 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September 2010.
- Myers, MD. 2013. *Qualitative research in business and management*. Sage: London
- NAFAKA. 2012. *Staples value chain activity baseline report*. http://pdf.usaid.gov/pdf_docs/PA00MBNR.pdf (Accessed 26 September 2013).

- Nakamori, Y. 2012. *Knowledge Science: Modeling the Knowledge Creation Process*. Boca Roton: Taylor & Francis Group.
- Nallaperumal, K. 2014. *Engineering Research Methodology: A Computer Science and Engineering and Information and Communication Technologies Perspective*. New Delhi: PHI Learning Private Limited.
- Narayanamoorthy A, & Hanjra M. 2006. Rural infrastructure and agricultural output linkages: a study of 256 Indian districts. *Indian journal of agricultural economics*, Vol. 61 (3), 444–59.
- Naseem, A. Spielman, DJ. & Omamo, SW. 2010. Private-Sector Investment in R&D: A Review of Policy Options to Promote its Growth in Developing-Country Agriculture. *Agribusiness*, Vol. 26 (1), 143–173.
- Nawe, J. & Hambati, H. 2013. *Integrating Traditional and Modern Knowledge Systems in Improving Agricultural Productivity in Upper-Kitete Village, Tanzania*. http://www.repoa.or.tz/documents_storage/GD5.pdf (Accessed 26 September 2013).
- Naylor. J. 1999. *Management*. London: Financial Times Prentice Hall
- NBS. 2010. *National Sample Census of Agriculture 2007/2008: Preliminary Report*. Dar es Salaam: Government Printers.
- NBS. 2012. *2012 Population and Housing Census: Morogoro Region Population*. Dar es Salaam: Government Printers.
- NBS. 2013. *The 2012 population and housing census: Population*. Dar es Salaam: Government Printers.
- Neuchatel, G. 1999. *Common Framework on Agricultural Extension*. Paris: Neuchatel Group.
- Nemes, G. & High, C. 2013. Old institutions, new challenges: the agricultural knowledge system in Hungary. *Studies in agricultural economics*, Vol. 115 (2), 76-84.
- Neuman, LW. 2007. The Meanings of Methodology. In L. W. Neuman (Ed.), *Social research methods: qualitative and quantitative approaches*. Essex: Pearson Education Limited.
- Neuman, WL. 2006. *Social research methods: qualitative and quantitative approaches*. Boston: Pearson.
- Ngathou, IN., Bukenya, JO. & Chembezi, DM. 2006. Managing agricultural risk: examining information sources preferred by limited resource farmers. *Journal of extension*, Vol. 44 (6).

- Nonaka, I. & Konno, N. 1998. The concept of "ba": building a foundation for knowledge creation. *California management review*, Vol. 40 (3), 40-54.
- Nonaka, I. & Takeuchi, H. 1995. *The knowledge creating company: How Japanese companies create the dynamic of innovation*. New York: Oxford University Press.
- Nonaka, I. 2008. *The knowledge-creating company*. Harvard: Business Review Press.
- Nonaka, I. 1994. A dynamic theory of organizational knowledge creation. *Organization science*, Vol. 5 (1), 14–37.
- Nonaka, I., Toyama, R. & Nagata, A. 2001. SECI, Ba and leadership: a unified model of dynamic knowledge creation in Nonaka, I. and Teece, DJ. (eds) *Managing Industrial Knowledge*. London: Sage.
- Norizah S., Ibrahim, AA. Mohamed, ZA. Yahya, M. & Abdul, M. 2005. Factors affecting knowledge sharing and its effect on performance: a study of three selected higher academic institutions. *International journal of computer science issues*, Vol. 8 (4), (2), 106-114.
- NRI. 2011. *Agricultural Extension, Advisory Services and Innovation*. http://www.nri.org/images/documents/promotional_material/D10678-14_Agri_Extention_WEB.pdf (Accessed 02 June 2016).
- Nyamba, SY. & Mlozi MRS. 2012. Factors influencing the use of mobile phones in communicating agricultural information: a case of Kilolo District, Iringa, Tanzania. *International journal of information and communication technology research*, Vol. 2 (7), 585-563.
- Obidike NA. 2011. Rural farmers' problems accessing agricultural information: a case study of Nsukka Local Government Area of Enugu State, Nigeria. *Library Philosophy and Practice* (e-journal). <http://www.webpages.uidaho.edu/~mbolin/obidike.htm> (Accessed 02 June 2016).
- Ofori-Dwumfuo GO. & Kommey RE. 2013. Utilization of ICT in knowledge management at the Ghana Volta River Authority. *Current research journal of social sciences*, Vol. 5 (3), 91-102.
- Ojokuku, RM. Odetayo, TA. & Sajuyigbe, AS. 2012. Impact of leadership style on organizational performance: a case study of Nigerian banks. *American journal of business and management*, Vol. 1 (4), 202-207.

- Okwu, OJ. & Daudu, S. 2011. Extension communication channels' usage and preference by farmers in Benue State, Nigeria. *Journal of agricultural extension and rural development* Vol. 3 (5), 88-94.
- Okwu, OJ. Obinne CPO. & Agbulu, ON. 2006. A paradigm for evaluation of use and effect of communication channels in agricultural extension services. *Journal of social science*, Vol. 13 (1), 31-36.
- Oladele OI. 2008. Factors determining farmers' willingness to pay for extension services in Oyo state, Nigeria. *Agricultura tropica et subtropica*, Vol. 41 (4).
- Oluwasegun, FO. 2013. Farmers perception of the effect of aging on their agricultural activities in Ondo State, Nigeria. *Venets: The Belogradchik journal for local history, cultural heritage and folk studies*, Vol. 4 (3).
- Oniang'o, RR. 2005. Women are still the key in agriculture and food security in Africa: women and food security. *South African journal of clinical nutrition*, Vol. 18 (2), 1-5.
- Onwuegbuzie, AJ., Leech, NL. & Collins, KMT. (2012). Qualitative analysis techniques for the review of the literature. *The qualitative report*, Vol 17 (56), 1-28.
- Ozowa, VN. 1997. Information needs of small scale farmers in africa: the nigerian example. *Quarterly bulletin of the international association of agricultural information specialists*, Vol. (40), 1.
- Palmer, T. & Pshenichnaya, N. 2015. Tigo kilimo impact evaluation. http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/09/GSMA_Tigo_Kilimo_IE.pdf (Accessed 15 May 2016).
- Pan, W. & Zhang, Q. 2014. A study on motivations of graduate students' knowledge hiding based on wuli-shili-renli system approach. http://www.atlantispress.com/php/download_paper.php?id=13942 (Accessed 19 May 2014).
- Pardey, PG., Alston, JM. & Piggott, R. 2006. *Agricultural R and D in the Developing World*. Washington: International Food Policy Research Institute.
- Pathirage, CP. Amaratunga, RDG and Haigh, R. 2005. Knowledge management research within the built environment: Research methodological perspectives, *5th International postgraduate research conference proceedings*, University of Salford, Salford.
- Paulin, D. & Suneson, K. 2012. Knowledge transfer, knowledge sharing and knowledge barriers: three blurry terms in KM. *The electronic journal of knowledge management*, Vol. 10 (1).

- Pelizzari, E. 2003. *Academic staff use, perception and expectations about open-access archives: a survey of social science sector at Brescia University*. http://eprints.rclis.org/4408/1/Academic_staff_perception_about_Open_archives.htm (Accessed 20 May 2014).
- Pérez-Mira, B. 2010. Validity of DeLone and McLean's model of information systems success at the web site level of analysis. D Dissertation, Northwestern State University, Natchitoches.
- Peters, J. & Le Cor\zznu, R. 2005. *Beyond Communities of Practice: Learning Circles for Transformational School Leadership* in P. Carden and T. Stehlik (eds) *Beyond Communities of Practice*. Queensland: Post Pressed.
- Phillips, EM. & Pugh, DS. 2005. *How to get a PhD: a handbook for students and their supervisors*. Berkshire: Open University.
- Pinda, MP. 2012. *Accelerating agricultural transformation in tanzania through multi stakeholder partnerships: key note address*. http://www.pmo.go.tz/index.php?view=article&catid=38%3Aspeeches&id=91%3Akey-note-address-by-honourable-mizengo-p-pinda-&format=pdf&option=com_content (Accessed 13 March 2013).
- Pitt LF. Watson RT. & Kavan CB. 1995. Service quality: a measure of information systems effectiveness. *Management information system quarterly* 19 (2), 173–187.
- Polanyi, M. 1966. *The tacit dimension*. Chicago: University Of Chicago Press.
- Ponelis, S. & Fairer-Wessels, FA. 1998. Knowledge management: a literature overview. *South African Journal of Library and Information Science*, Vol. 66 (1), 1- 9.
- Ponterotto, JG. 2005. Qualitative research in counseling psychology: a primer on research paradigms and philosophy of science. *Journal of counseling psychology*, 52 (2), 126–136.
- Powell, RR. 1997. *Basic research methods for librarians*. Portsmouth: Greenwood Publishing Group.
- Pray, CE. 2002. *The growing role of the private sector in agricultural research* in Byerlee, D. and R.G. Echeverria (eds.) *Agricultural Research Policy in an Era of Privatization: Experiences from the Developing World*. Wallingford: CABI.
- Putti, VR. 2011. *Energy access for poor in urban and peri-urban areas – an emerging challenge*. Energy Sector Management Assistance Programme (ESMAP), The World Bank.
- Quigley, E. J. & Debons, A. 1999. Interrogative theory of information and knowledge. *Proceedings of SIGCPR 99*. New Orleans: ACM Press

- Rad, GP., Alizadeh, N. Miandashti, NZ. & Fami, HS. 2011. Factors influencing knowledge sharing among personnel of agricultural extension and education organization in Mranian Ministry of Jihad-e agriculture. *Journal of agricultural science and technology*. Vol. 13, 491-501.
- Ragasa, C. Mazunda J. and Kadzamira, M. 2010. *The impact of agricultural extension services*. <http://dspace.africaportal.org/jspui/bitstream/123456789/35514/1/130299.pdf?1> (Accessed 26 June 2014).
- Rajasekar, S. Philominathan, P. & Chinnathambi, V. 2006. *Research methodology*. <https://arxiv.org/pdf/physics/0601009.pdf> (Accessed 10th June 2014).
- Ranjan J. & Bhatnagar V. 2008. Critical success factors for implementing CRM using data mining. *Journal of knowledge management practice*, Vol. 9 (3), 18–25.
- Rao, M. (Ed). 2005. *Knowledge management tools and techniques: practitioners and experts evaluate KM solutions*. Amsterdam: Elsevier.
- Reeves, S., Albert, A., Kuper, A. & Hodges, B. D. 2008. Qualitative research: why use theories in qualitative research? *British medical journal*, Vol. 337 (7670), 631-634.
- Reichel, M. & Ramey, MA. (Eds.). 1987. *Conceptual frameworks for bibliographic education: Theory to Practice*. Littleton Colorado: Libraries Unlimited Inc.
- Rigg, J. 2006. Land, farming, livelihoods, and poverty: rethinking the links in the rural South. *World development*, Vol. 34 (1), 180-202.
- Ritchie, J. & Lewis, J. 2003. *Qualitative research practice: a guide for social science students and researchers*. New Delhi: SAGE Publications.
- Rivera W.M., Qamar M.K., Mwandemere H.K. 2005. *Enhancing coordination among AKIS/RD actors: an analytical and comparative review of country studies on agricultural knowledge and information systems for rural development (AKIS/RD)*. Rome: FAO.
- Röling, N. 2009. *Conceptual and methodological developments in innovation*. in Sanginga, P.C., Waters-Bayer, A., Kaaria, S., Njuki, J. & C. Wettasinha (eds), *Innovation Africa: enriching farmers' livelihoods*. Earthscan: London & Sterling.
- Rollet, H. 2003. *Knowledge management: processes and technologies*. Dordrecht: Kluwer Academic Publishers.
- Rolling, N. 1986. Extension science increasingly preoccupied with knowledge systems. *Journal of the European society for rural sociology*, Vol. 25 (3-4), 269–290.

- Rovai, AP., Baker, JD. and Ponton, MK. 2013. *Social science research design and statistics: a practitioner's guide to research methods and IBM SPSS*. Chesapeake: Watertree Press LLC
- Rudman, C. 2010. *Agricultural knowledge systems in transition: towards a more effective and efficient support of learning and innovation networks for sustainable agriculture*. <http://www.proakis.eu/sites/www.proakis.eu/files/SOLINSA%20Italy.pdf> (Accessed 18 June 2014).
- Rusu, A., Santiago, C. & Jianu, J. 2007. Real-time interactive visualization of information hierarchies. *Proceedings of the 11th international conference information visualization*, 117–123.
- Rutatora, DF. & Mattee, AZ. 2001. Major agricultural extension providers in Tanzania. *African study monographs*, Vol. 22 (4), 155-173.
- Ryu, S., Ho, SH. & Han, I., 2003. Knowledge sharing behavior of physicians in hospitals. *Expert systems with applications*, Vol. 25 (1),113-122.
- Sabesh, M. 2007. *Computer applications in agricultural research*. <http://www.cicr.org.in/pdf/ELS/so3.pdf> (Accessed 18 June 2014).
- Salawu, A. 2006. Paradox of a milieu: communicating in African indigenous languages in the age of globalisation. In A. Salawu (Ed.), *Indigenous language media in Africa*. Lagos, Nigeria: Centre for Black and African Arts and Civilization (CBAAC).
- Salkind, NJ. 2012. *100 questions (and answers) about research methods* (Vol. 1). London: SAGE Publications.
- Sanchez, P. 2004. Defining corporate culture. *Communication world*, Vol. 21 (6), 18-21.
- Sanchez, R. 2005. *Tacit knowledge' versus 'explicit knowledge' approaches to knowledge management practice*, In D. Rooney, G. Hearn, and A. Ninan (Eds) 2005. *Handbook on the knowledge economy*. Cheltenham: Edward Elgar.
- Sanga, C. Mlozi, MRS., Tumbo, S., Mussa, M, Sheto, MCR. Mwamkinga, GH. & Haug, R. 2013. On search for strategies to increase the coverage of agricultural extension service: web-based farmers? Advisory information system. *International journal of computing and ICT research*, Vol. 7 (1), 42-55.
- Sanga, C. Tumbo, S. Mlozi, MRS. & Kilima, F. 2013. Stakeholders' analysis using value chain analysis: AHP in action. *Interdisciplinary studies on information technology and business*, Vol. 1 (2), 47-66.

- Sanga, C., Kalungwizi, VJ. A& Msuya CP. 2013. Building an agricultural extension services system supported by ICTs in Tanzania: progress made, challenges remain. *International journal of education and development using ICT*, Vol. 9 (1), 80-99.
- Schrock, KD. Gugerty, MK. Anderson, L. & Gugerty, MK. 2011. *Tanzania: agricultural sector overview*. http://evans.washington.edu/files/UW_EPAR_Request_133_Tanzania_Agriculture_Background_03072011.pdf (Accessed 10 February 2013).
- Schuch K. 2013. *Knowledge triangle*. Centre for Social Innovation: Vienna.
- Seddon PB. & Kiew M-Y. 1996. A partial test and development of DeLone and McLean's model of IS success. *Australian journal of information systems*, Vol. 4 (1), 90–109.
- Serenko, A, Turel, O. & Yol, S. 2006. Moderating roles of user demographics in the American customer satisfaction model within the context of mobile services. *AMCIS 2006 Proceedings*, paper 24.
- Sharma, L. & Mehta, N. 2012. Data mining techniques: a tool for knowledge management system in agriculture. *International journal of scientific and technology research*, Vol. 1 (5).
- Sife, AS., Kiondo, E. & Lyimo-Macha, J.G. 2010. Contribution of mobile phones to rural livelihoods and poverty reduction in Morogoro region, Tanzania, *The electronic journal of information systems in developing countries*, Vol. 42 (3), 1-15.
- Silverman, D. 2000. *Doing qualitative research: a practical handbook*. London: Sage.
- Siyao, PO. 2012. Barriers in accessing agricultural information in Tanzania with a gender perspective: the case study of small-scale sugar cane growers in Kilombero district. *International journal of education and development using ICT*, Vol. 51 (6), 1-19.
- Slikkerveer, LJ. 1992. Indigenous agricultural knowledge systems in East Africa: origins and development. *African Studies Association of the United Kingdom Conference*. Issue 16 of Papers, Stirling, Scotland.
- Smedlund, A. 2008. The knowledge system of a firm: social capital for explicit, tacit and potential knowledge. *Journal of knowledge management*, Vol. 12 (1), 63 – 77.
- Smith, E. & Smith Jr, J. 2008. *Using secondary data in educational and social research*. London: McGraw-Hill Education.
- Smith, EA. 2001. The role of tacit and explicit knowledge in the workplace. *Journal of knowledge management*, Vol. 5 (4), 311-321.

- Smyth, R. 2004. Exploring the usefulness of a conceptual framework as a research tool: a researcher's reflections. *Issues in Educational Research*, Vol. 14, 167–180.
- Spielman, DJ. & Grebmer, K. 2004. *Public-private partnerships in agricultural research: an analysis of challenges facing industry and the consultative group on international agricultural research*. Washington: International Food Policy Research Institute.
- Spielman, DJ. & von Grebmer, K. 2006. Public–private partnerships in international agricultural research: an analysis of constraints. *The journal of technology transfer*, Vol. 31 (2), 291-300
- Sridhar, MS. 1992. *Problems of collection development in special libraries*. New Delhi: Concept Publishing Company.
- Ssewanyana, J. & Busler, M. 2007. Adoption and usage of ICT in developing countries: case of Ugandan firms. *International journal of education and development using information and communication technology*, Vol. 3 (3), 49-59.
- Staplehurst, J. & Ragsdell, G. 2010. Knowledge sharing in SMEs: a comparison of two case study organisations. *Journal of knowledge management practice*, Vol. 11 (1).
- Starasts, A.M. 2004. Battling the knowledge factor: a study of farmers' information seeking learning and knowledge process with an online environment in Queensland. D Thesis, University of Queensland, Queensland.
- Stausberg, M. & Engler, S. 2013. *The Routledge handbook of research methods in the study of religion*. Kentucky: Routledge.
- Stevens, JB. & Nta, PJ. 2011. The role of extension support to irrigation farmers in Lesotho. *South African journal of agricultural extension*, Vol. 39 (2), 104–112.
- Stienen, J., Bruinsma, W. & Neuman, F., 2007. How ICT can make a difference in agricultural livelihoods. *The Commonwealth Ministers Reference Book*, 2-4.
- Stover, M., 2004. Making tacit knowledge explicit: The ready reference database as codified knowledge. *Reference Services Review*, Vol. 32 (2), 164-173.
- Struzak, R., 1997. Building information infrastructure in rural areas. *Global Communications Asia*. Singapore 9-14 June 1997, 227-233.
- Sturmer, M., 1998. *The media history of Tanzania*. Ndanda: Ndanda Mission Press.
- Sun, Y., Wang, N., Guo, X. & Peng, Z. 2013. Understanding the acceptance of mobile health services: A comparison and integration of alternative models. *Journal of electronic commerce research*, Vol. 14 (2), 183-200.

- Swanson B. & Rajalahti R. 2010. Strengthening agricultural extension and advisory systems: procedures for assessing, transforming, and evaluating extension systems. *Agriculture and Rural Development Discussion Paper 45*. The International Bank for Reconstruction and Development, Washington D.C.
- Swanson, BE. 2008. *Global review of good agricultural extension and advisory service practices*. Rome: FAO.
- Świgoń, M. 2013. Knowledge and information management behaviour in the light of empirical studies among students. *Qualitative and quantitative methods in libraries*, Vol. 3, 251–261.
- Taylor-Powell, E. & Renner, M. 2003. *Analyzing qualitative data*. <http://learningstore.uwex.edu/assets/pdfs/g3658-12.pdf> (Accessed 12 November 2014)
- TCRA. 2011. *The electronic and postal communications Act*. Dar es Salaam: Government Printer.
- TCRA. 2015a. *Licensed content service providers*. <http://www.tcra.go.tz/index.php/licensing/licensed-operators/2-tcra/45-licensed-content-service-providers> (Accessed 02 July 2016).
- TCRA. 2015b. *Quarterly communications statistics report july- september 2015 quarter*. Dar es Salaam: Government Printer.
- TCRA. 2012. *Broadcasting services 2000 - 2006*. Dar es Salaam: Government Printer.
- TCRA. 2013. *Quarterly telecom statistics*. Dar es Salaam: Government Printer.
- Teddle, C. & Yu, F. 2007. Mixed methods sampling a typology with examples. *Journal of mixed methods research*, Vol. 1 (1), 77-100.
- Terrell, SR. 2012. Mixed-methods research methodologies. *The qualitative report*, Vol. 17 (1), 254-280 <http://www.nova.edu/ssss/QR/QR17-1/terrell.pdf> (Accessed 02 July 2016).
- Thomas, JR., Nelson, J.K., & Silverman, S. 2010. *Research methods in physical activity*. Champaign: Human Kinetics.
- Tiffin, R. and Tiffin, A., 2005. *The adoption and use of computers in agriculture in England and Wales*. <http://www.personal.reading.ac.uk/~aas00jrt/wps/comp.pdf> (Accessed 12 April 2014).
- Toikka, S. 2007. *ICT supported inter-organizational knowledge creation: application of change laboratory*. in G. Goos, J. Hartmanis and JV. Leeuwen (Eds.). *Lecture notes in computer science*. Berlin: Springer Verlag.

- Tologbonse, D. Fashola, O. & Obadiah, M. 2008. Policy issues in meeting rice farmers' agricultural information needs in Niger state. *Journal of Agricultural Extension*, 12 (2), 84-94.
- Tong, J. & Ayres, R. 2009. Knowledge needs: uncharted area in knowledge management. *Proceeding of the international conference on organizational learning, knowledge and capabilities*. <http://www2.warwick.ac.uk/fac/soc/wbs/conf/olkc/archive/olkc4/papers/5bjinto ng.pdf> (Accessed 29 May 2016).
- Tounkara, T. & Saad, I. 2012. *Improving knowledge transfer with knowledge engineering methods*. In: Chaparro, F. (ed). 2012. Proceedings of the 9th international conference on intellectual capital, knowledge management and organizationallLearning (ICICKM 2012). South Oxfordshire Academic Conferences Limited.
- Tounkara, T. 2012. Increasing transferability of tacit knowledge with knowledge engineering methods. *The electronic journal of knowledge management*, Vol. 11 (3), 268- 279.
- Trochim, W. 2006. Positivism vs. post-positivism. <http://www.socialresearchmethods.net/kb/positvsm.htm> (Accessed 10 July 2015).
- Trochim, W., Donnelly, J. & Arora, K. 2015. *Research methods: the essential knowledge base*. Boston: Cengage Learning.
- Tsai, W. 2001. Knowledge transfer in intra-organizational networks: effects of network position and absorptive capacity on business unit innovation and performance. *Academy of management journal*, Vol. 44 (5) 996-1004.
- Tsehay, AB. 2014. Seeking Health Information in Rural Context: Exploring Sources of Maternal Health Information in Rural Ethiopia. M Thesis, University of Bergen, Bergen.
- Tyagi K. & Misra, P. 2010. *Professional communication*. New Delhi: PHI Learning Pvt. Ltd
- Udo-Akang, D. 2012. Theoretical constructs, concepts, and applications. *American international journal of contemporary research*, Vol. 2 (9), 89-97.
- Ugboma, MU. 2010. Access to agricultural information by fish farmers in Niger Delta Region of Nigeria. *Library Philosophy and Practice*. <http://digitalcommons.unl.edu/libphilprac/424> (Accessed 21 May 2015).
- Ulimwengu, J. & Sanyal, P. 2011. *Joint estimation of farmers' stated willingness to pay for agricultural services*. <http://ebrary.ifpri.org/utis/getfile/collection/p15738coll2/id/124896/file/ename/124897.pdf> (Accessed 15 March 2015).

- Umemoto, K. 2002. Managing existing knowledge is not enough, In Choo and Bontis (Eds.) *The strategic management of intellectual capital and organizational knowledge*. New York: Oxford University Press.
- Umrani-Khan, F. & Iyer, S. 2009. *ELAM: a Model for Acceptance and use of e-Learning by Teachers and Students*. 4th International Conference on e-Learning, Bombay.
- UNDP. 2012. *Promoting ICT based agricultural knowledge management to increase production and productivity of smallholder farmers in Ethiopia*. UNDP Ethiopia No. 3/2012.
- UNISA. 2007. *Policy on research ethics*. http://cm.unisa.ac.za/contents/departments/res_policies/docs/ResearchEthicsPolicy_apprvCounc_21Sept07.pdf (Accessed 23 September 2013).
- Urbach, N., Smolnik, S., & Riempp, G. 2008. A methodological examination of empirical research on information systems success: 2003 to 2007. Fourteenth Americas conference on information systems, Toronto, ON, Canada August 14th-17th 2008.
- Uriarte, FA. 2008. *Introduction to knowledge management*. Jakarta: ASEAN Foundation.
- URT. 2007. *Morogoro Region Socio Economic Profile*. Dar es Salaam: Government Printers.
- URT. 2016. *Morogoro Region Socio Economic Profile*. Dar es Salaam: Government Printers.
- URT. 2008. *Agricultural Sector Reforms in Tanzania: Perspectives from within*. Dar es Salaam: Government Printers.
- URT. 2008a. *Agriculture sector review and public expenditure review 2008/09*. Dar es Salaam: Government Printers.
- URT. 2009. *The cereals and other produce Act, 2009*. Dar es Salaam: Government Printers.
- URT. 2011. *Tanzania Agriculture and Food Security Investment Plan 2011/12 to 2020/21*. Dar es Salaam: Government Printers.
- URT. 2011a. *List of potential rice stakeholders and their roles*. Eastern African Agricultural Productivity Programme. Dar es Salaam: Government Printers.
- URT. 2011b. *National and zonal research priorities*: Division of Research and Development. Dar es Salaam: Government Printers.
- URT. 2012a. *National sample census of agriculture 2007/08 Volume Vol. E: Regional Report: Morogoro Region*. Dar es Salaam: Government Printers.
- URT. 2012c. *National sample census of agriculture small holder agricultur: Crop Sector national report*. Dar es Salaam: Government Printers.

- URT. 2013a. *National agriculture policy*. Ministry of Agriculture Food Security and Cooperatives. Dar es Salaam: Government Printers.
- URT. 2013b. *Tanzania in figures 2012*. Dar es Salaam: Government Printers.
- URT. 2013c. *Hali ya uchumi wa taifa katika mwaka 2012*. Dar es Salaam: Government Printers.
- URT. 2013d. *Key findings 2011/12 household budget survey Tanzania mainland: National Bureau of Statistics*. Dar es Salaam: Government Printers.
- URT. 2014. *Tanzania profile*. Dar es Salaam: Government Printers.
- USAID. 2012. *Expert Consultation on the G8 new alliance for food security and nutrition ICT extension challenge*. October 11-12, 2012. Washington D.C.
- Van den Hooff, B. & de Ridder, JA. 2004. Knowledge sharing in context: The influence of organizational commitment, communication climate, and CMC use on knowledge sharing. *Journal of Knowledge Management*, Vol. 8 (6), 117–130.
- Van der Spek, R. & Spijkervet, A. 1997. Knowledge management: dealing intelligently with knowledge'', in Liebowitz, J. and Wilcox, L.C. (Eds), *Knowledge management and its integrative elements*. Boca Raton: CRC Press.
- Vanicharoenchai, V. 2007. Development of knowledge creation systems using team learning methods for nursing instructors in higher education institutions. *Educational journal of Thailand*, Vol. 1 (1), 69-82.
- Van Schaik, P. 2009. Unified theory of acceptance and use for websites used by students in higher education. *Journal of educational computing research*, Vol. 40 (2), 229-257.
- Van Teijlingen ER & Hundley V. 2002. The importance of pilot studies. *Nursing standards*, Vol. 16 (40), 33-36.
- Vartanian, T. P. 2010. *Secondary data analysis*. Oxford: Oxford University Press.
- Vaseegaran, N., 2014. Evaluating the user perceived usefulness of enterprise social networking. D Dissertation, Victoria University of Wellington, Wellington.
- Velasquez, NF., Durcikova, A. & Sabherwal, R. 2009. Studying knowledge management system success in system administration. *Proceedings of the 42nd Hawaii international conference on system sciences*, Hawaii.
- Venkatesh, V. & Davis, FD. 2000. A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, Vol. 46 (2).

- Venkatesh, V., Morris, M.G., Davis, GB. & Davis, FD. 2003. User acceptance of information technology: toward a unified view. *Management information systems quarterly*, Vol. 27 (3), 425–478.
- Venkatesh, V., Thong, JYL. Chan, FKY. Hu, PJ. & Brown, SA. 2011. Extending the two-stage information systems continuance model: incorporating UTAUT predictors and the role of context. *Information Systems journal*, Vol. 21 (6), 527–555.
- Vidanapathirana, N.P. 2012. Agricultural information systems and their applications for development of agriculture and rural community, a review study. The 35th Information Systems Research Seminar in Scandinavia.
- Vishwakarma, DD. 2003. *Adoption of agricultural development measures in chhindwara*. New Delhi: Northern Book Centre.
- Von Krogh, G. Ichijo, K. & Nonaka, I. 2000. *Enabling knowledge creation: how to unlock the mystery of tacit knowledge and release the power of innovation*. Oxford: Oxford University Press.
- Wacker, JC. 1998. A definition of theory: research guidelines for different theory-building research methods in operations management. *Journal of operations management*, Vol. 16 (4), 361–385.
- Wahid, KA. Ismail, MN. Wanarat, S. & Laohavichien, T. 2003. The relationship between sources of knowledge and knowledge creation. *Journal of information and knowledge management*, Vol 3 (1), 35-50.
- Wang, CY. Yang, HY. & Chou, ST., 2008. Using peer-to-peer technology for knowledge sharing in communities of practices. *Decision support systems* 45 (3), 528–540.
- Wang, K., Hjelmervik, OR. & Bremdal, B. 2001. *Introduction to knowledge management: principles and practice*. Trondheim: Tapir Academic Press.
- Wang, S. & Noe, RA. 2010. Knowledge sharing: A review and directions for future research. *Human resource management review*, Vol 20 (2), 115-131.
- Wang, Y. S., Wang, Y. M., Lin, H. H. & Tang, T. I. 2003. Determinants of user acceptance of Internet banking: an empirical study. *International journal of service industry management*, Vol. 14 (5), 501-519.

- Wang, Y., Wu, M. & Wang, H. 2007. Investigating the determinants and age and gender differences in the acceptance of mobile learning. *British journal of educational technology*, Vol. 40 (1), 92–118.
- Weathington, BL. Cunningham, CJL. & Pittenger, DJ. 2010. *Research methods for the behavioral and social sciences*. Hoboken: John Wiley & Sons.
- Weaver, K. & Olson, J. 2006. Understanding paradigms used for nursing research. *Journal of advanced nursing*, Vol. 53 (4), 459-469.
- Weber, NM. 2011. *Knowledge infrastructure: the research library's role in information transfer*. <http://trace.tennessee.edu/cgi/viewcontent.cgi?article=1017&context=ccisymposium> (Accessed 17 May 2016).
- Webster, J., Brown, G., Zweig, D., Connelly, CE., Brodt, S. & Sitkin, S. 2008. *Beyond knowledge sharing: knowledge withholding at work*. in JJ. Martocchio (Ed.), *Research in personnel and human resources management*. Bradford: Emerald Group Publishing.
- Weiner, J., 2007. *Measurement: reliability and validity measures*. Baltimore: Johns Hopkins University.
- Wenger, E. 2006. *Communities of practice a brief introduction*. <https://www.vpit.ualberta.ca/cop/doc/wenger.doc> (Accessed 26 August 2013).
- Wenger, E. 2010. *Communities of practice and social learning systems: the career of a concept*. in Blackmore, C. (ed.) *Social learning systems and communities of practice*. Dordrecht: Springer.
- Wenger, E., McDermott, R. & Snyder, WM. 2002. *Cultivating communities of practice: a guide to managing knowledge*. Boston: Harvard Business School Press.
- Wenneker, M., Van Selm, M. & Nelissen, P. 2002. *Role of ICT in processes of knowledge sharing in organizations*. in *CAIR 2002: Proceedings of the conference of the association of internet researchers*, Panel 4C The Internet in Work and Organizations.
- Westen, D. & Rosenthal, R. 2003. Quantifying construct validity: two simple measures. *Journal of personality and social psychology*, Vol. 84, (3), 608-618.
- Wickremasinghe, D., Kuruvilla, S., Mays, N. & Avan, BI. 2016. Taking knowledge users' knowledge needs into account in health: an evidence synthesis framework. *Health policy and planning*, Vol. 31 (4), 527-537.

- Widen-Wulff, G. & Ginman, M. 2004. Explaining knowledge sharing in organizations through the dimensions of social capital. *Journal of information science*, Vol. 30 (5), 448–58.
- Wiig, KM. 1993. *Knowledge management foundations: thinking about thinking – how people and organizations create, represent, and use knowledge*. Arlington: Schema Press.
- Wilmot, A. 2005. Designing sampling strategies for qualitative social research: with particular reference to the office for national statistics' qualitative respondent register. *Survey methodology bulletin - office for national statistics*, Vol. 56 (53).
- Wilson, TD. 1999. Models in information behaviour research. *Journal of documentation*, Vol. 55 (3), 249-270.
- Wilson, TD. 2000. Human information behavior. *Informing science*, 3 (2), 49-55. <http://inform.nu/Articles/Vol3/v3n2p49-56.pdf> (Accessed 17 March 2014).
- Wong, KY. 2005. Critical success factors for implementing knowledge management in small and medium enterprises. *Industrial management and data systems*, Vol. 105, no. 3, 261-279.
- Wu, H., Zubair, M. & Maly, K. 2006. Harvesting social knowledge from folksonomies. *Proceedings of the seventeenth conference on hypertext and hypermedia*, ACM, 111-114.
- Wyche, S. & Steinfield, C. 2015. Why don't farmers use cell phones to access market prices? Technology affordances and barriers to market information services adoption in rural Kenya. *Information technology for development*, Vol. 22 (2), 1-14.
- Yang, C. & Chen, LC. 2007. Can organizational knowledge capabilities affect knowledge sharing behavior? *Journal of information science*, Vol. 3 (1), 95-109.
- Yi, LW. & Jayasingam, S. 2012. Factors driving knowledge creation among private sector organizations: empirical evidence from Malaysia. *Journal of organizational knowledge*, Vol. 2012.
- Yount, WR. 2006. *Research design and statistical analysis in Christian Ministry*. Nashville: B&H Publishing Group.
- Zahra, SA. Neubaum, DO. & Larrañeta, B. 2007. Knowledge sharing and technological capabilities: The moderating role of family involvement. *Journal of business research*, Vol. 60, 1070–1079.
- Zakaria S. & Nagata, H. 2010. Knowledge creation and flow in agriculture: The experience and role of the Japanese extension advisors. *Library management*, Vol. 31, 1/2, 27–35.

- Zecca, F. 2012. The evaluative process of European agricultural research policies and key strategies for development. *Politica agricola internazionale-international agricultural policy*, Vol. 3.
- Zeffane, R. 2006. Factors affecting preferred sources of information: exploring the impact of trust, job satisfaction and communication effectiveness. *Journal of contemporary management*, Vol. 11 (2), 77–93.
- Zepeda, L. 2001. Agricultural investment, production capacity and productivity. <http://www.fao.org/docrep/003/x9447e/x9447e03.htm#c> (Accessed 12th June 2014).
- Zhang, M. 2013. A study on symbiosis of recycling economy enterprise cluster based on knowledge value chain. *Engineering management research*; Vol. 2 (2).
- Zohrabi, M. 2013. Mixed method research: instruments, validity, reliability and reporting findings. *Theory and practice in language studies*, Vol. 3 (2), 254-262.

APPENDICES

Appendix 1: Summary of data collection tools

S/N	Research question	Data collection tool/information source
1.	Which types of AKS are used in the study area?	<ul style="list-style-type: none"> • Literature review (Chapter 2) • Questionnaire (Appendix 3: Q. 12 and 13) • Checklist for key informant interviews (Appendix 4: Q. 3) • Focus group discussion guide (Appendix 5: Q. 2)
1.1	Who are the major AKS actors?	<ul style="list-style-type: none"> • Literature review (Chapter 2) • Focus group discussion guide (Appendix 5: Q. 3)
1.2	What roles are played by AKS actors?	<ul style="list-style-type: none"> • Literature review (Chapter 2) • Focus group discussion guide (Appendix 5: Q. 4)
1.3	To determine how farmers and agricultural research are linked?	<ul style="list-style-type: none"> • Literature review (Chapter 2) • Questionnaire (Appendix 3: Q. 20, 38, 40, 41, 47)
2.	What categories of knowledge do AKS actors need?	<ul style="list-style-type: none"> • Questionnaire (Appendix 3: Q. 14 - 19) • Checklist for key informant interviews (Appendix 4: Q. 4 - 6) • Focus group discussion guide (Appendix 5: Q. 4 - 6)
2.1	Which sources of knowledge are preferred by AKS actors?	<ul style="list-style-type: none"> • Questionnaire (Appendix 3: Q. 20 - 24) • Checklist for key informant interviews (Appendix 4: Q. 7)

		<ul style="list-style-type: none"> • Focus group discussion guide (Appendix 5: Q. 7)
3.	Which factors hinder access to agricultural knowledge among AKS actors?	<ul style="list-style-type: none"> • Questionnaire (Appendix 3: Q. 17, 24, 37, 53 - 67) • Checklist for key informant interviews (Appendix 4: Q. 8) • Focus group discussion guide (Appendix 5: Q. 8)
4.	How is agricultural knowledge shared among actors forming the AKS?	<ul style="list-style-type: none"> • Questionnaire (Appendix 3: Q. 38 - 43) • Checklist for key informant interviews (Appendix 4: Q. 17 - 18) • Focus group discussion guide (Appendix 5: Q. 14 - 15)
5.	How ICTs support agricultural knowledge management and AKS?	<ul style="list-style-type: none"> • Questionnaire (Appendix 3: Q. 25 - 37) • Checklist for key informant interviews (Appendix 4: Q. 9 - 16) • Focus group discussion guide (Appendix 5: Q. 9 - 13)
6.	What roles are played by government in enhancing access to and use of AKS?	<ul style="list-style-type: none"> • Literature review (Chapter 2) • Questionnaire (Appendix 3: Q. 53 - 67) • Checklist for key informant interviews (Appendix 4: Q. 19 - 20)
7.	What are the significant variables that influence AKS usage among actors?	<ul style="list-style-type: none"> • Literature review (Chapter 2) • Questionnaire (Appendix 3: Q. 1, 2, 4, 7, 9, 13, 14, 16, 17, 18, 19, 23, 24, 27, 29, 31, 34, 37, 53 - 67)

		<ul style="list-style-type: none"> • Checklist for key informant interviews (Appendix 4: Q. 3, 8, 9, 16, 17) • Focus group discussion guide (Appendix 5: Q. 1, 2, 4, 8, 10, 13, 14)
7.1	What is the suitable model for enhancing access to agricultural knowledge along the AKS?	<ul style="list-style-type: none"> • Model assessment

Appendix 2: Introductory letter for a survey on “Strengthening agricultural knowledge systems for improved rural livelihoods in Morogoro region of Tanzania”

Dear respondent,

I kindly request you to participate in this survey that aims at investigating how Agricultural Knowledge Systems (AKS) can be strengthened for improving rural livelihoods in Tanzania so as to recommend a model for enhancing access to agricultural knowledge among actors. AKS play important roles in enhancing access and usage of agricultural knowledge among farmers and other actors.

Thus, this survey aims at determining the level of your involvement in Agricultural Knowledge Systems. Your experience and views are highly valuable in determining how to strengthen AKS. Results from this survey form a crucial component of my PhD thesis and will provide an important input in recommending a most suitable model for strengthening AKS.

All of the responses given will be treated with high confidentiality and at no time will your data be given to a third party. Survey results will only be used for intended purposes.

Kindly yours,

Wulystan Pius Mtega

PhD student (University of South Africa)

E-mail: wmtega@suanet.ac.tz

Phone: +255 769 831 893

Appendix 3: Questionnaire for farmers

Code		Date	
Name of respondent (optional)		Village	
Ward		Division	
District			

A: General

1. Sex

- a) Male ()
- b) Female ()

2. Age group:

- a) 15-25 ()
- b) 26-35 ()
- c) 36-45 ()
- d) 46-50 ()
- e) 51-60 ()
- f) 61and above ()

3. Are you a household head?

- a) Yes ()
- b) No ()

4. Educational level

- a) Informal education ()
- b) Adult education ()
- c) Primary education ()
- d) Secondary education ()
- e) Post secondary ()
- f) University ()
- g) Postgraduate ()

5. Marital status

- a) Single ()
- b) Married ()
- c) Widow ()
- d) Divorced ()
- e) Separated ()

6. Family size

- a) 1 to 3 ()
- b) 4 to 6 ()
- c) 7 to 9 ()
- d) >10 ()

7. For how many years have you been a farming

- a) 1 to 5 years ()
- b) 6 to 10 years ()
- c) 11 to 15 years ()
- d) 16 to 20 years ()
- e) 21 to 25 years ()
- f) 26 to 30 years ()
- g) More than 30 years ()

8. Major crops grown

- a) Maize ()
- b) Paddy ()
- c) Sorghum ()
- d) Cassava ()
- e) Sweet potatoes ()
- f) Legumes/pulses ()
- g) Sugar cane ()
- h) Horticultural crops ()
- i) Fruits ()
- j) Others (please specify).....

9. How many bags/kilograms/tones/tins do you harvest per acre?

Crop	Bags/tins (of 100 kgs)	Kilogram/tones
Maize		
Paddy		
Sorghum		
Cassava		
Potatoes		
Legumes/pulses		
Horticultural plants		
Fruits		
Sugar cane		
Others		

10. What is the size of your farm?

- a) Less than an acre ()
- b) 1 to 2 acres ()
- c) 3 to 5 acres ()
- d) 6 to 8 acres ()
- e) >10 acres ()

11. How have you acquire the farm?

- a) Hired ()
- b) Own ()
- c) Given by relative ()
- d) Other means of ownership (please specify).....
.....

B: CATEGORIES OF AGRICULTURAL KNOWLEDGE NEEDED

12. Do you use agricultural knowledge when conducting agricultural activities?

- a) Yes ()
- b) No ()

13. Which types of systems do you use for acquiring agricultural knowledge?
.....
.....

14. Which categories of agricultural knowledge do you use? (tick all that apply)

- a) Weather ()
- b) Inputs (seeds, fertilizers, pesticides) ()
- c) Animal and crop husbandry practices ()
- d) Post-harvest information ()
- e) Agricultural marketing and prices ()
- f) Agricultural credits ()
- g) Others

15. What is the frequency of using the following categories of agricultural knowledge?

Agricultural knowledge category	Usage			
	Very frequently	Frequently	Infrequently	Not used
Weather				
Inputs (seeds, fertilizers, pesticides)				
Animal and crop husbandry practices				
Post-harvest practices				
Agricultural marketing and prices				
Agricultural credits				
Others				

16. At what time of the cropping calendar do you access and use agricultural knowledge mentioned in 14 above?

Category of agricultural knowledge	Season/time when knowledge is needed					
	Land preparation	Sowing time	Fertilizer application	Weeding	Harvest time	Post-harvest
Weather						
Inputs (seeds, fertilizers, pesticides)						
Crop husbandry practices						
Post harvest practices						
Agricultural marketing and prices						
Agricultural credits						
Others						

17. Which factors stimulate accessibility of agricultural knowledge in your area?

- a) Ownership of communication tools ()
- b) Accessibility of agricultural knowledge sources ()
- c) Affordability of mobile phone tariffs ()
- d) Well developed ICT infrastructure ()
- e) Reliable sources of power ()
- f) Broadcasting agricultural radio and TV programmes during relevant time ()
- g) Membership in farmers' groups ()
- h) Adequate agricultural extension services ()
- i) Others (please mention)

18. Which factors hinder accessibility of agricultural knowledge in your area?
- a) Sources not easily accessed ()
 - b) Sources found far away from residential areas ()
 - c) Difficult language used ()
 - d) Feedback not easily made ()
 - e) Do not own communication tools ()
 - f) Not a member of a farmers' group ()
 - g) Poor network/signal of some ICTs ()
 - h) Poor/lack power supply ()
 - i) TV and radio programmes aired during odd hours ()
 - j) Limited agricultural related issues during village meetings ()
 - k) Irrelevant content disseminated by some sources ()
 - l) Agricultural extension services not provided frequently ()
 - m) Others (please specify)

19. Do you use all of the acquired agricultural knowledge?

- a) Yes ()
- b) No ()

20. Why don't you use acquired agricultural knowledge?

C: SOURCES OF AGRICULTURAL KNOWLEDGE

21. Which sources of agricultural knowledge do you use? (tick all that apply)

- a. Agricultural extension officers ()
- b. Fellow farmers ()
- c. Radio ()
- d. TV ()
- e. Mobile phone ()
- f. Newspaper ()
- g. Posters ()
- h. Books/booklets ()
- i. Research institutions ()
- j. Internet ()
- k. Leaflets/brochures ()
- l. Village executives ()
- m. Trainings and seminars ()
- n. Input suppliers ()
- o. Buyers of agricultural produce ()
- p. Films/cinema ()
- q. Demonstration plots ()
- r. Agricultural shows ()
- s. Libraries ()
- t. Churches/mosques ()
- u. Rural Information centers ()
- v. Others (please specify)

22. Which category of agricultural information is accessed through each of the sources you use?

Source of agricultural knowledge	Category of agricultural knowledge					
	Crop husbandry	Post-harvest handling	Weather	Inputs	Markets/prices	Credit
Agricultural extension officers						
Fellow farmers						
Newspaper						
Posters						
Books/booklets						
Research institutions						
Leaflets/brochures						
Village executives						
Trainings/seminars						
Input suppliers						
Buyers						
Demonstration plots						
Agricultural shows						
Libraries						
Churches/mosques						
Rural Information centers						
Others						

23. Which among the following traditional sources of agricultural knowledge are used frequently?

Source of agricultural knowledge	Frequency			
	Very frequently	Frequently	Infrequently	Not used
Agricultural extension officers				
Fellow farmers				
Newspaper				
Posters				
Books/booklets				
Research institutions				
Leaflets/brochures				
Village executives				
Trainings/seminars				
Input suppliers				
Buyers				
Demonstration plots				
Agricultural shows				
Libraries				
Churches/mosques				
Rural Information centers				
Others				

24. Why some agricultural knowledge sources are used more frequently than others? (*tick all reasons that apply to either very frequently or frequently used sources only*)

Source of agricultural knowledge	Reasons for some sources being more useful than others						
	Good public relation	Simple language is used	Feedback easily made	Easy to access source	Source found near to home	Source is cheap to access	Two way communication
Agricultural extension officers							
Fellow farmers							
Newspaper							
Posters							
Books/booklets							
Research institutions							
Leaflets/brochures							
Village executives							
Trainings and seminars							
Input suppliers							
Buyers of agricultural produce							
Demonstration plots							
Agricultural shows							
Libraries							
Churches/mosques							
Rural Information centers							
Others							

25. Why some agricultural knowledge sources are either less or not used at all? (*tick all reasons that apply to either infrequently or not used at all sources*)

Source of agricultural knowledge	Reasons for some sources being less useful than others						
	Poor public relation	Difficult language	Feedback not made	Not easily accessed	Far from residency	Source expensive	One way communication
Agricultural extension officers							
Fellow farmers							
Newspaper							
Posters							
Books							
Research institutions							
Brochures							
Village executives							
Trainings/ seminars							
Input suppliers							
Buyers of agricultural produce							
Demonstration plots							
Agricultural shows							
Libraries							
Churches/mosques							
Rural Information centers							
Others							

D: ICTs IN ACCESSING AGRICULTURAL KNOWLEDGE

26. Which of the following ICTs do you use?

- a. Radio
- b. Television
- c. Mobile phones
- d. Others (please mention).....
.....

27. Which among the ICT tools is/are used for accessing agricultural knowledge?

- a. Radio
- b. Television
- c. Mobile phones
- d. Others (please mention)

28. From question 26, for ICT tools you use, where do you access them?

Communication tool	Source of ICT tool					
	Own	Relative	Friends	Kiosk	Club/bar	Not applied
Radio						
TV						
Mobile phone						
Others:						

29. Among the ICT tools used (from question 26), which among them are used frequently?

ICT Tool	Level of usage for those who use ICT tools only			
	Very frequently	Frequently	Infrequently	Not used
Radio				
Television				
Mobile phones				
Other:				

30. Among the ICT tools used, how competent are you with respect to usage of the following applications? (tick at a relevant place)

Application	ICT tool	Competence level for those who use ICT tools only				
		Poor	Basic	Good	V. Good	Excellent
Turning on	Radio					
	TV					
Tuning	Radio					
	TV					

31. What categories of agricultural knowledge have you accessed through each of the ICT tools?

Category of agricultural knowledge	ICT tools	
	Radio	TV
Crop husbandry practices		
Post-harvest information		
Weather		
Inputs		
Agricultural marketing and prices		
Credit		
Others (please specify)		

32. If you use mobile phones, how competent are you with respect to usage of the following mobile phone applications? (*tick at a relevant place*)

Application	Competency level				
	Poor	Basic	Good	Very good	Excellent
SMS					
Voice calls					
Photo taking					
Video recording					
Knowledge sharing applications					
Mobile money applications					
Others					

33. If you use mobile phones, which among the following mobile phone applications do you frequently use?

Mobile phone application	Frequency			
	Very frequently	Frequently	Infrequently	Not used
SMS				
Voice calls				
Photo taking				
Video recording				
Knowledge sharing applications				
Mobile money applications				
Others				

34. Which mobile phone application is used for accessing each category of agricultural knowledge?

Agricultural knowledge category	Mobile phone applications						
	Voice calls	SMS	Photo taking	Video recording	Information sharing	Mobile money transfer	Others
Crop husbandry practices							
Post-harvest information							
Weather							
Inputs							
Agricultural marketing and prices							
Credit							
Others (please specify)							

35. If you use radio and TV sets for accessing agricultural knowledge, at what time of the day is agricultural radio/TV programmes broadcasted?

Time	Radio set	TV set
Morning		
Afternoon		
Evening		
Night		
Early morning		

36. What is your appropriate time for access agricultural knowledge through radio and TV broadcasts?

Time	Radio set	TV set
Morning		
Afternoon		
Evening		
Night		
Early morning		

37. If you have been using radio and TV sets for accessing agricultural knowledge, have you ever called to seek for clarifications during agricultural broadcasts?

ICT tool	Tick only where applicable for each ICT tool	
	Call to seek clarifications	Did not call to seek clarification
Radio		
TV		

38. Which constraints are encountered when using the tools/channels mentioned above? (*tick all that apply*)

Tool	Illiteracy	Poor signals/network	Programmes aired during odd hours	No power source	No relevant content	Too expensive
Radio						
Television						
Mobile phones						
Computer/ laptop						
DVD/CDactor						
Others						

E: AGRICULTURAL KNOWLEDGE SHARING

39. Have you ever shared agricultural knowledge with fellow farmers?

- a. Yes
- b. No

40. If the answer to Question 36 is “Yes”, what category/ies of agricultural knowledge have you ever shared to fellow farmers? (*Tick all that apply*)

- a) Animal and crop husbandry practices
- b) Post-harvest information
- c) Weather
- d) Inputs
- e) Agricultural marketing and prices
- f) Credit
- g) Others (please specify).....

41. Who are the recipients of shared agricultural knowledge?

- a. Fellow farmers
- b. Input suppliers
- c. Agricultural extension agents
- d. Buyers
- e. Members of farmers’ group
- f. Village based agricultural advisors
- g. Village executives
- h. Agricultural researcher

42. Which channels are used for sharing agricultural knowledge?

- a. Face to face oral communication
- b. Voice calls
- c. SMS
- d. Village meetings

e. Others (please specify)

43. What is the frequency of sharing agricultural knowledge to different recipients?

Channel	Frequency			
	Very frequently	Frequently	Infrequently	Not used
Fellow farmers				
Input suppliers				
Agricultural extension agents				
Buyers				
Members of farmers' group				
Village based agricultural advisors				
Village executives				
Agricultural researcher				

44. Which category of agricultural knowledge is shared to each recipient? (*Tick all that apply*)

Recipient	Categories of agricultural knowledge					
	Crop husbandry	Post-harvest handling	Weather	Inputs	Markets /prices	Credit
Fellow farmers						
Input suppliers						
Agricultural extension agents						
Buyers						
Members of farmers' group						
Village based agricultural advisors						
Village executives						
Agricultural researcher						

F: AGRICULTURAL KNOWLEDGE CREATION

45. Have you ever observed a problem facing your farm or animals?

- a) Yes ()
- b) No ()

46. From question 45 above, did you manage to solve the observed problem facing your crops or livestock without consulting your fellow farmer/extension staff or reading books?

- a) Yes ()
- b) No ()

47. What was the problem about?

48. How did you solve it?

49. Have you ever reported the observed problem facing your farm to others for assistance from other parties?

- a) Yes
- b) No

50. If the answer to Question 49 is “Yes”, where did you report?

- a) Researchers
- b) Agricultural extension staff
- c) Village authorities
- d) Agro-dealer
- e) Fellow farmer
- f) Others (please specify)

51. How did you report the problem?

- a) Through oral communication for describing the problem is
- b) Through phone calls describing how the problem is
- c) Took a photo and shared it others
- d) Others (specify)

52. For how long did you have to wait for the solution

53. Did you report any other observed problem to the same person/authority again?

- a) Yes
- b) No

G: GOVERNMENTAL INTERVENTIONS

54. Do you have a library/information centre in your area?

- a. Yes
- b. No

55. Can you access library services?

- a) Yes
- b) No

56. Do you have village meetings in your area?

- a. Yes
- b. No

57. If the answer to Question 56 is “Yes”, are agricultural related issues discussed during village meetings?

- a. Yes
- b. No

58. Do you have a reliable mobile phone network in your village?

- a) Yes
- b) No

59. Do you afford to use mobile phone services frequently?
 a) Yes ()
 b) No ()
60. If the answer to Question 59 is “No”, which among the following constraints you from using mobile phone services?
 a) Tariffs are very high ()
 b) Can’t afford to buy mobile phones ()
 c) No mobile phone agricultural related services ()
 d) Do not have power source to charge mobile phones ()
 e) Poor quality of mobile phone ()
 f) Others (please specify)
61. Do you have agricultural extension officers in your village?
 a) Yes ()
 b) No ()
62. Have you been visited or assisted by agricultural extension officer at any time?
 a) Yes ()
 b) No ()
63. Do you have electricity in your area?
 a) Yes ()
 b) No ()
64. If the answer to Question 63 is “No”, where do you get power to run radio, TV, mobile phones etc?
65. Do you listen to different radio programmes from your village?
 a) Yes ()
 b) No ()
66. Are there agricultural related programmes broadcasted through radio you have been accessing?
 a) Yes ()
 b) No ()
67. Do you access TV broadcasts from your village?
 a) Yes ()
 b) No ()
68. Are there agricultural related programmes broadcasted through TV you have been accessing?
 a) Yes ()
 b) No ()

H: RECOMMENDATIONS

69. What can be done to promote access to agricultural knowledge in your area?

END

Appendix 4: Guide for key informant interviews/other AKS actors

District:

Division:

Ward:

Village:

Position:

A: CATEGORIES OF AGRICULTURAL KNOWLEDGE

1. For how many years have you been involved in the current activity?
2. Do you provide agricultural knowledge in your agricultural activities?
3. Which agricultural knowledge systems do you use for providing agricultural knowledge?
4. Which categories of agricultural knowledge do you provide?
5. Which categories of agricultural knowledge are used more by the community you serve?
6. Which sources of agricultural knowledge are mostly used in your area?
7. Which factors influence accessibility of agricultural knowledge in your area?

B: ICTs IN AGRICULTURAL KNOWLEDGE PROCESSES

8. Where do you access ICT tools?
9. Which ICTs are used in your area for different agricultural purposes?
10. How do you use each of the ICT tools for performing your roles?
11. Which ICT applications from each tool do you use?
12. How do you use each of the application mentioned in number 11?
13. Do community members you serve know how to access knowledge through such applications?
14. How are radio and TV sets/stations used in performing your agricultural roles?
15. Which constraints are encountered when using ICT tools for performing your agricultural knowledge processes?

C: AGRICULTURAL KNOWLEDGE SHARING

16. How do you share agricultural knowledge? Which channels are used for sharing agricultural knowledge?
17. Who are the recipients of shared agricultural knowledge?

D: AGRICULTURAL KNOWLEDGE CREATION

18. Are you involved in creating agricultural knowledge? In what extent do you involve yourself in this process?
19. Why are you involved in creating agricultural knowledge?

E: RECOMMENDATIONS

20. What can be done to promote access to agricultural knowledge in your area?

END

Appendix 5: Focus group discussion guide for farmers

District:

Division:

Ward:

Village:

Position:

A: CATEGORIES OF AGRICULTURAL KNOWLEDGE

1. Which categories of agricultural knowledge do you use?
2. Which agricultural knowledge systems do you use for acquiring agricultural knowledge?
3. Who are the major actors in AKS in your area?
4. What roles are played by each of the AKS actors?
5. Among the categories of agricultural knowledge acquired, which are used more?
6. Do you use all of the acquired agricultural knowledge? If “No” why you do not use all of the acquired agricultural knowledge?
7. Which are the sources of agricultural knowledge used in your area?
8. Which factors influence accessibility of agricultural knowledge in your area?

B: ICTs IN ACCESSING AGRICULTURAL KNOWLEDGE

9. Which ICT tools do you use when acquiring agricultural knowledge?
10. Where do you access ICT tools?
11. Which mobile phone applications are used for acquiring agricultural knowledge?
12. At what time do you access radio and TV agricultural programmes? How many programmes are aired per week?
13. Which challenges are encountered when using ICT tools for acquiring agricultural knowledge?

C: AGRICULTURAL KNOWLEDGE SHARING

14. How do you share agricultural knowledge? Which channels are used for sharing agricultural knowledge?
15. Who are the recipients of shared agricultural knowledge?

D: AGRICULTURAL KNOWLEDGE CREATION

16. Are you involved in creating agricultural knowledge? In what extent do you involve yourself in this process?
17. Why are you involved in creating agricultural knowledge?

E: RECOMMENDATIONS

18. What can be done to promote access to agricultural knowledge in your area?

END

Appendix 6: Research clearance letter



Department of Information Science
College of Human Sciences
Date: 24 January 2014

Proposed title: Strengthening the Agricultural Knowledge Systems for Improved Rural Livelihoods in Morogoro Region, Tanzania

Principal investigator: Mtega Wulystan Pius
Student number: 53537815

Reviewed and processed as: Class approval (see paragraph 10.7 of the UNISA Guidelines for Ethics Review)

Approval status recommended by reviewers: Approved

The Research Ethics Committee of the Department of Information Science in the College of Human Sciences at the University of South Africa has reviewed the proposal and considers the methodological, technical and ethical aspects of the proposal to be appropriate to the tasks proposed. Approval is hereby granted for WP Mtega, (53537815) to proceed with the study in strict accordance with the approved proposal and the ethics policy of the-University of South Africa.

In addition, the candidate should heed the following guidelines:

- To only start this research study after obtaining informed consent from the interviewees
- To carry out the research according to good research practice and in an ethical manner
- To maintain the confidentiality of all data collected from or about research participants, and maintain security procedures for the protection of privacy
- To notify the committee in writing immediately if any adverse event occurs.

Kind regards

A handwritten signature in black ink, appearing to be "S. Ndwandwe", written over a horizontal line.

Mr SC Ndwandwe
Chair: Research Ethics Committee
Department of Information Science
Tel + 2712 429 6037



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Appendix 7: Research permit

THE UNITED REPUBLIC OF TANZANIA

PRIME MINISTER'S OFFICE

REGIONAL ADMINISTRATION AND LOCAL GOVERNMENT

Telegraphic Address: "REGCOM"
Phones: 023 2604237/2604227



Regional Commissioner's Office,
P.O. Box 650,
MOROGORO.

Fax No: 260 09 73
In Reply please quote:
Ref. No: AB. 175/245/01/280

08/10/2015

District Administrative Secretaries,
Mvomero, Kilombero and Kilosa.

Re: RESEARCH PERMIT

Please refer to the above mentioned subject.

I am writing to introduce to you **Mr. Wulystan P.Mtega** who is a bonafide PhD student with registration number 53537815 of University of South Africa.

The title of the Research in question is "**Strengthening the Agricultural Knowledge system for Improved Rural Livelihoods in Morogoro, Tanzania**". The period for which this permission has been granted is from 15/09/2015 to 31/03/2016

Please provide him with all necessary assistance to enable the accomplishment of this activity.

Thank you for your cooperation.

Handwritten signature of Sophia K. Mnyanyi.

Sophia K. Mnyanyi

For: REGIONAL ADMINISTRATIVE SECRETARY

Copy: Mr.Wulystan P.Mtega,
Sokoine University of Agriculture,
P. O. Box 3000,
Morogoro.