18th ANNUAL RESEARCH WORKSHOP

Integrating Traditional and Modern Knowledge Systems in Improving Agricultural Productivity in Upper-Kitete Village, Tanzania

by

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Draft Report *GD5*

Presented at REPOA's 18th Annual Research Workshop
held at the Kunduchi Beach Hotel, Dar es Salaam, Tanzania;
April 3-4, 2013

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ABSTRACT

The objective of this study was to assess the integration of Traditional Environmental Knowledge Systems (TEKS) and Modern Environmental Knowledge Systems (MEKS) for improving the productivity of arable and pasture land and ultimately improving livelihood of rural communities in Upper-Kitete Village for present and future generations. The data were collected from both secondary and primary sources. Participatory Rural Appraisal (PRA) techniques were employed in collecting primary data. These included questionnaires, interviews, focus group discussions, and field observation.

The findings of the study indicated that Upper-Kitete Village people are living in a vulnerable ecosystem (diverse landscape, wildlife and plants). As individuals and as a community they apply both TEKS and MEKS in the classification of land and the use to which it is put. Specific land utilization types are found to be suited only to a particular ecological and management conditions as tested over years. There is evidence that, the Upper-Kitete Village community is ready to adopt new technologies and evaluate them scientifically before being put into practice as reflected by use of both TEKS and MEKS. Integration of TEKS and MEKS was noted to contribute significantly to improvement in agricultural productivity. Findings also indicated that efforts are required in documenting TEKS because respondents relied on memories and there were no standard measures used in applying TEKS.

It is recommended that development of information management system (at policy level) that takes on board globalization pressures with respect to land and land use conservation and management is critical for sustainable human development. Documentation of knowledge needs to go through three levels: identification of TEKS, setting standards to its application, and disseminating information to wider community. Integration of TEKS and MEKS also needs to follow a similar process.

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1.0 INTRODUCTION

1.1 Background to the Study

The twentieth century witnessed exciting initiatives in revitalizing technologies owned by local resource users in developing countries. On the 18th December 1992, for instance, the United Nations Resolution 164 declared 1993 the 'International Year of the World's Indigenous People'. This was aimed at strengthening international cooperation, in order to address the problems faced by the indigenous communities, in such fields as human rights, the environment, development, education and health (WCED, 1987). According to WCED, indigenous communities are "repositories of accumulated traditional knowledge and experience hereafter known as Traditional Environment Knowledge Systems (TEKS), which large society could learn from managing complex ecological systems." These are essentially land use systems, which support various livelihoods.

The Commission on Development and Global Change of 1995 issued a report titled: *For Earth's Sake* which listed areas of research interest of the highest priority if solutions to national and international environmental problems are to be found. One such area concerns TEKS in conservation measures and "approaches to rescuing and revaluing TEKS about natural resources and their management" (IDRC, 1997:123). It is within this context that TEKS and resource management systems (RMS) are identified as research themes that, when studied critically, constitute an important and timely area of environmental research for sustaining land, land use systems and the land user.

It is worth noting here that in the second half of the 1990's, TEKS entered the mainstream of activities and initiatives undertaken by developing countries and by the international donor community, UN Agencies and the World Bank (1998). TEKS are on the agenda of the first conference devoted to the Global Knowledge for Development (GK 97), held in Toronto, Canada, and even more prominently on the agenda of the second conference (GK II), held in Kuala Lumpar, Malaysia in 2000. The final action plan of the GK II Action Summit and Forum includes a strong endorsement of the TEKS programme and specifically calls for the identification, development and dissemination of local knowledge in various forms including local languages. It also calls for developing strategies for using TEKS in development.

Recently there has been a growing interest and appreciation among scientists in traditional knowledge systems. The body of scientific publications grew over the last two decades. For instance, the UNESCO - World Conference on Science recommended that traditional knowledge be integrated into the mainstream science (UNESCO, 1999). It is in this context that Agenda 21 seeks to address these

initiatives by re-examining and applying TEKS techniques, as opposed to the wholesome importation of Modern Environmental Knowledge Systems (MEKS). The ultimate goal is to attain the optimum combination of the best practices from TEKS and MEKS that demonstrate the good use of indigenous knowledge and developing cost-effective and sustainable livelihood strategies for wealth creation and income generation.

In asserting control and direction over their lives in order to safeguard social structures, communities applying informal science have utilized knowledge, practices, skills and tools that their societies have developed in the course of centuries (Rugumamu, 2003). As observed by Lane (1996), traditional knowledge is sum of experience and knowledge within a given group, which forms the basis for decision-making related to familiar and unfamiliar problems and challenges. Nevertheless, formal knowledge, that is, knowledge generated in schools, universities, research institutes and industrial firms still dominates development thinking. This knowledge gradually spreads over the developing world as the dominant system shaping politics, values and careers; a system that puts great emphasis on the contribution of MEKS to development. In this context TEKS were considered inferior and were denied a role in the development process. As a result, TEKS were classified as non-scientific compared to MEKS.

Nonetheless the situation is changing as decision makers in developing countries are seeing more and more examples of how TEKS can be put to good use. They are beginning to realize that TEKS is the largest and a single powerful asset that many developing countries posses but not yet mobilized for sustainable development (Hambati and Rugumamu, 2005). In the 1960s Tanzania initiated various programmes on integration of TEKS and MEKS. In order to facilitate provision of services and cost effective, Ujamaa Villages approach was used. Upper-Kitete Village was one of the first villages sampled for Ujamaa Village Programme in Tanzania in 1963 (URT, 2000). The people were placed in the village and provided with the basic social services to enable them work as a team for their development through integration of traditional and modern farming systems. The project worked well when all provisions were met by the government and degenerated, and finally collapsed when the village took over the full responsibility of managing the programme and integrating it into their livelihood. This implies that integration of TEKS and MEKS through involvement of local people in the planning and implementation processes of programmes are inevitable for programmes to succeed. The inventory of locally driven solutions to complex issues on land resource conservation and management is very important in getting the desired results in developing countries that lack capital investment but would like to benefit from existing knowledge and what is gained from formal education. This study is in line with the Millennium Development Goals (MDGs) with specific reference to the first

goal which addresses extreme poverty and hunger; and National Strategy for Growth and Reduction of Poverty (NSGRP), through efficient use of available and affordable resources to improve livelihood of rural communities in Tanzania.

1.2 Research Problem and Significance of the Study

1.2.1 Research Problem

Survival of local communities in rural areas is predominantly dependent on utilizing land resources for their livelihoods. Effective utilization of resources is influenced by technical know-how. Studies conducted by Toima (1997) Mapinduzi (2001) Borjeson (2002) and Hambati and Rugumamu (2005) noted that most of the modern technical solutions that have been implemented to address land resources conservation for increased production in rural areas have failed because they did not take into account the local culture, particularly community preferences, skills and knowledge. Integration of modern knowledge into traditional knowledge is expected to boost development in an area and to have a pull effect on improved agricultural productivity. For instance in Upper-Kitete Village in Northern Tanzania, a desired impact (poverty reduction) expected out of using modern knowledge in farming activities was insignificant because the local culture, particularly community preferences, skills and knowledge were not adequately exploited. Thus this study investigated how best TEKS and MEKS could be merged on arable land resource conservation and management in Upper-Kitete village.

1.3 Research Objectives

1.3.1 General Objective

The general objective of the study is to assess the integration of TEKS and MEKS in improving the productivity of arable and pasture land in Upper-Kitete Village for present and future generations.

1.3.2 Specific Objectives

The specific objectives of this study are to:

i. Identify TEKS and MEKS used in farming practices on arable and pasture land in Upper- Kitete Village so as to characterize them;
ii. Determine the efficiency of TEKS and MEKS in improving household agricultural productivity; and
iii. To examine how TEKS and MEKS could be best integrated on arable and pasture land utilization for sustainable use of land resources so as to inform the public and policy makers on how best the two can be integrated.

1.3.3 Research Questions

This research project is guided by three main questions:

(i) Which TEKS and MEKS are applied on arable and pasture land use in Upper-Kitete Village?

(ii) How effective and efficient are TEKS and MEKS in improving household agricultural productivity; and

(iii) How can TEKS and MEKS be best integrated on arable and pasture land utilization for sustainable use of land resources?

2.0 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 The Best African Land Resource Conservation and Management Practices

Traditional Environmental Knowledge (TEK) is defined as “a body of local environmental knowledge and beliefs that has been gathered by firsthand observations from living in close contact with nature, and transmitted through oral tradition” which includes “a system of classification, a set of empirical observations about the local environment, a system of self-management that governs the sustainable resource base, and an understanding of the relationships of living things with one another and their environment” (CEMA, 2008). Hambati and Rugumamu (2005) noted that TEKS was used in Kainam in exploiting specific land resources, such as knowledge of different trees and their products. A similar situation noted earlier by Maganga (1995) shows that gradually, a consensus is emerging that rural communities in Africa and other parts of the world have detailed knowledge of their physical environment, which they are in contact with. The large-scale “systems management knowledge” is embodied in sustainable resource utilization.

As observed by Nabhan (1985), the farmers are awareness of soil characteristics, while many rural people have detailed knowledge of plant species, their characteristics, and water requirements. According to Schmidt (2000), it is possible to construct from TEKS, taxonomy of useful trees and grasses, including fruits, which are edible, and trees and grasses, which provide good materials for roofing. Furthermore Kalland et al. (1996) noted that, indigenous people know which plants have medicinal properties and which can provide handles for hoes, cutlasses, and axes. Pastoralists have detailed knowledge of animal diseases and vectors as well as those that are poisonous. Over the years these communities have developed effective ways of ensuring that this knowledge is used to ensure sustainable utilization of the environmental land resources (Kalland, 1994).

Farrington and Martin (1988) observed that, throughout human history, human survival has depended on seizure of whatever survival potential is available in the surrounding. Meeting livelihood needs has not always been an easy task to community’s individuals and environmental practitioners in the world (Amanor, 1991). The aim of research is to better understand the past and present TEKS practices and to determine the potential future of TEKS to manage and conserve land resource as well as to mediate conflicts over such resources to better adapt MEKS to local conditions through adaptive co-management.

Local people through their traditional lifestyle, especially cultural practices such as norms, rituals, and taboos, contributed significantly to ensure survival of various land resources enjoyed today. For instance, according to Warren (1991), traditional knowledge of Shaman is very famous and, is still receiving a great recognition from the South American communities and global drug companies. The knowledge precisely identifies the physical, biological and chemical characteristics of various types of plants in the tropical rainforest. In relation to herbs and modern medicinal use of plants, the Shamans are regarded as unique traditional data banks. When natural scientists interact with them (indigenous people) they do not only grasp the biological facts, but also the traditional aspects of the invisible world.

Problems encountered in many development programmes and conservation initiatives could be attributed to failure of adaptation of MEKS to the indigenous ways of handling nature (Kipuri, 1995). Made (1995) in his study on *Land Tenure and Impacts of Indigenous Knowledge Systems for Southern Africa* found that to restore TEKS without addressing the allocation of land resources on equity basis and available resources is not an easy task. Mubonda et al.'s (1995) study on Lozi's IKS in Zambia found that participation of local communities facilitates adaptation processes in management of natural resources and that TEKS are easy for local people to adapt and inexpensive to run because they are part of them.

In developing countries like Tanzania much of the TEKS are not covered in literature that deals with resource management. The few studies undertaken show that indigenous knowledge systems were considered inferior and were denied in development. For example, Mbuta (2001) has shown that TEKS is not widely practiced in Mang'ula village ecosystem in Kilombero Valley due to internal and external factors. In this study it was noted that cultural beliefs and values that mould historical resource management and decision making are fading away as a result of modernization. Simon (1997) observed that TEKS were overlooked in water furrow management along the southern slopes of Mount Kilimanjaro. This situation led to the gradual disappearance of numerous TEKS related to natural resource management. Excluding TEKS also means excluding the indigenous people from participating in managing their natural resources because indigenous systems are considered as conservative, speculative, and inaccurate.

Contrary to the above, Mapinduzi's (2001) study on *Pastoralist Community in Monduli District in Northern Tanzania* revealed that TEKS on land resource management, especially pastureland was effective in promoting conservation of biodiversity. He observed that community has knowledge of allocating different pastures to livestock over time to conserve the existing biodiversity.

Borjeson's (2002) study on *The History of Indigenous Knowledge System of Farmers In Mbulu Highlands Since 1880-2000*, shows that TEKS were used in this area since pre-colonial period (1880s) especially in soil-water conservation in their agricultural systems. Loiske (1995) noted that the TEKS of Iraqw people was first interrupted by colonialists in 1906, when the Roman Catholic missionaries arrived. During the German colonisation the missionaries failed to convert the Iraqw to Christianity and had, after a hard struggle, to move out from Mbulu highlands. Mission station was, after some years, moved to Tlawi outside Kainam and is well established. Furthermore the same happened to colonial governments and MEKS. For example, the Iraqw were considered also by the British colonialists as using "passive resistance" against the colonial government (Heartly, 1938).

Loiske (1995) noted TEKS is becoming stronger and dominating in land resource conservation in Mbulu highlands while completely disappearing in other areas of Iraqw people, including Hanangw, Karatu, Babati and other parts of Mbulu District. Most people in those areas have used MEKS since 1940's when they engaged themselves in commercial agriculture (i.e. coffee, tobacco and wheat) (Borjeson, 2002). In those areas he observed severe land degradation as compared to Mbulu highland areas of Kainam.

Kikula and Mwalyosi (1994) noted that before colonialism, in Tanzania there were sound conservation and management measures, which were built in the indigenous agricultural practices that were quite effective. As observed by Toima (1997) in Monduli District, the practices were intended to improve land resources and agricultural production, and in the long run improve their quality of life.

Some of the most notable traditional management measures include: the Ngoro (Matengo pit) System in Mbinga, the Ukara mixed farming system in Ukerewe, Iraqw intensive farming in Mbulu, Ufipa mound cultivation system in Rukwa, and the mixed farming and zero/stall grazing of the Chagga (Kerario, 1996; Kikula and Mwalyosi, 1994). These systems were practised among the crop cultivators and mixed farmers. Others practices include the 'Ngitiri' system in Shinyanga, Mwanza and Tabora Regions that involved traditional rotation of grazing, and the 'Ndobindo or Mbugha' in Singida to avoid overgrazing.

2.2 Integration of TEKS and MEKS in Land Resource Conservation and Management

During this era of globalization, it is inevitable to have MEKS on environmental issues (Thompson, 1991). However, it is the task of Africans to adapt the technologies that suit their environment and are cost effective over time and space. The concerns should reflect the needs and aspiration of the stakeholders as well as

those of natural resource base that is demand driven. This goal is achieved through democratic participatory design, implementation, monitoring, and evaluation of the land resources policies, legislation, and convention in order to develop the best ways for harmonizing both the TEKS and MEKS in land resources conservation and management.

Thompson's (1991) study on *Combining Local Knowledge and Expert Assistance in Natural Resource Management in Small-Scale Irrigation in Kenya* shows that the project of water resource management was successful because the local people were involved throughout the project cycle (i.e. in planning, implementation, monitoring and evaluation) and their TEKS were integrated with expert knowledge. The local people felt that their knowledge were recognized, and they also recognized the expert knowledge. The same success was recorded in Tanzania especially in community development projects funded by World Vision Tanzania (WVT), whereby the community is involved right from the beginning that is in planning, implementation, monitoring, and evaluation through Participatory Learning and Action (PLA) and Participatory Rural Appraisal (PRA) in adaptive co-management (Dirk, 2000).

There were situations where MEKS did not involve local people's TEKS in management of land resources. The projects initiated in that manner have proved failure as they were against local people's perception and aspiration as their ideas were neither included nor valued. In many instances people have rejected, abandoned or undermined programmes, which they regarded as being imposed on them (Chambers, 1983). For instance, in Latin America, a community pipe-borne water project was set up to deal with guinea worm infestation. It failed because the women preferred to get water from brooks, which traditionally serve as social meeting places (Rogers, 1962).

The same situation was experienced in Shinyanga, Tanzania as observed by Dirk (2000) where a community manually pumped bore-hole water project which was set up to reduce the distance traveled and time consumed by household members in searching for water for domestic use was abandoned. The projects failed because the local community preferred to get water from rivers and local wells, which were traditionally identified as good quality water (soft water) compared to the pumped bore-hole water, which was hard water.

Development in knowledge is said to be sustainable when it is self-perpetuating, self-regulating, and beneficial to the coming generations (Alao, 1995). Among the factors, which are crucial to this process, are good resource management, an effective flow of information, and appropriate technology. TEKS through participatory approaches are seen as most appropriate measure to achieve that aim, particularly in rural areas

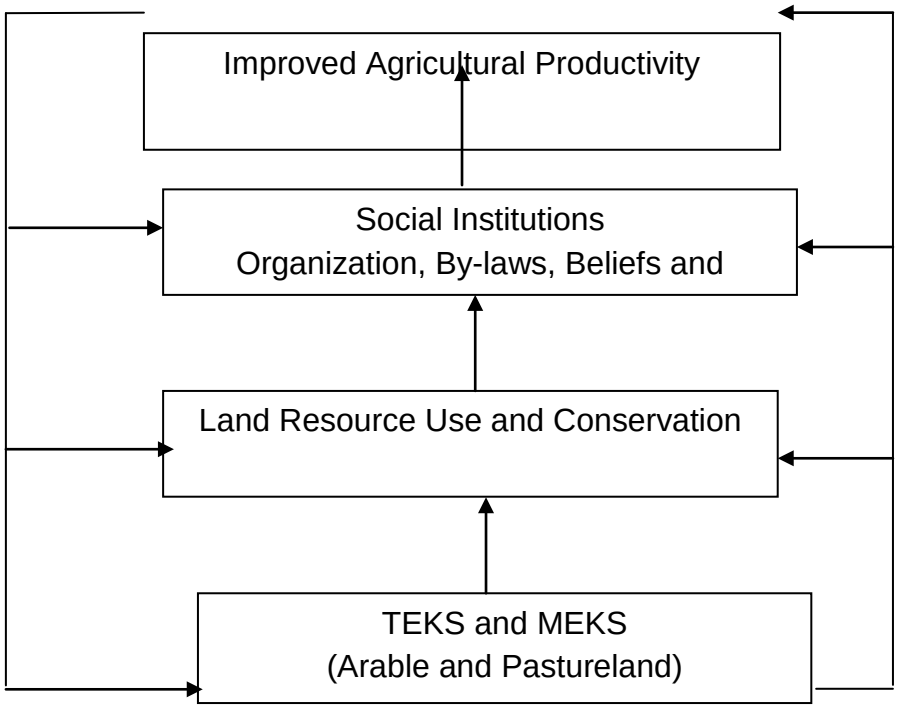
where over 70% of the total population in the developing world lives (Chambers, 1989).

2.3 Conceptual Framework

In this study the theoretical underpinning is that there is a complex relationship between and among individuals, local communities, land use systems and environment in the whole process of earning livelihoods. The linkages in a given ecosystem, an underlying sound resource conservation and management for sustainable development are intricate. There are several concepts used in the analysis of TEKS and MEKS. Given the linkages between them, none of the concepts can stand alone. Traditional environmental knowledge systems are embedded in places and lives of people. TEKS may be considered as an integral part of the local knowledge, classification systems and social interaction with the environment. Social interactions provide the rules for relations and management systems. Therefore, unlike MEKS which is universal, TEKS have restrictive application which is location specific but might also be applied to develop concepts such as conservation of particular land.

TEKS and MEKS are analyzed at four different levels. Firstly, traditional and modern knowledge of land resources that is arable land, pastureland and water resources. This level includes the knowledge of plants, animals, soils, water and landscapes. Secondly, the land resources conservation and management systems (adoption of practices), which includes users of environmental knowledge and appropriate set of practice, tools and techniques. This is the level where the local people seek the mutual and harmonious relationship with their environment. It is a stage that requires an understanding of ecological processes to sustain their daily livelihoods. Thirdly, are social institutions which include a set of rules and code of social relationships that govern human behaviour. The fourth is the improved productivity of the land resources, which shapes the traditional perceptions and gives meanings to observations of the practices experienced. Subsequently, successful TEKS and MEKS are disseminated to the whole community to be practiced to improve the productivity of land resources and human population over time and space. The four levels of TEKS and MEKS analysis are summarized in Figure 1.

Figure.1. Level of analysis of TEKS and MEKS



Source: Modified from Berkes (1999:3)

3.0 RESEARCH METHODOLOGY

Both qualitative and quantitative research approaches were integrated to facilitate answers to the research questions that guided the study. Multiple methods were used to collect data and information on how the modern and traditional knowledge were integrated to improve household productivity.

3.1 The Study Area

3.1.1 Rationale for Selection of the Study Area

The study was conducted in Upper-Kitete Village. The village was chosen purposively because it was one of the first four villages (others are Kerege in Bagamoyo District, Kabuku in Handeni District and Mlale in Songea District) selected for implementation of the Ujamaa and Rural Development Programme in 1963. This Programme emphasized the use of MEKS in agricultural production so that the community could learn and adopt the knowledge through diffusion. The study area had interesting features of integration of traditional and modern knowledge in improving agricultural productivity for development.

3.1.2 Geographical Location, Size and Population

Upper-Kitete Village is situated in Karatu District, one of the six districts of Arusha Region. It lies between latitudes 3^{o}19'S and 4^{o}15'S and longitudes 34^{o}60'E and 35^{o}50'E (see map1). Karatu District covers an area of 24,536 km^2. According to the 2002 census, the district has a total population of 186,182 people: 95,755 males and 90,227 females (URT, 2002). The dominant ethnic groups are Iraqw and Barbaig. Other ethnic groups are Chagga, Pare, Arusha, Rangi and Maasai who migrated into the area for various activities namely business and administration purposes. Karatu District is among the fast population growing district in the region with the growth rate of 2.8% per annum (Meindertsma and Kessler, 1997, URT, 2002). Upper Kitete Village is dominated by the Iraqw ethnic group.

3.2 The Sample Size and Sampling Techniques

Nachmias and Nachmias (2000) observed that for a sample to be representative enough in social sciences research it should be not less than 10% of the total population. In this study a sample size of 100 households was selected. This is 16.8 percent households. The village has 595 households (See Table 1). The unit of the study is the household in the village.

The satellite imagery covering the study area were downloaded from http://glovis.usgs.gov and interpreted to identify different land uses in Upper-Kitete Village, using GIS techniques (See Map 1). Then stratified sampling was undertaken in order to get the village different land uses such as farming, grazing, settlements and forest. In each of these land uses, interviewees were selected randomly. With the help of village leadership, the numbers of sub-village leaders were identified. From each sub-village a proportionate sample was drawn in order to include the different land users in the sample. Structured interviews were conducted with 100 adults: 50 males and 50 females. Twenty one respondents were involved in in-depth interviews and five focus group discussions were formed (with seven respondents each), coming from all the seven wards.

The map was used as a reference/guiding tool for inquiry on land use and land management issues in the study area. Therefore during the fieldwork, the respondents were asked questions regarding their traditional and modern knowledge as applied to different land use in order to improve land productivity. The major land uses in the village include cultivation (arable land), grazing (pasture land), forest land and related uses like water sources, fuel and timber.

3.3 Data Collection Procedures and Instruments

The data were collected from both secondary and primary sources. Secondary data was obtained from published and unpublished sources such as papers, journals, books and proceedings while different PRA techniques were employed in collecting primary data. These included questionnaires, interviews, focus group discussions, and field observation. All these methods were triangulated in order to compliment each other as each method has strengths and weakness in data collection.

3.3.1 Questionnaires

The questionnaires were used for collecting the household socioeconomic data and information on available resources such as human, forest, livestock, water, crops and infrastructure services. Household head whether father or mother or any member of the household who was above 18 years old was asked questions from a structured questionnaire by the researcher/research assistant who filled in the answers. These socioeconomic data helped in understanding the influence of population increase on the utilization and management of land resources over time and space. This technique was used because it has the ability to gather data beyond the physical boundary of an observed space (Hay, 2005). Both open-ended and closed ended questionnaires were used.

3.3.2 Focus Group Discussions

Focus group discussions were held with five groups of seven respondents each. A group of village leaders provide general information on land ownership and use and influential people provided information on the people's perception regarding TEKS and MEKS. Composition of other groups included a cross section of land users (both men and women on the basis of nature of the activity, type of management, right of access to and ownership). Selection of participants in the latter category was done purposively using a snowball approach. This technique helped to test the information acquired through questionnaires and information gathered from village leaders and influential people. The knowledge from several people on land use by estimated assessment on specific subject matter was gathered through this technique.

3.3.3 Field Observation

This technique assisted in gaining on the spot information about TEKS and MEKS in relation to socio-economic activities, policy implications and cultural perceptions towards land resources and land use patterns. Field observation also included photographing to provide pictorial evidence of land use in the study area. Field observation increased reliability and validity of the data collected through questionnaire and focus group discussions.

3.4 Data Analysis and Presentation

3.4.1 Quantitative Data Analysis

Microsoft Excel Programme was used to analyze descriptive statistics (respondents' characteristics and socioeconomic activities). However, SPSS was used to analyze quantitative data to derive frequencies and relationships between independent variables (farm implements) and dependent variable (household yields).

3.4.2 Qualitative Data Analysis

Hay (2005) argued that, qualitative data analysis is "intellectual art of decision making in a logical sequences of ideas". It involves the organizing, compiling, interpreting, and primary analysis of data with the community members to enable discussion and agree upon the existing situations of their land use and the respective responses. Content analysis was done by the researchers after the field visits to describe and explain the meaning attached to information given by the village leaders, influential people and household members.

3.5 Limitation of the Study

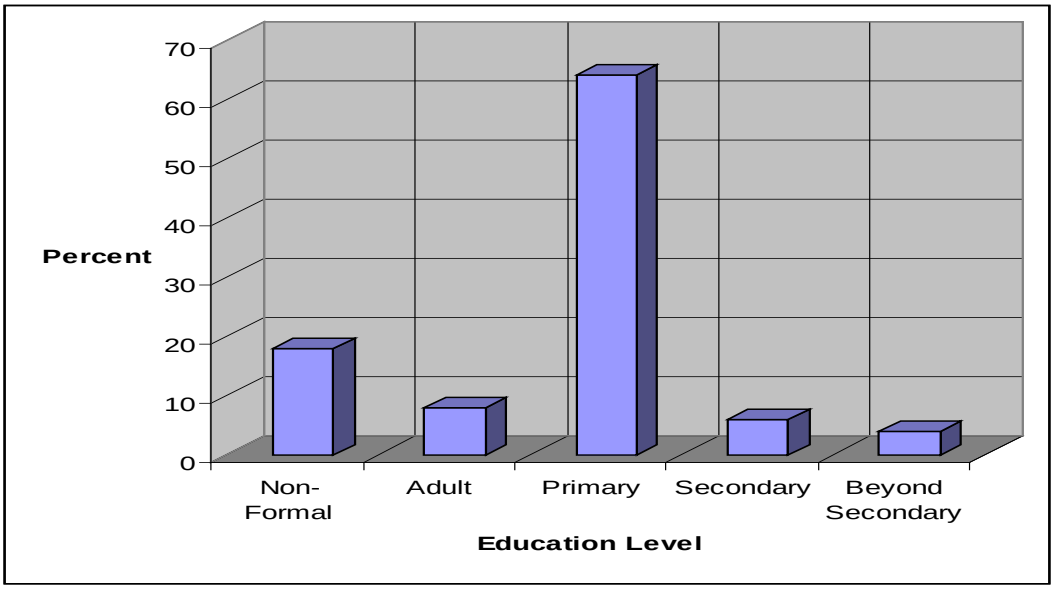
At the beginning of the study it was anticipated that people's interpretation of the motive of the research could be tainted by the fact that Karatu District is a politically sensitive district in Tanzania as most of the members of the district council are from the opposition party. Any questions concerning the people's welfare is likely to be interpreted differently by different stakeholders due to the existing political situations. However, no problem related to this was encountered in the course of conducting the study.

4.0 FINDINGS AND DISCUSSIONS

4.1 General Characteristics of Respondents

Knowledge in any society is embedded in human resource mostly in terms of quantity and quality of population. Quantity is measured in terms of number of persons while quality is mostly measured in terms of education level and health status. As shown in Figure 1, most (64%) respondents had primary education followed by 6% with secondary education, 4% beyond secondary education, adult education 8%, and non-formal education 18% (most of them belonged to the age category of above 50 years). Ninety one (91) percent of the respondents were mainly engaged in farming or farm related activities. The rest of the respondents were either employees (4%), petty businesspersons (3%) and 2% engaged in construction activities. These findings imply that, the majority of the respondents integrate TEKS and MEKS as they learn by doing from families and as taught in schools respectively. However it is worth noting that traditional knowledge acquired from families and communities is not standardized nor documented. Respondents relied on memories and estimation of measures, for instance use of ash for preservation of cereals and beans but no exact proportions of ash to preserved crops was given measure or standard. This indicated that apart from identification of knowledge, it is important to set standard measures and to document them.

Figure 2: Education Level



Source: Field Survey (2012).

Upper Kitete Village has a population of 3,851; 1,984 men and 1,867 females. The majority of the population belonged to age category of 18-60, followed by 6-17 and under 5 age categories respectively. The village had only 27 civil servants (See Table 1 for details). These implies that majority of the people are the labour force and users of TEKS and MEKS. During the household interviews it was noted that old people who were 50 years and above were more conversant in explaining how TEKS works and those who were 40 years and below tended to use MEKS more than TEKS. Evidence from these findings indicated that TEKS and MEKS are integrated but the degree of integration was strongly influenced by level of education and age.

Table 1: Village Statistics: Upper-Kitete Village: Population

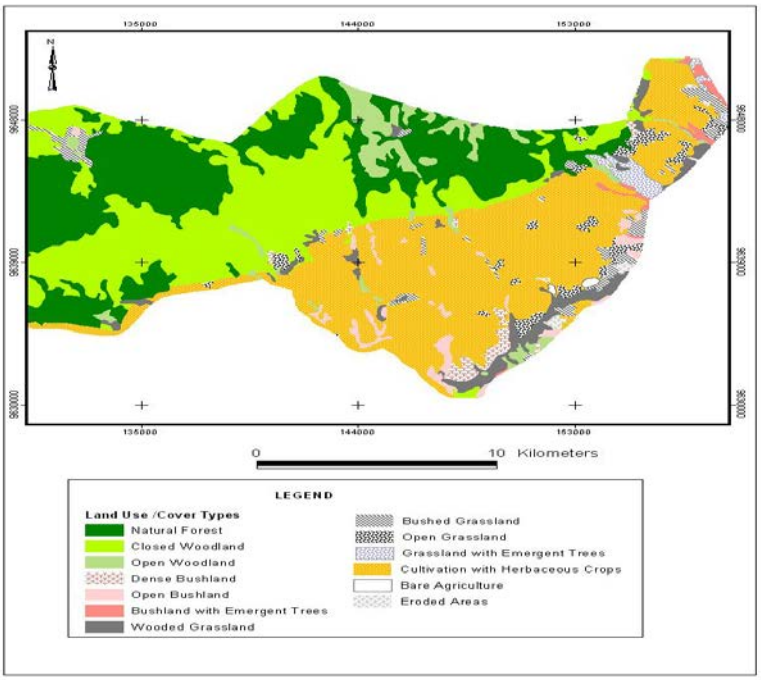
Ward	Household	Children 0-5 years		Children 6-17 years		Adults 18-60 years		Adults Above 60 years		Disabled		Civil Servants		Subtotal		Total
		M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Tloma	82	49	56	75	84	137	109	5	7	2	1	4	0	266	256	522
Sabasaba	45	44	41	66	68	66	70	7	11	1	2	0	0	183	190	373
Antsi	85	66	63	100	94	136	118	23	26	4	0	2	0	326	300	626
Bonde la Faru	70	64	57	96	87	100	104	6	5	0	3	3	2	266	253	519
Juu	83	48	47	70	64	266	116	15	12	1	0	0	0	259	239	498
Qanqari	125	79	80	119	117	156	142	21	24	12	6	7	0	375	363	738
Kati	103	60	53	100	80	129	114	14	14	4	2	7	2	309	266	575
Jumla	**595**	**417**	**396**	**626**	**594**	**850**	**773**	**91**	**104**	**24**	**14**	**23**	**4**	**1,984**	**1,867**	**3,851**

Sources: Upper-Kitete Village Records (2012)

4.2 Land Use Types

Land use in Upper Kitete Village is highly diverse, reflecting the variety of soils, slopes and natural micro-environments as also noted by Rhode and Hilhorst (2001). The most common land use patterns are settlement, forest, woodland, bush land, grassland, and cultivated land as shown in Map 1. The area has a good rainfall (an average of more than 800mm annually) and fertile volcanic soils; thus if well managed, is good for both cultivation and livestock keeping (See Map 1).

Map 1: Land Use/Cover Types in Upper-Kitete Village



Source: Interpreted from Satellite Images Downloaded from http://glovis.usgs.gov (2009).

4.3 TEKS and MEKS on Arable and Pasture Land

4.3.1 TEKS and MEKS on Arable Land

People's capacity to organize themselves for managing the land resource is founded on their knowledge of TEKS. According to Iraqw traditions, the first man to occupy a new land and build a house is known, as *kahamusmo* and becomes the owner of the land. He has the authority to allocate land to those who follow. According to focus group discussions, the owner of the land settles land disputes and punishes those who are found guilty. Therefore, the Iraqw security of tenure depended on the leadership qualities of the *kahamusmo.* There is a strict adherence to these procedures of land allocation and arbitration or fines in case of conflicts. However, in the study area allocation of land was done through village government who has the

authority over land management system. This village started with 100 households as a pilot study area for use of MEKS under Ujamaa Village System. Each household was allocated six acres. Land was classified according to its best use in terms of its characteristics (vegetation type, soils, terrain). The community continued to apply TEKS and also used MEKS in using land but not in its management.

The agricultural fields in the study area are found in patches according to village land use guidelines. According to the focus group discussions, the average farm size in the Village was 3.5 acres per household in 1963 to 1980 (See Table 2). It was noted in the discussions that as population increased over the years, land was further distributed to young married males. Thus the land formerly distributed to the household in 1963 decreased to 0.7acres per household in 2012. However, in some cases the households had more than 6 acres, this is because of land renting practice whereby an individual can cultivate land belonging to another person or/and a land owned by the village at a minimum fee of Tanzanian Shillings 30,000/= per acre per year. As it was noted during the focus group discussions, the village had set aside 75 acres for renting to interested individuals but an individual can rent up to five acres only from the village land. The decrease of household farm size implies the intensification of agricultural activities so as to improve the productivity per acre. The nature of farm size and farm inputs (implements) used by households is another evidence of TEKS and MEKS integration in the area.

Table 2: Farm Size and Knowledge Applied

Knowledge Applied	Period	Farm Size in Acre	
		Range	Average
TEK	Before 1963	0.3 – 0.5	0.4
MEK	1963-1980	1- 6	3.5
TEK and MEK	1981 - 2012	0.6 - 0.8	0.7

Source: Field Survey (2012).

Traditional (such as wooden hand hoe, a thick piece of wood known as *duqsay* for clearing bush) and modified traditional tools (hand hoe, bush knife and ox-plough) were used in preparation of land for farming in areas where modern machines cannot be effectively used, especially along the slopes and hilly rocks (See Figure 3). The Iraqw community manufactures farm tools to improve their production and productivity. All the interviewed respondents reported that they use traditional farm implements such as hand tools in farm preparation (35%), planting (80%), weeding (98%) and harvesting (75%) because of the nature of the landscape.

Figure 3: Integration of TEKS and MEKS in Land Tillage

Source: Field Survey (2009)

Traditionally the Iraqw people have their own knowledge of selecting seeds to be planted next season. Maize, beans, wheat and pigeon peas were the main staple and cash crops while millet and sorghum are used for making local brew and back-up food crops in cases of drought. The seed selection is done mostly by the elders (mother or the father or grand parents) soon after harvesting period. They select the seeds that have performed well in the past season. Factors considered in seed selection include germination efficiency, productivity and attributes such as taste, resistance to pests and tolerance to weather uncertainties. The study observed that TEKS and MEKS are integrated at different levels of crop production from land preparation to storage and use of harvested crops. Crops grown are maize, beans, wheat, pigeon peas, millet, finger millet, sorghum, pumpkins, sweet potatoes and barley. Traditionally maize, beans, pigeon peas, pumpkins and bananas, are intercropped as a strategy for sustaining soil fertility. In addition, intercropping of crops is used as a survival strategy to minimize effects of severe drought. In areas where drought is more likely to occur (lowland areas) it is common to find intercropping of maize, beans, pigeon peas, sun flower and pumpkins. Sunflower and pigeon peas are drought resistant crops. Traditional tools and equipment were both used for various activities relating to agriculture. Some of the modern implements and tools include farming machinery, processing machinery and transportation machinery (See Table 3).

Table 3: Modern Equipment by Ward

Ward	Tractor	Milling Machines	Lories
Tloma	-	-	-
Sabasaba	1	1	-
Antsi	9	2	3
Bonde la Faru	7	-	-
Juu	-	1	-
Qanqari	8	1	-
Kati	3	2	-
Total	**32**	**10**	**5**

Source: Field Survey (2012)

Traditionally, people used contours planted with sweet potatoes or covered with maize stalks to control soil erosion. According to focus group discussions, it was noted that the introduction of modern technology led to planting of fodder grasses on ridges to replace contours planted with sweet potatoes and use of maize stalks to make contours to control soil erosion as shown in Figure 5.

Figure 5: Elephant Grass Grown on the Contour Lines in Between the Fields

Source: Field Survey (2009)

Apart from controlling soil erosion, villagers also practice intercropping of crops to sustain soil fertility. Normally leguminous and non-leguminous plants are intercropped (mostly beans and maize). Other crops intercropped include pigeon peas, bananas, sugar cane, pumpkins and sorghum. However, beans grown in November/December are normally not intercropped because the same farms are used for growing barley and wheat in February/March (See Figure 6).

Figure 6: Beans grown in November/December (2009)

Source: Field Survey (2009)

The harvested crops especially maize and beans are stored for future use because they are less perishable and can be preserved by using local technologies. According to focus group discussions these crops are stored in two ways: on cobs or when shelled. For instance cobs of maize are stored outside on trees or inside on wooden scaffolds suspended from the ceiling over the cooking fire. The smoke and heat from the fire below repels the weevils. The shelled grains are normally kept in a clean locally built container through use of wet cow dung known as *kunti*. Then the shelled grain stored in *kunti* is mixed with sand, burned animal dung, and ashes; all contribute to reducing insect damage to stored grain. Sand occupies air spaces between grains, excludes air, and suffocates grain weevils. It also scratches their skins and this causes dehydration and eventual death, especially if the grain is very dry. This system has been used over years and has proved effective in preserving crops. Insects are killed and rodents excluded without using any other chemical substances. However, farmers are increasingly using bags instead of *kunti* for storing grains and beans for convenience of transportation and insecticides for convenience of use by those who can afford to buy them.

According to agricultural plan document for Karatu District for the 2005-2010, a target for maize yields is 900 kg per acre while the output by using TEKS, MEKS and integrating TEKS and MEKS was 700 kg/acre, 1,250 kg/acre, and 800 kg/acre respectively. This implies that application of MEKS results in higher farm yields than integration of TEKS and MEKS and lower when only TEKS is applied. This pattern also applies to beans and wheat (See Table 4). Integration of TEKS and MEKS was noted among the majority of respondents. This implies that integration of the two systems, if well done, could help in reducing poverty for the majority because the yields, though very far from those of MEKS, are close to the District's optimum yield per acre. It is also worth noting that apart from the cost factor, application of MEKS is

constrained in some areas by the size of farm (owned or rented) and the landscape. Use of modern farming implements is uneconomical on small plots and inapplicable on steep slopes.

Table 4: Farm Yield per Acre

Knowledge Applied	Maize Kg/Acre		Beans Kg/Acre		Wheat Kg/Acre	
	Range	Mean	Range	Mean	Range	Mean
TEKS	600-800	700	200-300	250	700-800	750
MEKS	1000-1500	1250	500-600	550	800-1000	900
Both TEKS & MEKS	700-900	800	300-400	350	800-900	850
District's Optimum Yield per Acre	800-1000	900	400-500	450	900-1100	1000

Source: Field Survey 2012

4.3.2 TEKS and MEKS on Pastureland

According to the focus group discussions, the study area pastureland is identified according to landforms, topographic location, soils and the vegetation type in relation to land units, such as interfluves, mid-slopes, and the valley bottoms. The work of identifying pastureland is done traditionally by the group of old wise men known as *barisersagaloen* aged between 46-64 years who have been trained since their youth by the former *barisersagaloen.* According to focus group discussions with the *barisersagaloen* there are four types of grazing lands and these are: hill grazing land traditionally known as *tlomma.* This is the land specified for distant grazing during the afternoon and it is communally owned. The major dominant trees species on the hills are traditionally known as *narrey* or shrubs especially *solanum* species and *brackens* (*Pteridium acquilibrium*) (See Figure 7).

Figure 7: Community Grazing Land

Source: Field Survey (2009)

Interfluve grazing land traditionally known as *dindirmo*, is the area nearby homesteads. Each household owns an area less than 0.5ha for grazing near homestead for grazing. This is traditionally known as *hindiwi.* The grazing near homesteads is normally done during the morning. This is also a grazing land for the weak and lactating animals. Mid-slopes grazing land traditionally known as *geay* (area along the mid-slopes ranging from 4^0-8^0 are left uncultivated for grazing purposes) is owned communally. Valley bottom grazing land traditionally known as *khatsa*, is where livestock get water. After having water they spend few hours resting. The *khatsa* is divided into three parts: area where cattle rest after drinking water; protected wetlands for collecting grasses for livestock and thatching houses; and fields for dry season cultivation.

Seventy (70) percent of the respondents practice rotational grazing (to allow regeneration of plants and grasses) and fencing of pastures in some area to put those areas under quarantine for certain purposes such as diseases and ticks control and recently for village income generation. People in need of livestock feed cut grass from the protected area at an agreed upon price. The most known grass species include, *heteropogon species*, traditionally known as *harri,* which regenerates naturally from seeds. The traditional livestock extension officers known as *deemusersagaloen* determine and estimate the carrying capacity of pasturelands according to the seasonal use of the different pastures, variable rainfall between the years (and thus variable availability of pastures), the importance of available trees and shrubs fodder as well as the water availability in the area. Crop residues are not included in the carrying capacity estimates as they are used as supplement feed to weak animals and lactating or pregnant cows. The carrying capacity of a grazing area is a measure of the land's potential to support livestock.

In pastureland as in the case of arable land, there is an interaction of TEKS and MEKS in conservation and management of the pastureland resources. This interaction has been seen in new species of fodder, introduction of the dairy cows, and the caring for the livestock and pastures. Leaves and stems from the banana plant are said to be most important fodder. This is the new plant grown on contour lines in-between the fields, where also other plants, for example elephant (*Pennisetum purpreum*) and Guatemala (*Tripsacum laxum*) grasses are grown to provide cattle fodder.

All the seven wards keep livestock. This was noted from the village records, responses from the respondents and field observation. The details of the various livestock kept are given in Table 5.

Table 5: Livestock Statistics

Ward	Dairy cattle	Traditional livestock	Traditional Goats	Sheep	Donkeys	Pigs	Dogs	Cats	Chicken	Ducks
Tloma	6	201	222	88	9	0	30	33	285	0
Sabasaba	0	247	528	95	44	0	32	28	321	0
Antsi	10	160	141	30	13	4	28	28	221	8
Bonde la Faru	8	191	240	27	20	0	44	28	275	0
Juu	0	205	382	57	21	0	31	26	312	0
Qanqari	8	182	342	79	12	0	56	35	299	0
Kati	6	160	317	65	0	0	31	15	505	12
Total	**38**	**1,346**	**2,154**	**441**	**119**	**4**	**252**	**193**	**2,218**	**20**

Source: Upper-Kitete Village Records (2009).

The breakdown of livestock types in Table 5 indicates that Upper-Kitete Village practices both traditional and modern livestock keeping, with more inclination to traditional practices (1,346 traditional livestock as compared to 38 dairy cattle). It is worth noting that presence of ticks and tse-tse fly in the area hampers keeping of dairy cattle. MEKS is very costly, thus not affordable to most of the households. In addition poor infrastructure also constrains sell of products outside the village (most villagers have livestock for domestic use, thus internal market is constrained).

The dairy cattle are fed on the collected fodder at the homestead especially during the dry season (See Figure 8a). The elephant and Guatemala grasses were introduced by the British, but growing on the contour-lines was an established practice. The introduction of crossbreed and exotic cattle in the village is a means of intensifying animal production, controlling animal numbers, and their mobility, and consequently improving the environment (See Figure 8b). The local and modern way of taking care of livestock was also observed in the study area.

Figure 8a: Dairy Cattle Feeding in the Shed

Source: Field Survey (2009).

Figure 8b: Both Dairy and Traditional Cattle Feeding Outside the Homestead

Source: Field Survey (2009).

According to the focus group discussion the community depends significantly on their livestock for getting money to meet their daily expenses and also for food (milk and meat). Livestock is also treated as a traditional form of capital for most economic transactions such as purchase of food, clothing, medicines and schooling and insurance/security against drought and plant diseases as well as cultural functions such as rituals and marriage. According to the household interviews, 80% of the respondents depend on livestock for food, manure, and income from livestock keeping, while 20% for food, manure, income, dowry, and prestige. 63% of the respondents who apply TEKS get less than two litres of milk per day per cow. 30% integrated TEKS and MEKS in livestock keeping. These get 1.5 to 6 litres of milk per day per cow depending on the knowledge applied. However, the yield of milk per

cattle is far below the District optimum yield (See Table 6). As in the case of agricultural output, integration of TEKS and MEKS was noted among the majority of respondents. This implies that integration of the two systems, if well done, could help in reducing poverty for the majority because, in addition to milk, they get manure which they use in their farms.

Table 6: Milk Yield per Cow in Litres

Knowledge Applied	Zebu (traditional)		Cross-bred		Exotic Cattle	
	Range	Mean	Range	Mean	Range	Mean
TEKS	0.5-1	0.75	1-2	1.5	3-4	3.5
MEKS	1-2	1.5	2-4	3	4-6	5
Both TEKS & MEKS	1-2	1.5	1-3	2	5-7	6
District's Optimum Yield	2-4	3	4-6	5	10-20	15

Source: Field Survey (2012)

4.4 Synthesis of TEKS and MEKS Integration on Arable and Pasture Land Utilization and Management

In their efforts to assert control and direction over their lives and to safeguard their social structures, Africa's rural people have traditionally utilized the knowledge, skills, and tools that their societies have developed in the course of centuries. TEKS is an important aspect of a society's culture. According to Dewes (1993) traditional knowledge is characterized as the sum of experience and knowledge within a given group, which forms the basis for decision-making related to familiar and unfamiliar challenges. Experiences are the challenges of an individual, group, community or society which drive TEKS at a particular moment in time.

Rugumamu (2002) observed that conservation and management technologies in the community are aimed at preserving natural resources for future production of goods and services and is essential for survival of certain groups of people over a given time and space. In the study area, the community has traditional ways of classifying land use depending on the nature of the landscape in terms of slope angle, aspect and length. As noted by Sikina (1994), in the northern province of Zambia, the rural farmers have their own ways of identifying local soil and land types for agricultural uses. The main criteria used by farmers to classify soils were colour of the top soil layer, texture, consistency, and organic matter content. The same criteria were also observed in Upper Kitete Village. For example, black soils are considered to be soils rich in organic matter, and are often found in valley bottoms and farmers normally plant maize and beans. These are the staple food.

Traditional ways of conserving fertility and productivity of soil practised by the community include manure application in all farming system, which are collected and processed in different ways. As noted by Tengo and Andersson (2000), to maintain soil productivity on permanent fields, it is necessary to compensate for the loss of nutrients gained by the crop and lost through leaches by a constant input. The importance of livestock as manure producers is well recognized by the farmers of Upper-Kitete Village and this is said to be one of the main reasons for keeping cattle.

Also, after harvesting the crops, weeds and maize stalks are cut and spread as mulch or buried in the soil during farm preparation for subsequent planting season. This traditional practice returns nutrients to the soils. 80% of the respondents who were agropastoralists reported to use manure. However, it was noted that those who had more than three acres also used artificial fertilizers to augment manure.

As Smaling and Braun (1996), noted elsewhere beans rotated with cereals out-yield inter-cropping practices. Nitrogen fixation by beans provides nutrient soil input. This is also supported by the results in the study area whereby beans are used as the most common nitrogen fixation crop. Through the use of beans in inter-cropping and crop rotation systems, an input of nitrogen is therefore, automated in the fields. As noted by Tengo (1999), wild nitrogen fixating plants, such as *Fabaceae species*. are found on fallow and in the grazing areas. Nitrogen fixation is one of the processes that restore nitrogen to the arable land during a fallow period and to pasture land.

The crop fields in the study area are found at different land units, with different slope degrees, length and aspect. The traditional land classification which has been conducted over years revealed that different land units with different land uses or same use require different land management systems. FAO (1983) notes that management practices on different areas within one land utilization type are not necessarily the same. For example, land utilization type may consist of mixed farming with part of the land under arable use and part allocated to grazing. Such differences may arise from variation in the land, requirements in land use type, from requirements of the management system or all of them. This concept was supported by the results in the study area whereby fields were prepared and organized differently in accordance with the cropping patterns in different land units with different traditional land management systems.

The TEKS-MEKS interface was demonstrated by 28% of the interviewees who cultivated modern seeds supplied by Farm Africa, an NGO working with rural people in Karatu District via Village Government. The improved seeds include maize, H 622/32 (Kilima), SEEDCO 403 or 513 and beans 85/90 (Lyamungu). These interviewees used traditional fertilizers and pesticides and also used hand-hoe for cultivating land.

As also observed by Rugumamu (2003) in semi-arid areas of Tanzania and Hambati and Rugumamu (2005) in Northern Tanzania, traditional pastoralism depends heavily on rotational grazing between different land units to take advantage of fluctuations in the availability and quality of forage and water. This is also supported by the results in the study area whereby the traditional rotational grazing system is a coping mechanism aimed at ticks control and fallowing to allow for leaves and twigs to decompose and fertilise the land. The findings are also echoed by Tengo and Andersson (2000) in Hanang.

Further the study revealed that, there are no reliable veterinary services in the village, hence more dependence on the traditional veterinary attendants. This implies that the traditional livestock healthcare is a dominant system in the village and the livestock practices have lead to the capability of the ecosystem to sustain the present livestock population within the village pastureland resource base. As Ellies and Swift (1988) observed, a pastoralist has detailed knowledge of animals, their characteristics, diseases, and vectors. Tengo and Andersson, (2000) noted that over the years the Iraqw community has developed effective ways of ensuring that this knowledge is used for sustainable utilization of environmental resources. The same situation has been observed by Loiske (1995), in Gitting village in Hanang District and Rugumamu (2003) in Busongo and Makomero villages in Shinyanga region.

TEKS practices as observed by Rugumamu (2003) have conserved and managed several species on the forestland in the proximity, especially those that anthropogenic forces easily affected their germination or growth. Upper Kitete Village community for years has been observing the dynamics of the forest growth and regeneration using TEKS. As observed by Mark et al. (1992), in Indian rural communities the community protects the forest through their beliefs as the source of rainfall and water in the villages. Mbuta (2001) also observed the similar case in Mangula village. This is also supported by the results in the study area where there is a strong belief that, trees should remain as natural as possible as a place where their gods rest and give blessings.

Policies in any community greatly influence the form of land resources use and conservation. Land resources management in rural areas is the concern of many sectoral policies. Officially, land in Tanzania is owned by the state, but in practical sense it is privately owned (Ellis, 1988). Customary laws of land tenure are still propagated in most parts of Tanzania (Shivji, 1998). This influences resource management practices depending on the interest, applicability to community and acceptance with regards to effectiveness. The same case was observed in the study area.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The findings of the study show that traditional societies have knowledge of their land resources. They know their needs, values, as well as threats and possible alternative solutions. The Upper-Kitete Village community has traditional systems of land classification and good understanding of the effects of land use on agro-biodiversity. Their landscape assessments are used as indicators for verifying their knowledge against modern knowledge on land resources management. The findings of the study show that involvement of local people in resources inventorying in the arable and pasture land resources is critical for conservation of land resources over time and space. This is due to the fact that the local people have culturally in-built knowledge, which has been historically accumulated, and used for survival and sustainable land resources utilization in the village ecosystems. However, the local community failed to implement MEKS because it was too capital intensive, thus not affordable to most of the community members. For those who had reasonable size of land MEKS was used for cultivation and harvesting. TEKS and MEKS were integrated in other processes at various levels. In areas that were either too small or on slopes MEKS was inapplicable in cultivating land. TEKS and MEKS are integrated in other process.

Interaction of TEKS and MEKS in this era of globalization is inevitable. Success in development through use of land resources is likely to be achieved when local people are involved in the planning and implementation of development projects and programmes. The concerns should reflect the needs and aspiration of the stakeholders as well as those of the land resources base. Land uses in most rural areas are complementary or even competitive and conflicting. Therefore, the inventory of locally driven solutions to complex issues on land resource conservation and management is very important in getting the desired results in developing countries that lack capital investment.

There is evidence that, the Upper-Kitete Village community is ready to adopt new technologies and evaluate them scientifically before being put into practice as reflected by use of both TEKS and MEKS. Land size, landscape and cost factors also played a significant role in determining efficiency and effectiveness of system to be applied (integration of TEKS and MEKS and appropriate application of one system or integration of the two determines level of agricultural productivity). Findings of the study indicated that more efforts are required in documenting TEKS to facilitate identification of compatible strategies for integrating the two. It is recommended that development of information management system (at policy level) that takes on board globalization pressures with respect to land and land use conservation and management is critical for sustainable human development. Documentation of knowledge needs to go through three levels: identification of TEKS, setting standards to its application, and disseminating information to a wider community. Integration of TEKS and MEKS also needs to follow a similar process.

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