

LIVELIHOOD ZONES ANALYSIS

A tool for planning agricultural water management investments

Tanzania



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About this report

The AgWater Solutions Project aimed at designing agricultural water management (AWM) strategies for smallholder farmers in sub-Saharan Africa and in India. The project was managed by the International Water Management Institute (IWMI) and operated jointly with the Food and Agriculture Organization of the United Nations (FAO), International Food Policy Research Institute (IFPRI), the Stockholm Environmental Institute (SEI) and International Development Enterprise (IDE). It was implemented in Burkina Faso, Ethiopia, Ghana, Tanzania, Zambia and in the States of Madhya Pradesh and West Bengal in India.

Several studies have highlighted the potential of AWM for poverty alleviation. In practice, however, adoption rates of AWM solutions remain low, and where adoption has taken place locally, programmes aimed at disseminating these solutions often remain a challenge. The overall goal of the project was to stimulate and support successful pro-poor, gender-equitable AWM investments, policies and implementation strategies through concrete, evidence-based knowledge and decision-making tools.

The project has examined AWM interventions at the farm, community, watershed, and national levels. It has analyzed opportunities and constraints of a number of small-scale AWM interventions in several pilot research sites across the different project countries, and assessed their potential in different agro-climatic, socio-economic and political contexts.

This report was prepared as part of the efforts to assess the potential for AWM solutions at national level. The livelihood zones analysis divides the country in a series of areas where rural people share relatively homogeneous living conditions on the basis of a combination of biophysical and socio-economic determinants. It describes the main sources of livelihood of rural populations (by category of people), their natural resources base, potential and key constraints to development. It analyses the relation between people and water and helps understanding to what extent and how water can be a factor for development.

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Abbreviations and acronyms

AWM	Agriculture Water Management
BMGF	Bill and Melinda Gates Foundation
DRC	Democratic Republic of Congo
ECF	East Coast Fever (Theileriosis, a tick-borne disease of cattle and goats)
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical information systems
iDE	An NGO creates income and livelihood opportunities for poor rural households
IFPRI	International Food Policy Research Institute
IRA	Institute of Resource Assessment
IWMI	International Water Management Institute
Miombo	Species-rich tropical savannah ecosystem
NAFCO	National Agriculture and Food Corporation
NGO	Non-governmental organization
PADEP	Participatory Agricultural Development and Empowerment Project (Ministry of Agriculture and Food Security; Tanzania)
PMD	Pasteurella multocida disease
SEI	Stockholm Environmental Institute
SSA	Sub-Saharan Africa
WMA	Wildlife Management Areas
WUA	Water user association

EXECUTIVE SUMMARY

The livelihoods of the majority of communities living in the rural areas of Tanzania depend on agriculture production where a wide range of both annual and perennial food and cash crops predominate. Livestock and crop production continue to dominate the national economy through export of agricultural commodities and products, in particular cashews, coffee, tea, pyrethrum, tobacco, sisal, cocoa and staple food crops.

Agriculture is mainly rainfed and production is currently threatened by several factors including climate change and variability as well as progressive land degradation associated with human-induced activities. This poses a serious challenge to agricultural, irrigation and water sectors, which requires specific interventions to increase and sustain productivity.

The livelihood mapping approach intends to address some of these agricultural challenges, including lack of water for crop production in support of rainfed agriculture. The report presents findings on mapping livelihood zones in Tanzania focusing on the potential for developing agriculture in Tanzania. A total of 14 livelihood zones were identified and characterized accordingly using existing secondary data.

An attempt has been made to identify and assess the potentiality of poverty alleviation through agricultural water management (AWM) in different zones. Promising AWM solutions in different zones have been analysed.

1. BACKGROUND

1.1 About the project

The Bill and Melinda Gates Foundation funded a project to help design agricultural water management strategies for smallholder farmers in sub-Saharan Africa and in India. The project was managed by the International Water Management Institute (IWMI) and jointly operated by IWMI, the Food and Agriculture Organization of the United Nations (FAO), International Food Policy Research Institute (IFPRI), the Stockholm Environmental Institute (SEI) and (IDE), a non-governmental organization (NGO) specialized in small-scale water technologies. This project was implemented in Burkina Faso, Ethiopia, Ghana, Tanzania, Zambia and India.

The overall goal of the project was to stimulate and support successful pro-poor, gender-equitable agricultural water management (AWM) investment, policy and implementation strategies through concrete, evidence-based knowledge and decision-making tools. Several large-scale studies carried out by the project team and others have highlighted the potential of AWM for poverty alleviation. In practice, however, adoption rates of AWM solutions remain low. Moreover, even where adoption has taken place locally, implementing programmes promoting adoption at a large scale, in a sustainable manner, and that targeting the poorest people, including women, is still a challenge. Understanding the constraints to AWM adoption in different settings and concrete measures to overcoming them open significant opportunities for successfully achieving pro-poor, gender-equitable AWM investments in the future.

The project examines agricultural water management interventions at the farm, community, watershed, and national levels in selected countries in sub-Saharan Africa and India. The project assessed opportunities and constraints of a number of small-scale AWM interventions in several pilot research sites across the different project countries. The project also assessed promising agricultural water management interventions and their potential in different agro-climatic, socio-economic and political contexts, and recommended out-scaling strategies. The results were presented in country level investment guides for selected countries.

1.2 Country-level livelihood analysis and mapping in Tanzania

The analysis is the basis for the out-scaling strategy of the most promising AWM solutions at country level. The objective of the analysis is to describe the socio-economic and biophysical context where AWM related activities are in place and, more specifically, to define linkages between water, rural poverty and livelihoods, and how access to agricultural water is directly related to rural livelihoods.

To this end, the expert stakeholders' workshop was to specifically map out and describe rural livelihoods, and to assess the potential for poverty reduction through AWM solutions out-scaling of promising interventions options at the national scale. More specifically the project:

- described and located the contexts where agriculture is practiced and AWM interventions are in place;
- assessed the potential for poverty reduction through AWM solutions; and
- assessed the relevance and potential of promising AWM solutions at the country level according to the different livelihood contexts.

2. NATIONAL EXPERT CONSULTATION WORKSHOP ON LIVELIHOOD

MAPPING

FAO and IRA organized a one-day national consultation workshop that gathered national experts from different fields (agriculture, social sciences, geography, etc.) and institutions (see workshop report). The main purpose of the consultation was to conduct a participatory mapping process to identify, locate and

describe the main livelihood patterns in Tanzania and discuss the relevance of AWM in relation to rural livelihoods. Because of the time constraint of a one-day workshop participants did not manage to address relevant AWM after identifying the livelihood zones.

More specifically the national stockholder's consultation aimed to:

1. Prepare a national map locating main livelihood zones of Tanzania with legend and criteria achieved by:
 - delineating the boundaries of the main zones;
 - describing the main characteristics of each zone (agro-climatic conditions, cropping patterns, livestock, population and gender, water, etc.) by three working groups.
2. Identify the main criteria for defining the potential of AWM interventions to contribute to poverty reduction by:
 - discussing criteria for identifying areas where AWM interventions have highest impact on rural livelihoods and can contribute the most to poverty reduction.
3. Assess the relevance of the most promising AWM solutions in the different livelihood zones.

3. METHODOLOGY USED IN CONSULTATIONS

3.1 Development of Tanzania livelihood zones

To develop livelihood zones, a total of 17 experts from different sector ministries, academic principles from Dar es Salaam and Sokoine Universities, from national and international NGOs and others with experience with water resource management and agriculture were divided into three groups, which produced livelihood maps and descriptions. See Tables 1 to 3 in Annex 1.

During the expert's consultation, the main biophysical and socio-economic variables were mapped using geographical information systems (GIS), which were the basis for interaction between the experts. The maps of Tanzania at different scales included:

- agro-ecological map
- land cover patterns
- climate zone map
- topography map
- principle crop production maps for maize, cassava and rice
- cattle/livestock
- access to markets
- rural population density map
- water infrastructure
- groundwater levels

3.2 Collection of relevant information for each of the livelihood zones

Detailed information that described both biophysical and social economic profiles of the livelihood zones identified were initially collected from existing studies and from regional social economic profile reports (latest versions). The collected information was updated from the agricultural survey reports of 2003. Different research reports and papers were used to provide relevant information required per zones. It should be noted that the zones do not follow administrative boundaries, rather information from a region or district that suited a particular zone was used for reporting. There is on-going updating of information.

3.3 Initial identification of promising agriculture water management

Based on the experts' experience concerning water sources and management in Tanzania, and information obtained during the secondary data review of socio-economic profiles of zones indicating potential for irrigation and water management, the team was able to identify different AWM per zone by filling a template developed by FAO. The input of assessed AWM was based on the on-going AWM mapping project, implemented by the soil and water management group of Sokoine University. The information provided will be further discussed by a wide-range of stakeholders.

4. FINAL OUTPUT BASED ON THE WORKSHOP

The three groups' outputs were integrated into one map, which was then digitized (Figure 1). The exercise was particularly challenging because of the complexity of the livelihood patterns in Tanzania and the different views of the participants. Upon analysis of the three group maps, workshop participants, with their facilitators, designed a livelihood map with a total of 14 zones (Figure 1) that described the main characteristics of the different livelihood zones.

Figure 1 – Consolidated map of livelihood zones in Tanzania

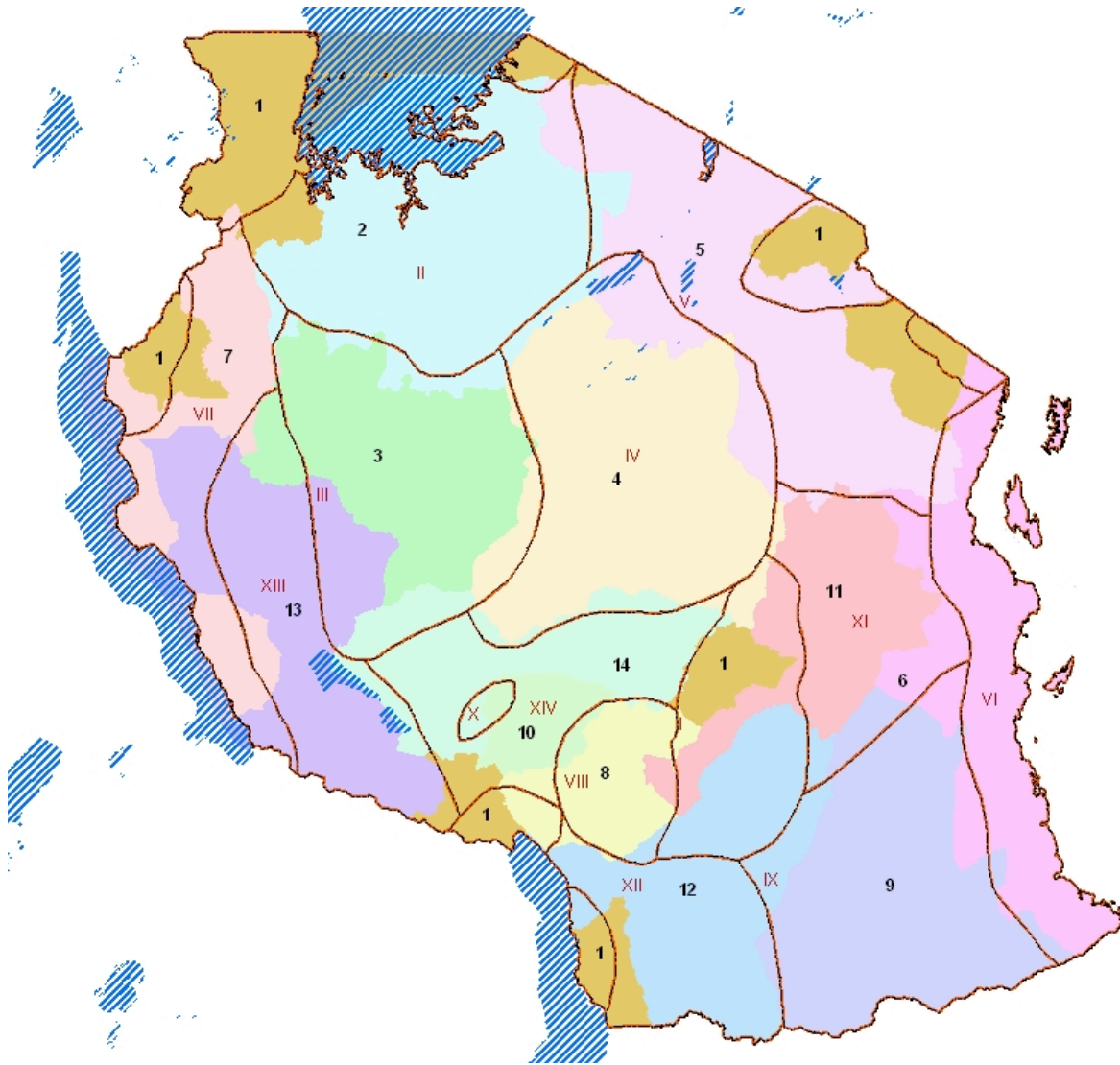


Table 1 – Final livelihood zones agreed by G1, G2 and G3

Livelihood zone (LZ)	Description	Similarities		
		G1	G2	G3
LZ 1	Highlands, humid, high rainfall, bi-modal coffee and banana zone	1, 3a	1, 5	1
LZ 2	Cotton, paddy and cattle midlands	2, 4	2	2
LZ 3	Tobacco-cotton zone	1, 3a	1, 5	1
LZ 4	Unimodal, semi-arid, sorghum-livestock zone	2	3	5
LZ 5	Pastoral zone	4	4	4
LZ 6	Coastal zone-tree crop (Cashew, coconut, fishing zone, spices, tourism)	1	6-9	9
LZ 7	Lake Tanganyika zone	2	9	10, 16
LZ 8	Plantation zone (tree, pyrethrum and tea)			12
LZ 9	Maize, cassava, cashew, Simsim zone	No significant similarities from the three groups. Agreed upon by workshop participants through dialogue and consensus		
LZ 10	Rice zone			13
LZ 11	Sisal, sugar cane and cattle	No significant similarities between the three groups. Agreed upon by workshop participants through dialogue and consensus		
LZ 12	Maize-tobacco zone			
LZ 13	Unimodal rainfall (Rice, maize, pulse, banana, tree, fishing, tourism, cotton, mining)		9	
LZ 14	Bimodal rainfall (Rice, maize, banana, fishing, tourism, Cotton, mining)		8	

5. LIVELIHOOD PROFILES

The team collected relevant information from the literature, i.e. books, research reports, consultancy reports, maps in order to come up with the livelihood profile for each livelihood zone. Collection of this information was particularly challenging as the livelihood zones do not necessarily represent the administrative boundaries, i.e. regions of Tanzania, and careful attention was exercised to write profiles appropriate for each livelihood zone. This section, therefore, presents a summary of the main biophysical and socio-economic characteristics of the 14 livelihood zones.

5.1 Livelihood Zone 1 (Coffee-banana humid highlands)

This covers the highlands of Kilimanjaro, Kagera and parts of Iringa region. It also includes Tukuyu, Tarime and Kasulu in Mbeya, Mara and Kigoma regions respectively. These areas are surrounded by mountainous forests and woodlands that form wet and dry Miombo woodlands. These highland areas have relatively fertile soils with good potential for growing different perennial and annual crops. The area receives high rainfall of over 1 250 mm/year and have a long growing period of between 250 and 300 days. Livelihoods are based on the sale of coffee, banana, tea, beans and maize crops as well as dairy cattle products, including milk. Some community members are employed on large coffee and tea estate farms. Traditional farmers make up 90 percent of farmers and the rest are commercial. This zone has a high population with a density of more than 150 people per km². Gender issues are characterized by male

dominance, whereby men own the cash crops and income from crop products. Accessibility to markets is good, taking 1-2 hours to reach the markets or less, and most roads are passable year round. Poverty is relatively low and the percentage of people living below the poverty line is around 31 percent.

These areas are blessed with near perfect climate, rainfall regime and soils. The major constraints affecting productivity include land scarcity, low soil fertility in coffee/banana complexes, declining yields, low technology and low producer prices. The importance of water for rural livelihoods is high, especially for irrigated agriculture and domestic consumption. Irrigation is not common but exceptionally high in Moshi rural and Hai districts in Kilimanjaro region. Irrigation infrastructure can be improved to make agricultural production possible year-round in most parts.

5.2 Livelihood zone 2 (cotton-paddy-cattle midlands)

This zone covers the midlands of Bukombe, Kahama, Maswa, Meatu, Bariadi, Sengerema, Geita, Magu, Kwimba, Misugwi districts. The landform is gently undulating plains covered with low, sparse vegetation. The rainfall pattern is medium, ranging from 700 to 1 200 mm/year with a crop growing period of between 200 and 250 days/year in inter-lacustrine areas. There is very low rainfall in the eastern parts of Shinyanga and Mwanza regions. Livelihoods are based on cotton, paddy, cattle and maize crops grown for sale and for food. Other sources include fishing, livestock keeping and mining activities, in particular gold, which is plentiful in the zone.

Employment on farms and in gold mines provides another source of income to a many communities within and outside the zone. Most communities are made up of traditional farmers comprising 90 percent of the population, which is very high, around 200 people per km². Gender is characterized by male dominance whereby men own cattle and income from the sale of crops.

Accessibility to markets is relatively good, mostly 2 hours to the market centres or less. Mostly, roads are earth and are somewhat difficult to travel on during the rainy season. Poverty is relatively high with nearly 45 percent living below the poverty line. Generally, soils have medium to poor fertility, which also affects soil-water retention. Rainfall in most areas is erratic, with the exception of inter-lacustrine areas.

Constraints to development include land scarcity because of the high population density, excessive livestock numbers and poor land tenure systems. There are also large-scale fisheries, which largely affect small-scale fishers who are the majority. Declining productivity of livestock, crops and fisheries is also a major factor affecting productivity. Other documented factors affecting productivity include, low technology and low producers price paid to farmers. Water has a high importance for livelihoods, especially for agriculture, livestock, fishing, farming and for domestic consumption. Lack of water limits crops production, without water most agricultural practices applied to crops do not result in significant yields. There is, however, a very high irrigation potential with water being drawn from Lake Victoria and the Mara river.

5.3 Livelihood Zone 3 (tobacco-cotton-miombo woodland zone)

The zone covers the midlands (1 100-1 300 m asl) of Nzega, Uyui, Sikonge and Urambo, Tabora rural districts in Tabora region. It also covers parts of Kigoma rural district in Kigoma region. The landform is mostly flat and gently undulating plains broken by prominent hills. Rainfall ranges from 700 mm in the northeast to over 1 000 mm in the western parts. This zone has a very high water table with plenty of seasonal wetlands as well as a large permanent wetland. The zone contains the famous Malagarasi Muyowosi wetlands, which have been designed as a Ramsar site.

The length of growing period ranges from 150 days in the east to 250 days in the west per year. Livelihood sources are food crops including tobacco, cotton, maize, rice, cassava, and sorghum. The conditions are suitable for cattle rearing and have attracted owners of large herds of cattle from nearby zones. Cotton and tobacco farms provide a livelihood to those employed. Farmers are made up of mostly 60 percent emergent, 30 percent traditional and 10 percent commercial. Much income is generated from harvesting forest products (wood and non-wood) including honey, timber, building poles and wildlife products.

The area has two designated wildlife management areas (WMA), which attract tourists and hunters, and contributes to income generation. Fishing, mainly from the Malagarasi Muyowosi wetlands is sustainable and large fish catches are realized during the fishing season.

The population density is low with about 20 people per km². Miombo woodlands, which are crucial to ecosystem conservation, dominate 50 percent or more of the land. Gender is characterized by male dominance in managing most livelihood sources, in particular agriculture and livestock.

Access to markets is reasonable in that it takes almost 3 to 5 hours to reach the market. However, the marketing of tobacco has been improved by establishing marketing centres in specific locations in villages. There is evidence that traders are now buying food crops, in particular maize and rice in villages. The roads within villages are generally poor and mostly impassable in the rainy season because of wetland characteristics. However, roads connecting districts are accessible.

Poverty is relatively low and 26 percent reportedly live below the poverty line. The major constraints to development and community livelihoods include low and erratic rainfall, prolonged spells of drought (Mongi *et al.*, 2010) and land degradation associated with large numbers of livestock (Majule *et al.*, 2010). Tsetse fly infestation is also a major factor limiting livestock production.

In the past, watering facilities for livestock used to be a constraint but the zone benefited from the Participatory Agricultural Development and Empowerment Project (PADEP) programme funded by the World Bank, which introduced a number of *chaco* dams. Water is highly important especially for agriculture and domestic consumption. There is good potential for irrigation by either promoting the current rice bund systems for harvesting rainwater or, because of the high water table, by extracting groundwater.

5.4 Livelihood Zone 4 (Semi-arid, sorghum-livestock zone)

Covers the midlands areas ranging from 900 to 1 500 m asl in the central plateau, comprising Iramba, Singida rural, Manyoni in Singida region and Kondoa districts in Dodoma region. The great central Rift Valley passes through this zone and there are a series of Rift Valley lakes including Kindai, Singida and the seasonal wetlands of Kitangiri and Bahi.

Rainfall ranges from 200 to 800 mm per year and the length of growing period is short, usually less than 200 days per year. Livelihood is mainly based on the production of annual drought-resistant crops including sorghum, maize, cassava, bulrush millet, cassava, groundnuts, sunflower, sesame, pigeon peas and finger millet. Small numbers of cattle contribute to the community livelihood in particular to Barbaig and Nyiramba tribes (Kangalawe *et al.*, 2005). Mostly, farmers are traditional (90 percent), and 10 percent are emergent.

The population is low (about 10 people per km²) and the zone is among the mainland's least densely populated. Gender is characterized by male dominance, i.e. men own cattle, cash crops and income. Access to markets is fair, taking almost 2-3 hours to reach the market centres and most roads are accessible year round.

Poverty is high and nearly 50 percent of the communities live below the poverty line. A study by Kangalawe *et al.*, (2005) established three main wealth groups at the community level (the rich, the middle-income and the poor). The rich are very few followed by the middle-income, but the former group is very strong and tends to employ the poor to work for them. Eventually the poor receive a cash or in-kind income to sustain their livelihoods.

The main constraints to development include: unreliable and low rainfall; low and declining soil fertility; crop pests and diseases; prevalence of livestock diseases, in particular East Coast Fever (ECF), tsetse infestation and limited marketing of both crops and livestock. Lack of water for livestock during the dry season is a major constraint to livestock production. Water is highly important to livelihoods in this zone, especially for crop production, livestock keeping and domestic consumption. Use of irrigation for farming is uncommon, except in the lowland areas. Soil and water conservation should focus on harvesting

rainwater including deep tillage, tie ridges, contours and terraces on slopes as well as valley bottom water harvesting and conservation.

Currently water is harvested from river sand in some places. Using this approach many hectares of land in the Bahi depression area have been put into production by taking water for irrigation from the Bubu river that passes through the area.

5.5 Livelihood Zone 5 (Pastoral zone)

This zone covers large parts of Arusha and Manyara regions in the northern parts of Tanzania. It consists of lowlands to midlands with low rainfall of 450 to 700 mm per year and includes Ngorongoro, Monduli, Simanjiro, Kiteto districts. The rainfall regime is unreliable. Soils are sandy loams to loamy sands with poor fertility and the main livelihood sources are from sales of cattle and associated products, cultivation and sale of annual crops mainly sorghum, bulrush millet, wheat, pigeon pea, finger millet, cassava and sweet potatoes. Some communities are involved in small-scale mining and tourism. Almost 80 percent are pastoralists and 20 percent are emergent farmers who combine crops with a few livestock.

The population density is very low (1 to 5 people per km²), making this the least populated livelihood zone. Gender is characterized by male dominance whereby men own the cattle and income from crops and livestock sales. Men are also head of the household.

Access to markets is poor, as most people live in remote areas and it takes about 6 to 8 hours to reach the nearest markets. Most roads are passable during the wet season but few are not.

The rate of poverty is medium, with about 39 percent living below the poverty line. The zone is in the drylands, therefore, constraints to production include water scarcity, which affects livestock rearing and crop production. Livestock production is also limited by tsetse infestation. Tick-borne diseases, including ECF, Heart water and Anaplasmosis are rampant in the region leading to poor livestock health and causing death of large numbers of livestock. Lack of adequate watering facilities and properly working dips is another problem. The poor technology of small-scale miners reportedly affects mining activities, in particular Tanzanite. Water is highly important for livelihoods, especially for livestock rearing (watering points, dips), crop production and domestic consumption.

This zone does not offer a great potential for irrigation because of the poor biophysical conditions. There are, however, areas suitable for medium- and small-scale irrigation. Simanjiro district has the largest area under irrigation (2 315 ha) and the potential irrigation area is 5 416 ha. There are no potential areas suitable for irrigation in Kiteto. Analysis of secondary data indicates that spring, shallow wells, gravity pump schemes, hand-operated pump schemes are common sources of irrigation water in the zone.

5.6 Livelihood Zone 6 (tree crops-fishing coastal zone)

This zone is along the Indian Ocean coastal belt (lowlands 0 to 400 m asl) comprising Muheza, Tanga, Pangani in Tanga region, Bagamoyo, Kibaha, Bagamoyo, Mkuranga, Rufiji in the coast region and Kilwa, Lindi rural in Lindi region as well as Mtwara rural districts in Mtwara region. This zone also known as the eastern-south cashew zone because most cashew nuts produced in Tanzania originate in this zone.

Rainfall is medium, bimodal, ranging from 700 to 1 100 mm per year. The length of growing period is 200 to 250 days per year and the main livelihood sources are production of cashew nuts, coconut, spices, rice, maize, cassava, pulses, fruits and vegetables. Fishing is carried out in the Indian Ocean, which contributes to community livelihoods. Coastal tourism, especially in Bagamoyo, Kilwa and Mikindani also contributes to community livelihoods. Farmers are mostly traditional (70 percent), 20 percent are emergent farmers and 10 percent are large-scale commercial cashew growers. The zone has a medium population of about 40 people per km².

Markets are mostly 2 to 3 hours way in Tanga, Pangani, Bagamoyo, Kibaha, Mkuranga and Mtwara rural. Kilwa and Rufiji areas, however, are remote being 6 to 8 hours away. The road that connects Dar es Salaam and the southern part of the coastal belt is accessible, but roads connecting remote areas are mostly impassable during the rainy season.

The poverty level in the zone is high, around 43 percent live below the poverty line. Climate and soil conditions for crops are good but flooding during the rain season is a major obstacle to agricultural production in Rufiji. Among other constraints affecting cashew production is the dramatic infestation of cashew trees and flowers by powdery mildew that may result in zero yields during severe epidemics (Majule, 1999).

The high costs of pesticides to control *Pasteurella multocida* disease (PMD), lack of agricultural inputs such as fertilizers, pesticides and insecticides are also constraints. Other factors affecting income generation is the inadequate level of horticultural technology for the production of fruits and vegetables and a lack of processing and storage facilities. Water is highly important to livelihoods, especially for horticultural production and domestic consumption.

There is the potential for irrigation for farming with water from the Pangani, Wami, Ruvu and Rufiji rivers on 188 500 ha. Currently there are several small-scale irrigation schemes including Matipwili, Makurunge, Mkoko.

5.7 Livelihood Zone 7 (Lake Tanganyika zone)

This covers the midlands of Rukwa and Kigoma regions, in particular Nkansi, Kigoma rural and Kibondo districts. The land is a gently inclined plateau with steep hills rising sharply from 800 m at the level of Lake Tanganyika to about 1 700 m in the east. Rainfall is variable, ranging from 600 to 1 500 mm/year and is heaviest in the highlands, intermediate on the lower slopes and low in the lowlands and lake offshore areas.

The main livelihoods are based on agricultural crops, in particular palm oil, maize, cassava, fishing, tobacco, cotton, beans and sweet potatoes. Fishing from Lake Tanganyika, especially fish and sardines provide a good source of income to communities living both near and far from the lakeshores. The zone also attracts tourism from the Igombe Game Reserve. Almost 80 percent of farmers are traditional, 15 percent are emergent and only 5 percent are commercial farmers.

This zone has a relatively low population density ranging from 5 people per km² in sparsely populated areas to 10 people per km² in slightly densely populated areas in peri-and urban centre. Gender is characterized by male dominance for ownership of crops and income. Access to markets is poor, taking 6 to 8 hours to reach the nearest markets. Most rural roads are accessible during the year but very few are not.

The road from Urambo to Kigoma town is inaccessible during the wet season because of the connecting bridge through the Malagarasi wetland. Poverty is high and 43 percent of the population lives below the poverty line.

Constraints to development are poor road infrastructure and poor transport to market centres (including the Democratic Republic of Congo), lack of appropriate agricultural production technology, including lack of sufficient farm inputs such as fertilizers and pesticides. Productivity is curtailed by tsetse infestation of livestock and water shortages during the dry seasons. Water is important for crop production, fishing and domestic consumption.

There is limited irrigation potential from water reservoirs. Research has confirmed the better irrigation potential in the valleys of Luiche and Ruchugi.

5.8 Livelihood Zone 8 (Tree plantations with crops-pyrethrum and tea)

This zone covers most parts of the southern highlands of Mufindi, Njombe and Makete districts ranging from 1 600 to 2 700 m asl. Rainfall ranges between 1 000 and 1 600 mm falling within 200 to 280 days per year.

The main livelihood sources include sale of timber from plantations and other wood products, pyrethrum and tea. Other crops produced include vegetables, tomatoes and green maize, which is produced in the valley bottoms of Vinyungu (Majule and Mwalyosi, 2005). This is a zone where there is good milk

production from exotic dairy cattle, which also supplies other parts of the zone and towns including Dar es Salaam.

Many communities are employed on tea estates and tree plantations and related industries. The livelihood zone is also supported by cultivation of maize and Irish potatoes for food and sale. Farmers are almost 60 emergent, 30 percent commercial and 10 percent traditional.

Population density is medium, between 30 to 40 people per km². Male dominance is characterized by ownership of woodlots and income generated from the sale of different products. Men are mostly employed on the plantations.

Access to markets is fair, taking 2 to 4 hours to reach the nearest markets. Roads are relatively good; although some feeder roads are impassable during the rainy season. Poverty is relatively low and the percentage of people living below the poverty line is around 27 percent. Water is important especially for crop production, watering plantation nurseries (seedlings) and domestic consumption.

Water availability for plantations is relatively good because of the characteristics of the catchment in the upper parts of the zone. Small-scale and traditional irrigation is common and an attempt to develop large-scale irrigation has been tested in the Kalenga flood plains. It is feasible considering the existing rivers and streams for artificial dams to supply water for irrigation. Furrow irrigation is frequently used in Mufindi areas. Localized flooding after rain is used where topographical conditions create low-lying, flat-bottomed basins.

5.9 Livelihood Zone 9 (Maize-cassava-cashew-simsim zone)

This zone covers the lowlands (300 m) to midlands (900 m) formed by Tundururu (Ruvuma region), Nachingwea, Liwale (Lindi region) plains and part of the Masasi district in Mtwara. The mean annual rainfall ranges between 700 and 1 200 mm per season with a growing period of between 200 and 250 days per season.

Major crops grown in the zone that contribute to community livelihoods include cashew, sesame, cassava, maize, pulses (pigeon peas, cowpeas), groundnuts and rice in the wetlands of the Kitere, Kinyope and Ruvuma river basin. Farmers are 70 percent traditional, 20 percent emergent and 10 percent commercial.

Population density in this zone is very low with between 1 and 5 people per km² in rural and peri-urban areas. Recently, there has been massive pressure to introduce livestock into the zone following eviction from Usangu plains and other parts of western Tanzania under Miombo woodlands.

This zone has relatively better gender balance in terms of socio-economic activities. Men manage trees crops, in particular cashew, while women manage other sources of livelihood particularly exploitation of non-wood food forest products (Majule *et al.*, 2009).

In the past access to markets used to be very bad, taking between 8 to 24 hours to the nearest market. Travel time has been reduced to a maximum of 6 hours because of significant improvement of the roads. Although villages are very remote, and most of the roads are bad, they are passable during the rainy season.

Poverty is very high and the percentage of people living below the poverty line is around 53 percent. Factors contributing to poor productivity include poor distribution and unreliability of rainfall, lack of technology for agriculture, lack of sufficient farm inputs, i.e. fertilizers and pesticides, tsetse infestation of livestock.

Water is highly important for crop production, watering livestock and domestic consumption. Water supply in the zone is met mainly by a multitude of shallow wells fitted with hand pumps. Rainwater harvesting is feasible using various means for most communities in Newala and Liwale districts. Water is also used to irrigate small vegetable gardens. Groundwater supply is plentiful and favouring installation of shallow wells.

5.10 Livelihood Zone 10 (rice zone)

This covers the midlands areas of Mbarali district in Mbeya region, with an elevation of about 1 000 to 1 400 m asl. Rainfall ranges between 650 and 800 mm per year. The length of crop growing season ranges from 150 to 200 days per year. Community livelihoods depend on the production of both rainfed and irrigated rice. This is the area where Mbarali rice farm under National Agriculture and Food Corporation (NAFCO) was developed and recently privatized by the government.

Over 90 percent of small-scale farmers on the Usangu plains, Mbarali, are growing paddy rice. Other crops include maize and sorghum in marginal areas. Livestock keeping, particularly on the Usangu plains, is by agro-pastoralists originating from drier parts of central and western parts of Tanzania. Farmers are 40 percent traditional, 40 percent emergent and 20 percent commercial.

Population density is medium to high ranging from 50 to 100 people per km². There is gender equality in terms of division of labour and ownerships of crops. There are many female-headed households.

Access to markets is fair (2-4 hours) to the nearest markets centres and most roads are fairly good and accessible during the wet season. Poverty is relatively low around 2 percent live below the poverty line.

Insufficient technology, poor farm implements and conflicts over resource uses, in particular land and water are among production constraints in the zone. Water is important for crop production and domestic consumption. Traditional irrigation practices on the Usangu plains dates back about 50 years. This suggests that the zone has potential for development of irrigation on about 130 000 ha; only about 50 000 ha of farms are currently being irrigated.

5.11 Livelihood Zone 11 (Sisal-sugar cane-cattle zone)

This zone is comprised of the mountains of Uluguru and Nguru in Morogoro region and the lowlands of the Mgeta and Ruvu plains (300-600 m asl) as well as the Kilombero flood plains. The length of growing period ranges from 200 days on the flood plains to 300 days in the Uluguru mountains per year.

Sisal production, sugar cane (large and small scale), cattle rearing, maize, Irish potatoes, paddy and oilseed production are the main livelihood sources. Farmers are 40 percent traditional, 40 percent emergent and 20 percent commercial.

The population density is about 20 to 30 people per km² and there is high pressure on land because of population growth and expansion of agricultural activities. The Kilombero plains are surrounded by game and forest reserves that restrict further expansion.

Access to markets is variable but good in the Morogoro urban area, which is about 2 hours travel time to the markets. Some roads are impassable during the rainy seasons. In Kilombero and Kilosa districts travel time to markets from rural areas is 2 to 4 hours. Regular flooding, however, during the rainy season affects mud roads making transportation of agricultural commodities more difficult. The poverty level is relatively low and 29 percent of the population lives below the poverty line.

Productivity of both crops and livestock in the zone is affected by inadequate agricultural inputs, lack of price incentives, inadequate crop marketing arrangements, and poor transport system. Clashes between pastoralists and crop farmers are common because of the scarcity of grazing land during the dry season.

Flooding of the floodplains in the rainy season constrains crop production. Kilombero wetlands are among the four designated Ramsar sites in Tanzania but a management plan is yet to be developed. The Kilombero river is the main source of water for various uses including irrigation of rice and sugar cane estates. Irrigation potential is enormous because of the Kilombero and Wami river basins. It is estimated that about 300 000 ha have potential for developing irrigation. Already, about 20 000 ha are under irrigation schemes, i.e. Mlegeni.

5.12 Livelihood Zone 12 (Maize-tobacco zone)

This zone covers part of the southern highlands of Namtumbo, Songea rural area in Ruvuma region and Mbinga and Ludewa district in Iringa region, which rises from 300 to 2 000 m asl. The zone receives

adequate annual rainfall and has one long growing season, which begins in November and ends in May. The length of growing period is between 150 and 200 days per year and the major crops grown are maize, tobacco, paddy, coffee and cashew (in Tunduru-Ruvuma region). These crops are the main sources of community livelihoods in the zone.

Farmers are 70 percent traditional, 20 percent emergent and 10 percent commercial. Population density in this zone is low (5-10 people per km²). Men head the households and they dominate the major sources of livelihood showing a gender imbalance.

It takes 6 to 12 hours to reach the nearest markets. Most villages are in remote areas and off the main roads. Poverty is relatively high and 41 percent of people live below the poverty line. Factors affecting production include poor road infrastructure, transport and soil fertility; lack of technology and modern agricultural innovations; lack of sufficient farm inputs, i.e. fertilizers and pesticides. Water is important for crop production and domestic consumption.

About 1 390 ha of land is currently irrigated. There is, however, a potential irrigation area of 65 730 ha. Water can be accessed from Lake Malawi, River Ruaha and other rivers found in Ludewa.

5.13 Livelihood Zone 13 (Rice-maize unimodal zone)

This zone includes the midlands and highlands areas of the Ufipa plateau ranging from 1 200 to 2 460 m asl. Rainfall ranges from 800 to 1 200 mm/year depending on elevation. The length of growing period is 150 or 200 days/year.

The major sources of livelihood are agriculture and crops produced for both sale and food are rice, maize, pulses and banana. Fishing, tourism and mining are also undertaken and contribute to community livelihoods. Farmers are 80 percent traditional, 15 percent emergent and 5 percent commercial. Population density in this zone is low (about 5-10 people per km²). Men at the household level dominate the major sources of income; although women do much of the work.

Access to markets is bad, travel time is 8-24 hours to the nearest markets. The villages are very remote and most roads are bad and some are inaccessible during the rainy season. Poverty is relatively low and around 24 percent of people live below the poverty line.

Constraints affecting production include inadequate and expensive agricultural inputs, lack of price incentives, inadequate crop-marketing arrangements, and poor transport system. Other constraints are lack of adequate cattle dips and prevalence of tsetse infestation affecting livestock.

Water is highly important, especially for crop production and domestic consumption. Irrigation potential is high with 814 000 ha of land classified as very suitable 68 000 ha; and about 746 000 ha being marginally suitable because of low soil fertility. The zone has a good network of rivers, most are perennial with fertile valleys. Very few of these rivers are utilized during the dry season for irrigated farming.

5.14 Livelihood Zone 14 (Rice-maize bimodal zone)

This zone covers the southern highlands of Tanzania and rises from 1 000 to 2 400 m asl. Rainfall ranges from 800 to 2 700 mm/year. The length of growing period varies from 150 to 250 days/year.

Major sources of livelihood include growing rice, maize, banana and cotton. Fishing, tourism and mining also contribute to community livelihoods.

Farmers are 40 percent traditional, 40 percent emergent and 20 percent commercial. Population density is medium with about 30 people per km². There is relatively better gender balance in terms of activities and resource ownership.

Travel time to markets varies from 2 to 8 hours to the nearest markets. There are good and bad roads that determine accessibility to different places.

Poverty is relatively low and 25 percent of people live below the poverty line.

Factors affecting productivity include lack of modern production technologies, including modern farm implements; farmer-herder conflicts and poor prices paid to farmers. Water is important for crop production and domestic consumption. Potential irrigation area is about 374 450 ha, out of which only 50 325 ha are currently in use.

6. POTENTIAL FOR POVERTY REDUCTION THROUGH AWM

AWM used to be synonymous with irrigation and, therefore, other forms of water management beneficial to agriculture were disregarded. The current trend among professionals and practitioners is to adopt a more holistic approach to water for agriculture. Thus, AWM is here defined as:

“All deliberate human actions designed to optimize the availability and utilization of water for agricultural purposes. The source of water could include direct rain as well as water supplied from surface and underground sources. AWM is therefore the management of all the water put into agriculture (crops, trees and livestock) in the continuum from rainfed systems to irrigated agriculture and all relevant aspects of management of water and land” (IMAWESA, 2008).

Therefore, AWM includes, soil and water conservation, rainwater harvesting, irrigation (full and supplemental irrigation), agronomic management, rangeland rehabilitation, wetland management and utilization, drainage of waterlogged soils, water conservation for livestock, soil fertility management, conservation agriculture, agroforestry, climatic variability mitigation, use of low quality or recycled water, water used for value addition, and interventions such as integrated watershed management (IMAWESA, 2008).

Water is not always the main constraint to poverty reduction in rural areas, but it is an essential input for enhancing agricultural production and other water-related livelihood activities. To achieve greatest efficiency in use of resources, water investment policies should take into consideration where water interventions can make a difference for rural livelihoods (FAO, 2008). In other terms, such interventions should be directed to livelihood zones where water is fundamental for alleviating rural poverty (FAO, 2008).

Potential for poverty reduction via AWM is analysed based on three criteria: rural poverty prevalence, water as a limiting factor for production and potential for water development (FAO, 2008). For instance, areas characterized by these three factors: (i) high prevalence of poverty (ii) water is a limiting factor for increased agricultural production and (iii) good potential for water development, are the right zones for investing on AWM.

On the other hand, areas with very low prevalence of poverty, and either water is not a limiting factor for increasing agricultural production or there is no potential for water development, then investing in AWM most likely will not make a difference.

Table 2, shows the potential for poverty reduction using AWM in the different livelihood zones. Livelihood zones 2, 4, 5, 7 and 9 have the highest potential for poverty reduction implementing AWM. Specifically, Livelihood Zone 2 (Table 2) has relatively high poverty incidence (nearly 45 percent living below the poverty line). Water is the factor limiting crop production in this zone and without water (insufficient water) most agricultural practices applied to crops do not result in significant increase in yield (URT, 2003₂, URT, 2002₃).

There is also high irrigation potential for AWM in this zone with water drawn from from Lake Victoria and the Mara river for irrigation; conservation agriculture; various water-lifting devices; *charco* dams; paddy-field bunding and rainwater harvesting (URT, 2003₂, URT, 2002₃). Moreover, Livelihood Zone 4, which covers the central plateau, characterized by semi-arid conditions, is also a good prospect for AWM (Table 2) as the zone has a high level of poverty, nearly 50 percent of communities live below the poverty line. Unreliable and low rainfall is a main constraint to development in this zone (URT, 2003₁, URT, 2005₁). Though irrigation farming is not common, soil and water conservation practices are paramount and should focus on harvesting rainwater-using practices including deep tillage, *chololo* pits, tie ridges,

contours and terraces on slopes as well as valley bottom water harvesting i.e. *charco* dams (URT, 2003₁, URT, 2005₁).

Livelihood Zone 5, which is lowlands to midlands with low rainfall of 450 to 700 mm/year and falls within the Ngorongoro, Monduli, Simanjiro, Kiteto districts, is also priority for AWM. The zone has moderate to high poverty, 39 percent of the population live below the poverty line. Water scarcity is a major constraint to development affecting livestock rearing and crop production as the zone is found in the drylands. This zone has few areas that are suitable for medium- and small-scale irrigation. It is not well endowed with large potential areas for irrigation because of its poor biophysical conditions (URT, 1997₆). An analysis of secondary data indicates that springs, *charco* dams, shallow wells, gravity pump schemes, hand-operated pump schemes, rainwater harvesting and conservation agriculture are possible investments in this zone, which is very much affected by unreliable sources of water.

Livelihood Zone 9 is also a high priority for AWM as the poverty level is very high, at around 53 percent. Factors contributing to poor productivity include poor distribution and unreliability of rainfall. Conservation agriculture practices, i.e. conservation tillage, contour farming, are feasible in this zone. Rainwater harvesting is also a possibility, especially in Newala and Liwale districts. Groundwater supply is plentiful, favouring installation of treadle pumps, motorized pumps and shallow wells (URT, 1997₅).

On the other hand, Livelihood Zone 1, characterized by highlands, humid conditions, high rainfall with bimodal trends, appears to be a relatively low priority area for poverty reduction through investment in AWM (Table 2). These areas are blessed with near perfect climate and rainfall regime and soils and water are good for production (URT, 1997₂, URT, 2002₁). Although, there is a high potential for AWM, especially rainwater harvesting, water-lifting technologies and conservation agriculture in these areas, the existing water availability for agriculture and low poverty level of about 31 percent living below the poverty line, make it a comparatively low priority for poverty reduction using AWM solutions.

Table 2 – Priority for action, poverty reduction through water interventions by livelihood zone

Livelihood zones			Criteria			
LZ	Name	Description	Rural poverty prevalence	Water as a limiting factor	Potential for water development	Priority for poverty reduction
LZ 1	Coffee-Banana Humid Highlands	Highlands, humid, high rainfall, bi-modal- Coffee and Banana zone	Low (31%)	Low	High	Low
LZ 2	Cotton-Paddy-Cattle Midlands	Cotton, Paddy and Cattle midlands	High (45%)	High	High	High
LZ 3	Tobacco-Cotton Zone	Tobacco- Cotton zone	Low (26%)	High	High	Moderate
LZ 4	Semi-arid Sorghum Livestock Zone	Unimodal, semi-arid, sorghum-livestock zone	High (50%)	High	Moderate	High
LZ 5	Pastoral Zone	Pastoral zone	Moderate to High (39%)	High	Moderate	High
LZ 6	Tree Crops-Fishing Coastal Zone	Coastal zone-Tree crop (Cashew, coconut, fishing zone, spices, tourism)	High (43%)	Low to Moderate	High	Moderate
LZ 7	Lake Tanganyika Zone	Lake Tanganyika zone	High (43%)	Low	High	Moderate
LZ 8	Plantation Zone	Plantation zone (tree, pyrethrum and tea)	Low (27%)	Low	High	Low
LZ 9	Maize-Cassava-Cashew-Simsim Zone	Maize, Cassava, Cashew, S Sesame zone	High (53%)	High	High	High
LZ 10	Rice Zone	Rice zone	Low (21%)	Low	High	Low
LZ 11	Sisal-Sugarcane-Cattle Zone	Sisal, Sugarcane and Cattle	Low (29%)	low	High	Low
LZ 12	Maize- Tobacco Zone	Maize- Tobacco zone	High (41%)	low	High	Moderate
LZ 13	Rice-Maize Unimodal Zone	Unimodal rainfall (Rice, maize, pulse, banana, tree, fishing, tourism, cotton, mining)	Low (26%)	Moderate	High	Moderate
LZ 14	Rice-Maize Bimodal Zone	Bimodal rainfall (Rice, Maize, Banana, Fishing, Tourism, Cotton, Mining)	Low (25%)	Low	High	Low

7. RELEVANCE AND POTENTIAL OF PROMISING AWM SOLUTIONS

According to IWMI, (2010) and Majule *et al.*, (2010), the most promising AWM solutions in Tanzania are categorized as: (i) conservation agriculture; (ii) water lifting and application technologies; (iii) communal irrigation schemes; and (iv) small reservoirs .

(i) Conservation agriculture – includes contour farming, matengo pits, vinyungu, terracing, deep tillage, minimum tillage, ripping and pit cultivation. Farmers usually use different combinations of conservation agriculture practices. The adopted conservation agriculture practices are agro-ecological zone specific. In the highlands such as Usambara (especially Lushoto), Kilimajaro (corresponds to Livelihood Zone 1) and Iringa (corresponds to Livelihood Zone 1) the specific practices include terracing and contour farming. In semi-arid areas such as those in Singida and Dodoma region (Livelihood Zone 4) conservation agriculture practices are conservation tillage, deep tillage, ripping and pit cultivation.

A good example is *chololo* pits, which are named after the village where they were invented in Dodoma region of Tanzania (Livelihood Zone 4). *Chololo* pits comprise a series of pits, about 22 cm in diameter and 30 cm deep. The pits are spaced 60 cm apart within rows, and 90 cm between rows, with the rows running along the contour. The soil removed during excavation is used to make a small bund around the hole. Inside the pit, ashes (to expel termites), farmyard manure and crop residues are added, then covered with the requisite amount of soil while retaining sufficient space in the hole for runoff to pond. These preparations ensure that the organic materials hold the infiltrated water. One or two seeds of either maize/millet or sorghum are planted per hole. The method can be widely adopted in semi-arid areas of Tanzania (Bancy, 2007).

(ii) Water lifting and application technologies – including treadle, motorized pumps and drip irrigation. A good example of a *water-lifting device* is treadle pumps. The treadle pumps are not location specific in Tanzania, but follow up KickStart Tanzania pumps (IWMI, 2010). The moneymaking treadle pump is a manual pump that can be owned, operated and managed by a household or an individual. The cost-benefit analysis for a pump owner growing onion shows a positive net benefit. The increased income can allow a farmer to properly feed and clothe the family (IWMI, 2005). Apart from the pump being used for irrigation it can be used for other purposes such as domestic and livestock water supply without change in design. The KickStart mode of promotion needs to be copied when promoting this technology. A good example of *water application technology* is drip irrigation. Drip irrigation is described as a water delivery system that involves application of water into the soil through a small opening directly on the soil surface. Although this technology seems to be expensive for the small-scale farmer, the cost benefit analysis shows the investment is viable for onion production (IWMI, 2005). The technology has other advantages such as the small amount of water used for production (suitable for semi-arid areas) and its convenience of operation. Adoption and the use of drip-irrigation technologies in Tanzania are found to be associated with high value crops such as flowers and vegetables grown mainly for marketing (IWMI, 2005).

(iii) Communal irrigation schemes + aquaculture – includes Mkindo irrigation scheme, faro and Ndimba systems. The Mkindo irrigation scheme is 42 ha with 96 farmers. A water user association (WUA) has been established with sub-committees responsible for different tasks (water distribution, field operations, operation and maintenance, etc.). The farmers each pay

TSh 4 500 per year to the WUA for maintenance of the scheme. They have applied for water rights, but do not yet pay for the water. The WUA needs to be strengthened and consolidated. It lacks for example skills on how much water is needed, which is very important if payment of water based on volume of water used is introduced (Frenken, 2001).

(iv) Small reservoirs – includes Ndiva system in Pare and charco dams. The charco dam technology is suitable in semi-arid areas where farmers keep livestock such as Livelihood Zone 5 (Monduli, Simanjiro, Kiteto and Ngorongoro districts), Livelihood Zone 4 (most of Singida and Dodoma region) and Shinyanga region (Livelihood Zone 2). Promotion of this technology will result in minimizing shortage and unreliable water sources, which creates permanent stress to livestock, especially during the dry season. It will also minimize deforestation and accelerated soil erosion resulting from semi-nomadic animal husbandry practiced in response to water shortage. However, in promoting this technology the respective community must be involved from the beginning, to encourage a sense of ownership. Since the technology is expensive the government or donor agencies intending to promote it must agree with the community on the percentage contribution for construction of the dam (Bancy, 2007).

Table 3 shows the relevance of promising AWM solutions in the different livelihood zones. In Livelihood Zone 1 (mostly highlands), the most promising AWM intervention is conservation agriculture through terracing and contour farming (Bancy, 2007). In Livelihood Zone 2, the most promising AWM technologies range from conservation agriculture (Table 3), i.e. conservation tillage achieved by: (i) zero or minimum soil turning, (ii) permanent soil cover, (iii) stubble mulch tillage, and (iv) crop selection and rotations. Also low cost water-lifting devices, communal irrigation schemes and small reservoirs for farming and livestock watering are promising solutions (URT, 2003₂, URT, 2002₃). In Livelihood Zone 3, the most promising AWM solutions include low cost water lifting techniques, small reservoirs and communal irrigation schemes as this zone has a high water table and permanent wetlands (URT, 2005₂).

In Livelihood Zone 4 and Livelihood Zone 5 (semi-arid areas), the most promising AWM solution is conservation agriculture such as conservation tillage, ripping and pit cultivation. Moreover, although water-lifting devices and small reservoirs have medium potential (Table 3) because of the limited water availability, they are crucial in certain areas within these two zones, bearing in mind that water is the main factor constraining production in these semi-arid areas. For instance, areas with potential for charco dams or areas where treadle pumps can extract water from springs.

Table 3 – Relevance of promising AWM solutions in the different livelihood zones

Livelihood zones			AWM Solutions			
LZ	Name	Description	Conservation agriculture	Individual farmer, low cost lifting devices (treadle, motorized pumps, rope and washer, drip, etc.)	Communal irrigation schemes (including aquaculture)	Small dams
LZ 1	Coffee-Banana Humid Highlands	Highlands, humid, high rainfall, bi-modal Coffee and Banana zone	High	Medium	Medium	Medium
LZ 2	Cotton-Paddy-Cattle Midlands	Cotton, Paddy and Cattle midlands	High	High	High	High
LZ 3	Tobacco-Cotton Zone	Tobacco-cotton zone	Medium	High	High	High
LZ 4	Semiarid Sorghum Livestock Zone	Unimodal, semi-arid, sorghum-livestock zone	High	Medium	Medium	Medium
LZ 5	Pastoral Zone	Pastoral zone	High	Medium	Medium	Medium
LZ 6	Tree Crops-Fishing Coastal Zone	Coastal zone-Tree crop (Cashew, coconut, fishing zone, spices, tourism)	Medium	High	High	low
LZ 7	Lake Tanganyika Zone	Lake Tanganyika zone	Medium	Medium	High	low
LZ 8	Plantation Zone	Plantation zone (tree, pyrethrum and tea)	Medium	Medium	Medium	Medium
LZ 9	Maize-Cassava-Cashew-Simsim Zone	Maize, Cassava, Cashew, S Sesame zone	High	High	Medium	Low
LZ 10	Rice Zone	Rice zone	Medium	Medium	High	Medium
LZ 11	Sisal-Sugarcane-Cattle Zone	Sisal, Sugarcane and Cattle	High	low	High	Medium
LZ 12	Maize- Tobacco Zone	Maize- Tobacco zone	High	low	High	Medium
LZ 13	Rice-Maize Unimodal Zone	Unimodal rainfall (Rice, maize, pulse, banana, tree, fishing, tourism, cotton, mining)	Medium	Low	High	Medium
LZ 14	Rice-Maize Bimodal Zone	Bimodal rainfall (Rice, Maize, Banana, Fishing, Tourism, Cotton, Mining)	High	Medium	High	Medium

Furthermore, in Livelihood Zone 6, the promising AWM solutions are water-lifting technologies and communal irrigation schemes, made possible by the multitude of rivers (Pangani, Wami, Ruvu and Rufiji) and their tributaries. In Livelihood Zone 7, the promising AWM intervention is communal irrigation schemes, which is possible in the valleys of Luiche and Ruchugi. In Livelihood Zone 8, there is relatively good availability of water for plantations but communal irrigation schemes is also feasible for other crops grown in the dry season, i.e. vegetables, because of the existing rivers and streams. In Livelihood Zone 9, use of water-lifting devices is a promising AWM solution because of plentiful of ground water in this zone (URT, 1997₅).

In Livelihood Zone 10 (Table 3), communal irrigation schemes are most promising, demonstrated by existing irrigation schemes (50 000 ha) and full potential for irrigation schemes (130 000 ha) on the Usangu plains (URT, 2003₃). In Livelihood Zone 11, conservation agriculture, i.e. terracing and contour farming, is the most promising AWM solution in the Uluguru and Nguru mountains. In the plains of Mgeta and Ruvu, the most promising AWM solution is communal irrigation schemes as there is an unexploited potential of 180 000 ha (URT, 2002₄).

Moreover, in Livelihood Zone 12, the most promising AWM solution is communal irrigation schemes. There are about 64 000 ha that may be cultivated using this intervention as water can be drawn from Lake Malawi, Ruaha river and other rivers found in Ludewa (URT, 2002₄). Also conservation agriculture, i.e. contour farming, terracing, matengo pits, are promising AWM solutions in the Namtumbo and Mbinga highlands. In Livelihood Zone 13 (Table 3), communal irrigation schemes are promising AWM solutions as this zone contains large areas with irrigation potential (814 000 ha) because of the good network of perennial rivers. In Livelihood Zone 14, conservation agriculture, i.e. contour farming, terracing and communal irrigation schemes are promising AWM solutions in this zone as there is good potential for irrigation, i.e. about 324 000 ha (URT, 1997₂).

8. CONCLUSION

In this report, 14 livelihood zones were identified based on different sets of data, for example, agro-ecological data, land cover, access to markets, livelihood sources, population density, gender patterns and rainfall patterns. In these livelihood zones, potential for poverty reduction was analysed based on poverty prevalence, water as a limiting factor for production and potential for small-holder AWM investment. After analysis, Livelihood Zones 2, 4, 5, 7 and 9 were found to have the highest potential for poverty reduction using AWM. A good example is Livelihood Zone 2, which has relatively high poverty incidence (nearly 45 percent living below the poverty line). Water is the limiting factor to crop production in this zone and without water (insufficient water) most agricultural practices applied to crops do not result in significant increase in yield. There is also high irrigation potential for AWM in this zone for irrigation, drawing water from Lake Victoria and the Mara river; various conservation agriculture practices; various water lifting and application technologies; charco dams, paddy-field bunding and rainwater harvesting. The most promising AWM solutions are conservation agriculture, water lifting and application technologies, communal irrigation schemes and small water reservoirs.

In Livelihood Zone 2, for instance, the most promising AWM solution is conservation agriculture, i.e. conservation tillage achieved by: (i) zero or minimum soil turning, (ii) permanent soil cover, (iii) stubble mulch tillage, and (iv) crop selection and rotations. Also low cost water-lifting devices, communal irrigation schemes and small reservoirs for farming and livestock watering are quite promising solutions in this zone.

9. REFERENCES

- Bancy, M.** 2007. *100 ways to manage water for smallholder agriculture in Eastern and Southern Africa. A compendium of technologies and practices.* SWMnet Working Paper Series 13.
- Critchley, W.; Cooke, R.; Jallow, T.; Njoroge, J.; Nyagah, V.; Saint-Firmin, E.** 1999. *Promoting farmer innovation: Harnessing local environmental knowledge in East Africa.* Workshop Report No. 2. UNDP- Office to Combat Desertification and Drought and RELMA, Nairobi.
- FAO.** 2008. *Water and the rural poor. Interventions for improving livelihoods in sub-Saharan Africa. Enabling poor rural people to overcome poverty,* Rome, IFAD.
- Frenken, K.** 2001. *Duty Travel Report in Tanzania and Zanzibar.* Water Resources Management Office (AGLW), Rome, FAO.
- IWMI.** 2005. *Experiences with micro agricultural water management technologies: Tanzania. An input to the Study on Agricultural Water Management Technologies for Small-scale Farmers in Southern Africa: An Inventory and Assessment of Experiences, Good Practices and Costs.*
- IWMI.** 2010. *International Water Management Institute* (Available at: <http://www.iwmi.cgiar.org/> Accessed 20th September 2010).
- Keraita, B.** 2010. *AWM Solutions – Tanzania Stakeholder’s report.* Workshop held at Council Chamber, University of Dar es Salaam. March 2010.
- Majule, A. & Perfect, J.** 2010. *Livelihood zoning and potential for agricultural water management (AWM). A Workshop held at the Institute of Resource Assessment (IRA) . University of Dar es salaam. March, 2010.*
- Majule, A.E & Nortcliff, S.** 2001. *Properties of selected organic residues added on highly weathered Rhodic Ferralsol and Luvic Arenosol soils under cashew, southern Tanzania. Tropical Agriculture (Trinidad) Volume 78 (4).*
- Majule, A.E., Shishira, E.K. & Yanda P.Z.** 2004. *Soil fertility response to application of selected organic residues under sulphur dusting environment, Southern Area of Tanzania. Bunda Journal of Agriculture, Environmental Science and Technology Vol. 3 No 1, pp 1-11.*
- Majule, A.E.** 2004. *Impacts of landuse/cover changes on land degradation and plant species richness on the slopes of Mount Kilimanjro, Tanzania. Journal of the Geographical Association of Tanzania. Volume 33.*
- Majule, A.E. & Shishira E.K.** 2008. *Participatory development of sustainable soil fertility management practices through innovative training, Southeastern, Tanzania. The ICFAI Journal of Environmental Economics. Vol. V1 No. 3*
- Majule, A.E., Mbonile, M.J. & Campbell, D.J.** 2009. *Ecological gradients as a framework for analysis of land use change in East Africa. African Journal of Ecology Volume 47. pp 55-61.*
- Majule, A.E. & Kalonga, S.** 2009. *Role of local knowledge and innovations in conserving forest biodiversity in Kilombero wetlands, Tanzania. The ICFAI Journal of Environmental Economics. Volume VII No. 1.*
- Majule, A.E., Yanda, P.Z., Shishira, E.K & Mwakaje, A.G.** 2009. *Underlying threats on forest reserves in Tabora region, western Tanzania: The case of Igombe river and Simbo forestry reserves. Research paper accepted for publication in the Journal Studia Universtatis Babes-Bolyai, series Geographia.*
- Majule, A.E., Liwenga, E.T., Kangalawe, R.M. & Yanda, P.Z.** 2009. *Natural resource contribution to community livelihoods. Experience from selected case studies in Tanzania. Dar es Salaam University Press LTD (Accepted for publication. ISBN: 978-9976-60-486-6).*
- Majule A.E. & Mwalyosi, R.B.B.** 2005. *Enhancing agricultural productivity through sustainable irrigation. A case of Vinyungu farming system in selected zones of southern Highlan, Tanzania. In: Social and environmental impacts of irrigation farming in Tanzania: Selected cases. (Edited by H.Sosovele, J. Boesen and F. Maganga). Dar es Salaam University Press. ISBN 9976 60 431 9.*

- Mongi, H., Majule, A.E. & Lyimo J.G.** 2009. Vulnerability assessment of rainfed agriculture to climate change and variability in semi-arid Tanzania. Submitted to the *Journal of the Geographical Association of Tanzania* (Submitted to reviewer)
- Mutungu, K., Critchley, W., Lameck, P., Lwakuba, A. & Mburu, C.** 2001. *Farmers' initiatives in land husbandry. Promising technologies for the drier areas of East Africa*. Technical Report No. 27. RELMA, Nairobi.
- URT.** 1997₁. Ruvuma region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Ruvuma Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2002₁. Kilimanjaro region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Kilimanjaro Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 1997₂. Iringa region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Ruvuma Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2002₂. Mara region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Mara Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 1997₃. Mtwara region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Mtwara Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2004. Rukwa region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Rukwa Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2005₁. Singida region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Singida Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2003₁. Dodoma region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Dodoma Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 1997₄. Kigoma region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Kigoma Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2003₂. Mwanza region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Mwanza Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2002₃. Shinyanga region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Shinyanga Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2002₄. Morogoro region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Morogoro Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 1997₅. Lindi region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Lindi Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.
- URT.** 2005₂. Tabora region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Tabora Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.

URT. 1997₆. Arusha region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Arusha Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam.

URT. 2003₃. Mbeya region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Mbeya Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam

URT. 1997₆. Arusha region. Socio-economic profile. Joint publication by National Bureau of Statistics (NBS) and Arusha Regional Commissioner's Office. Coordinated by The President's Office, Planning and Privatisation. Dar es salaam

Yanda, P.Z., Majule, A.E. Stromquist & Mwamfupe D. 2002. Man and landscape in the Ruhudji Basin. A research agenda. Dar es Salaam University Press LTD. ISBN 9976 60 374 6.

10. ANNEXES

Annex 1 – Description of Livelihood Zones by Group

Zone	Climate	Livelihood source	Farmer typology	Access to markets	Rural population density	Gender patterns	Poverty
I	High rainfall >1000mm, deep soils, 2 growing seasons, long rains	Sale of cash and food crops. Employment in farms	Small, medium and large scale farmers	Within or outside zones	Medium to high	Male with cash crops and income	10% rich, 50-70% middle income, < 50% poor.
II	Low , <1000mm, one growing season	Sale of cash and food crops. Employment	Small –medium scale farmers	Within the zone	Low to medium	Both male and female	Approx. 70% poor
III	High rainfall, 1-2 Seasons.	Sale of cash and food crops	Small scale	Within zone	High population	Male dominated	Poor, majority
IV	Low to medium rainfall <700m, infertile soils, drylands	Sale of crops and livestock products	Small scale farmers	Within and outside zones	Low	Male	Medium
V	2 rain seasons, high temperature, poor soils	-Sale of fish and sea products Employment	Small scale	Within the zone	High Coastal and lake region	Male	Poor majority
VI	1-2 rain seasons, fertile soils	Sales of crops/fish products Self employed	Small scale	Within	Low	Both F/M	Majority medium
VII	Variable	Sales of farm and non farm products	Small- Medium	Within and outside zone	Medium	Both	Medium (40% to 50%)
VIII	Low rainfall, bushland, poor soils	Hunting and forest products	Small scale	Within	Very low	Male	Majority poor
IX	Semi arid areas, poor soils	Sale of minerals Employment	Small-large	Within and outside	Very high, Exceeding 5000 per camp	Male	Mixed
X	-Semi-arid -Variable soils	-Sale of crops -Hunting and revenue collections	Small scale farmers	Within and outside	Low	Male	Majority poor
XI	Low to Medium rainfall (miombo zone) Deep soils	Sale of crops and forest products	Small-medium scale	Within and outside zones	Low	Mixed (F and M)	Poor majority
XII	High rainfall (>1 000 mm) -Fertile soils -Low temperature	-Sale of livestock products -Employment	Small to medium	Within and outside	High	Mixed	Low and medium

Annex 2 – Description of Livelihood Zones by Group

Livelihood zone	Climate	Livelihood source	Farmers	Population	Gender	Market	Poverty
LZ 1	Evergreen	Banana, beans, coffee, dairy cattle, weaving, fishing, oil palm	100% traditional	High	MHH 80% FHH 20%	Moderate	Low to Med
LZ 2	Uni-modal	Maize, Rice, Cassava, Sorghum, Cattle, Cotton, Fishing, Mining, Tourism	100% traditional	Very high	MHH 90%	Good	Low to medium
LZ 3 LZ 3a Tourism	Semi-arid	Cattle, Cotton, Rice, Maize. Tobacco, Simsim, Pulses, Tourism, Minerals	90% traditional 10% emergent	Med to High	MHH 90%	Good	Low to medium
LZ 4 Agro pastoral areas	Semi-arid	Cattle, rice, Maize, Pulses, Wheat, Coffee, Sugar, Tourism, Vegetables	70% Traditional 30% Commercial	Low to medium	MHH 90%	Very Good	Low to medium
LZ 5	Bimodal and Sem	Coffee, banana, sugar, maize, vegetable, flower, tourism, cattle	Traditional -70%, Emergent -15% Commercial -15%	Very high	MHH 90	Very good	Low
LZ 6	Humid/ Mod	Fishing, tree crops, rice, maize, pulses, tourism, poultry, swine, spices	Traditional 90%	Med to High	MHH 80%	Variable L M H	Low
LZ 7	Humid/ Mod	Fishing, tree crops, rice, maize, pulses, tourism, poultry, swine, spices	Traditional 90%	Low	MHH 80%	Low	High
LZ 8	Bimodal	Maize, rice, vegetable, cass, potato, banana, sugarcane, timber, tobacco, fish	Out grower -5% Traditional-95%	Med	FHH 50%	Good	Medium
LZ 9	Uni-modal	Rice, maize, pulse, banana, tree, fishing, tourism, cotton, mining	90% traditional 10% emergent	High (refugees)	MHH 80%	Very good (Zambia)	Low
LZ 10	Uni-modal	Rice, maize, pulse, banana, tree, fishing, tourism, cotton, mining	90% traditional 10% emergent	High (refugees)	MHH 80%	Low	High
LZ 11	Semi arid	Farming, maize, pulse, tree, cassava, fishing, tourism, livestock	Traditional (100%)	Low-med	MHH 70%	Low	Medium to High
LZ 12	Humid Temperature	Tea, Potatoes, Sheep, Timber,	Traditional (100%)	High	FHH 40%	Low	Variable

Annex 3 – Description of Livelihood Zones by Group

Livelihood zones	Agro-climate	Livelihood source	Typology			Access to markets	Population density	Gender patterns	Rural poverty	Areas
			Traditional	Emergent	Commercial					
LZ 1	Heavy rainfall, highlands	Coffee, banana, tea zone	93%	5%	2%	Good	Very high	Male dominance	Low	Kagera, Kigoma, Tarime, Moshi, Meru, Tukuuyu
LZ 2	Medium rain fall midlands	Cotton, paddy, cattle zone	90%	7%	3%	Good	Medium	Male dominance	Low	Mwanza, Shinyanga, Mara, Morogoro, Mbeya
LZ 3	Medium rainfall, Midlands	Tobacco-cotton zone	30%	60%	10%	Good	Medium to low	Mixed	Low	Kigoma, Tabora, Iringa, Mbeya
LZ 4	Dry low lands	Pastoral zone	100%	-	-	Mixed	Very low	Male dominance	Very high	Serengeti, Ngorongoro, Monduli, Simanjiro, Handeni, Kiteto, Hanang
LZ 5	Low rainfall, lowlands, dry	Agro-pastoral zone	40%	45%	15%	Good	Low	Mixed	High	Singida, Dodoma, Tabora, Mara, Shinyanga
LZ 6	Surrounding water bodies	Fishing zone	30%	50%	20%	Good	High	Mixed	High	Lake Victoria, Nyasa, Tanganyika, Rukwa, Dams-Mtera, Nyumba ya Mungu, Coastline
LZ 7	Surrounding National parks and other heritage sites	Tourism zone	5%	15%	80%	Poor	Low	Mixed	High	Arusha, Morogoro, Kilimanjaro, Coast, Iringa
LZ 8	Surrounding mines	Mining zone	10%	30%	60%	Good	High	Mixed	High	Mara, Shinyanga, Arusha,

										Mwanza, Chunya, Uvinza
LZ 9	Coast line, Medium rainfall	Cashew nut, Coconut, Cassava	70%	20%	10%	Good	Medium	Balanced	High	Tanga, Pwani, Lindi, Mtwara
LZ 10	Highlands, high rainfall	Maize, beans, sunflower, paddy zone	50%	40%	10%	Good	Medium	Balanced	Medium	Rukwa, Ruvuma, Iringa, Mbeya, Morogoro
LZ 11	Medium rainfall, Midlands	Wheat complex	70%	25%	5%	Good	High	Male dominance	Medium	Babati, Mbulu, Karatu, Hanang
LZ 12	High rainfall, highlands	Forest based, Irish potato, tea	10%	60%	30%	Good	High	Mixed	Medium	Njombe, Makambako, Mufindi, Makete
LZ 13	High rainfall	Paddy zone	40%	30%	20%	Good	Medium	Balanced	Medium	Kyela, Mbarali, Ifakara, Kilombero
LZ 14	Medium to high rainfall	Fruit zone	70%	25%	5%	Good	High	Balanced	Medium	Handeni, Lushoto, Karagwe, Morogoro
LZ 15	Medium rainfall	Lindi-Mtwara inland cashew	70%	20%	10%	Poor	Low	Balanced	High	Lindi and Mtwara inland
LZ 16	Medium rainfall-midlands	Kigoma- Palm, Maize and Cassava	80%	15%	5%	Good	Low	Male dominance	High	Kigoma Palm areas