# Study on best practices for technologies scaling up by small holder farmers

June 2014

For further information please contact:

ActionAid Tanzania

P. O. Box 21496

Dar – Es – Salaam

## Table of Contents

## Acknowledgement

The consultant acknowledges the honor bestowed on him by ActionAid and CCAP members, for being given the opportunity to carry out this Study on best practices for technologies scaling up by small holder farmers. It will be difficult to mention one by one of those who participated in this study, but I wish to convey my special thanks to representatives of the community members met with me and organizations or institutions consulted. Their contributions have made a great contribution to this report.

**Acronyms and Abbreviations**

| | |
|---|---|
| AATZ | Action Aid Tanzania |
| CA | Conservation Agriculture |
| CSA | Climate Smart Agriculture |
| C3S | Climate Smart Small Scale Agriculture |
| FAO | Food and Agriculture Organisation |
| MJUMITA | Community Forest Conservation Network of Tanzania |
| MVIWATA | Farmer’s Network of Tanzania |
| OPV | Open Pollinated Varieties |
| REDD | Reducing Emissions from Deforestation and Forest Degradation |
| RWH | Rain Water Harvesting |
| SSCSA | Small Scale Climate Smart Agriculture |
| TFCG | Tanzania Forest Conservation Group |

**1.0 Introduction**

**1.1 About the project**

ActionAid Tanzania, Community Forest Conservation Network (MJUMITA), the Farmer's Network of Tanzania (MVIWATA), the Tanzania Forest Conservation Group and the Tanzania Organic Agriculture Movement received funding from AcT for implementation of the project titled "Climate change, agriculture and poverty alleviation: putting small-scale farmers at the heart of policy and practice" in 2 districts of Kilosa and Chamwino. Development of this project is based on the fact that the majority of people in Tanzania are smallholders and depends on agriculture for their livelihood. When it comes to climate variability, it is small-scale farmers who are hit first and hardest by the climate change (CC). It has been realized that land use changes particularly deforestation as a result of shifting agriculture, is the largest source of greenhouse gas (GHG) emissions in Tanzania. Investment in agriculture and agricultural policies and practices are prioritizing a shift to more mechanized, fossil fuel dependent, larger scale agriculture with the aim of increasing productivity and commercializing smallholder production. Whilst this approach may increase short-term yields, it risks making small-scale farmers poorer and more vulnerable to CC. It is believed that there are alternative approaches to land use and food production that would bring 'wins' in terms of CC adaptation and mitigation, but lack of awareness to small-scale farmers and policy makers on the adaptation and mitigation to CC has been the problem. In view of this, the project goal is centered at reducing poverty amongst small-scale farmers in Tanzania and greenhouse gas emissions from agriculture through the widespread adoption of climate resilient, low emission agricultural practices. Consistently, it envisages to see that Tanzania has developed and is implementing policies and strategies that prioritize support to small-scale farmers to enable them to improve their livelihoods through the adoption of climate smart agriculture and sustainable land and natural resources management

**1.2 Background information**

**Goal**

Poverty has been reduced amongst small-scale farmers in Tanzania and greenhouse gas emissions from agriculture have been reduced through the widespread adoption of climate resilient, low emission agricultural practices.

**Intermediate objective**

Tanzania has developed and is implementing policies and strategies that prioritize support to small-scale farmers to enable them to improve their livelihoods through the adoption of climate smart agriculture and sustainable land and natural resources management.

**Immediate Objectives**

**Immediate objective 1:**

- Small-scale farmers and other stakeholders are demanding the integration of climate smart, small-scale agriculture and sustainable land and natural resources management in national policy and policy implementation.

**Immediate objective 2:**

- Government, private sector and civil society are cooperating to support Small-scale farmers to benefit from climate smart agriculture and sustainable land and natural resources management.

**Strategies of the project**

In order to achieve the outcomes of the project, the five partners apply four inter-linked strategies. A strategy is a bundle of activities that is carried out to bring about the outcomes that we are striving towards. It provides the direction and logic for individual activities. Each strategy may touch upon more than one of the outcomes. Some strategies may target a single stakeholder whilst others target the environment with which those stakeholders interact.

The four strategies that the project works through are:

1. Community networking as a force for securing climate-smart agricultural land management.
2. Research on policy and practice in relation to the interface between small-scale agriculture and climate change adaptation and mitigation
3. Demonstrating an integrated approach to Climate Smart Small-scale agriculture and REDD+
4. Advocating for Climate Smart Small-scale agriculture

### 1.3 Objectives, Scope and Output of the Assignment

The major focus of this study is to carry out a study on best practices for technologies scaling up by small holder farmer. Specifically the study will involve the following addressing the following key objectives:

i. To carry out a detailed analysis on the best practices for technologies scaling up by smallholder farmers.
ii. Provide recommendations on the best way for technologies scale up by smallholder farmers

### 1.4 Scope of the assignment

The scope of this study undertook a critical study on the best practices commonly by smallholder farmers and lessons for technologies scaling up by smallholder farmers. The study reported hereunder respond to the following key areas:

a. Assessing various types of technologies and interventions being promoted to smallholder farmers
b. Assessing views of smallholder farmers in relation to the technologies being promoted.
c. Assessing the current approaches used in promoting various technologies to smallholder farmers and indicate the strengths and gaps.
d. Improvements to be done to the approach of technologies dissemination
e. Recommendations on the best practices for technologies scaling up.

### 1.5 Methodology

The diverse of studies in two districts of Chamwino and Kilosa offered rich inputs on the practices around CSA. Contributions from the farmers experienced in Climate related issues in Semi arid and highlands areas were also appreciated and their views honored. The ranking of climate-smart agricultural practices that farmers thought would be important for their areas were mainly based on the traditional experiences on the same.

Apart from data explored from the two project areas, the consultant also managed to meet with 10 farmers from Kongwa and 10 from Bahi district [where INADES Formation Tanzania implements Climate change projects] and three farmer groups practicing their innovations in technologies close linked to Climate smart agriculture in Kondoa district where views on how farmer rate the technologies were shared

**2.0 CSA practices on the ground in Tanzania**

Many agricultural practices exist that can meet multiple demands and needs of livelihoods and agro-ecological systems whilst at the same time also contributing to an overall improved greenhouse gas balance of the agricultural sector.

In one of the study, the following CSA practices were identified and these will be related to practices on the ground by the smallholder farmers and recommendations for the scaling up will be proposed.

| **Climate change adaptation, mitigation, agriculture and REDD components** | **Elements considered in the analysis of policies, strategies and programmes** |
|---|---|
| Climate change Adaptation |  Change of crop varieties<br> Change of planting dates<br> Crop and livestock diversification<br> Erosion control<br> Technology innovations, capacity building in climate change adaptation (e.g., breeding water stress/drought tolerant crop varieties) |
| Climate change Mitigation |  Energy use in agriculture<br> Land preparation<br> Agricultural inputs (high versus low carbon food print)<br> Land use change |
| **Climate smart small scale agriculture** | |
| Climate smart practices at field and farm scale |  Soil, water and nutrient management along with agro forestry, livestock, husbandry and forestry and grassland management techniques |
| Diversity of land use across landscape |  Land cover<br> land use<br> species and varietal diversity of plant and animals |

**3.0 Semi arid climate:**

One study concluded that, Semi Arid in Tanzanian context may better refer areas with rainfall intensity below the 800 mm as semi-arid. Following this characterization semi-arid area of Tanzania includes the whole of Dodoma, Singida and Shinyanga regions in the central, and much of Mbulu District the lower areas of Arusha, Moshi and Pare District to the north, and lower areas of Iringa to the south (UNEP/FAO/UNESCO/WMO 1977).

The climatic conditions of most of the semi-arid areas of Tanzania are characterized by short and unreliable rains, both between and within season, which restrict the suitability of the land for crop cultivation (Kaduma, 1980; Madulu, 1996;). The semi-arid areas of central zone of Tanzania have erratic, low rainfall and short rainy seasons with widespread drought of one year in four (Majule and Mary, 2009) and repeated water shortages both between and within season.

Ngana (1983) reported that the presence of dry spells in critical periods for most crops contributed considerably to crop failure and famine in semi arid areas of Dodoma. Therefore, the most limiting factor to crop production and pasture development in semi-arid areas is repeated drought, dry spells within and between seasons.

Climate smart agriculture in these areas should ensure soil moisture conservation to improve soil moisture storage to ensure crop growth during the dry spell. Water supply through irrigation using water from rain water harvesting and storage in reservoirs is another climate smart option to reduce the impact of dry spell in crop production. Also unreliability of rainfall between season requires accurate weather forecast for timely planting of crops to avoid dry spell at critical stages of crop when is more vulnerable to drought.

In the central semi arid areas, crop cultivation and livestock keeping are common practices. These land use have contributed to degradation due to nutrient mining due to none replenishment of nutrients, soil erosion due to poor soil management, soil compaction due to overgrazing, and depletion of soil organic matter due to poor residue management. Therefore, adoption of climate smart agriculture to ensure proper integration of crop productivity and livestock keeping is essential to enhance resilience of agriculture to climate change.

**4.0 About Small scale Agriculture in Highland areas:**
The highlands of Tanzania are important in food production, especially now under climate change. This is because the climate of most of the highland areas of Tanzania is influenced of relief, and characterized by relatively higher rainfall and cooler temperature than their surrounding lowlands.

The modified climatic conditions also allow growth and hence production of wide range of crops ranging from tropical to temperate crops, further contributing to diversity of agricultural production for improved livelihood and hence adaptation to climate change. In addition, experience in the highland zone of eastern Arc shows that population growth makes more people to move up in the hilly areas for cultivation (Holmborn, 2003). The soils vary depending on the parent materials forming mountains.

The dominant land forms are hills with steep slopes, narrow to relatively wide valley bottom, usually with streams or rivers that drain water from the mountain catchment. For example in Kilosa, annual rainfall range from 800 mm in low-lying areas to about 1300 mm in high altitude areas (Mng'ong'o and Mwamfupe, 2003).

The humid highland areas of Tanzania are susceptible to land degradation due to soil erosion and excessive leaching of nutrients. The need to increase productivity and ensure food security for the growing population has been challenged by degradation of natural resources and recently hit by climate change impact (drought, seasonal variability, floods - Headey, 2011).

## 5.0 Types of technologies and interventions being promoted to smallholder farmers

Knowledge already exists on the CSA practices, as they are not quite new technologies; rather they have existed for some years and have been promoted and used for sustainable land resource management in most parts of the country, but their significant win benefits for the climate change challenge the smallholder farmers are facing, provides them with an increasing importance.

The lists of practices mentioned in visited areas, ranged from *soil water [moisture]* conservation and management, *soil structure improvements*, *nutrient recycling*, *crop pests and diseases control* and *soil erosion control* were mentioned as very important.

Further to this, *agro forestry practices* by increasing on-farm tree planting and reducing the rate of deforestation were also listed. Other practices mentioned were *improved manure management* and *composting*, *energy-saving cooking stoves, biogas unit installation*, *conservation agriculture,* and *installation of solar energy devices*.

Others mentioned diversification of sources of income generation to include, *keeping small stocks* like goats and Chicken and *Beekeeping.*

### 5.1 Climate smart agricultural technologies in semi arid areas

Chamwino is a semi-arid area receiving less than 600 mm rainfall per year. The landscape of Chamwino is mainly gentle slope extensive plains with few hills. The area has relatively strong winds. Farming and livestock keeping are dominant agricultural practices. Chamwino agro-ecological condition is highly susceptible to both wind and water erosion. Being semi-arid area moisture deficit problem is a dominant factor affecting crop productivity and vegetation cover or regeneration.

Overgrazing is the second dominant contributor to soil erosion. Gully and rill erosion are common features observed in agricultural land and along the roads in several villages Chamwino including Chololo, Manchali and nearby other villages. Compacted land due to overgrazing is widely common, and to a great extent reduced land area for cultivation. Because most farmers are agro pastoralists, there is advantage of availability of manure for soil fertility improvement.

Based on the above explanations regarding the semi arid areas, some studies and physical observations identified the following technologies to conserve soil and moisture are found appropriate to be used in general terms:

- Crop cover or soil cover
- Water harvesting and erosion control options.
- Reduced tillage using Magoye rippers and/or Ox – ploughs
- Adaptive crops selection
- Irrigation may be done for high value crops (vegetables) and for other crops when moisture deficit.
- Agro-forestry.
- Biogas production and utilization will have great potential to generate energy for cooking and to manage manure

For soil fertility management, the following practices are common:

- Integration of organic and inorganic fertilizers for crop production.
- Micro-catchment rain water harvesting and water storage in reservoir to provide water for irrigation during prolonged dry spell and for production of high value crops such as vegetables
- Agro forestry using leguminous trees which are adapted in Chamwino agro ecological condition are introduced/encouraged

### 5.1.1 Views of smallholder farmers on the technologies being promoted.

| CSA Practice | Description of practice and farmer's views |
|---|---|
| **Reduced tillage [using Magoye rippers]** | This is a common practice in soil compacted areas like most parts of Dodoma. The practice facilitates water conservation, reduces erosion because the top soil is protected, reduces soil compaction, and protects impact from rain and wind. The concern here is if not carefully done, weeds compete with the main crops, high tendency of the insect pests and diseases from the crop residues. |
| **Cover crops - Crop cover or soil cover** | Prevent soil erosion from wind and water, build soil organic matter (grass cover crop), improve water quality, suppress weeds, and provide nitrogen if leguminous crops are used. |
| **Kuberega and crop burning** | Non-burning of organic/plant residues can conserve soil and moisture due to residues form a surface mulch to cover the soil while non-burning reduce GHG emission. Very common practice in most part of Dodoma. |
| **Chololo pits** | Promote infiltration of rainwater, minimize soil, water and nutrient losses from the field,reduce siltation and pollution (by agrochemicals) downstream of the fields. Farmers are of the views that, this practice in most cases results into water logging especially in high rainfall seasons |
| **Earth Basins/bunds.** | |
| **Crop residue strips** | The technology can contribute to increased production as well as preventing soil erosion; improve water penetration and concentration of organic matters. It is a recommended practice in sloppy land. |
| **Composting** | Characterized as slow release organic fertilizer which stimulates soil life and improves soil structure. It also has beneficial effects on the resistance of plants to pests and diseases. According to farmers, the constraints may include availability and quality of raw materials, transport, labour and water. |
| **Adaptive crops selection** | Assures a degree of harvests even in bad years. Key note to be put here is that, despite their potentiality the major challenge remain to be on the adherence of other recommended agronomic practices.<br>Other challenge lies on the fact that potential indigenous varieties are disappearing [Genetic erosion] |
| **Irrigation** | Micro irrigation projects and techniques [lift pump, small dams, shallow wells water harvesting tanks etc] affordable to farmers significantly can compensate for crop losses due to moisture stress. In line to this, large scale irrigation schemes require high investment and management capacities which in most cases is lacking to smallholder farmers. |

| | |
|---|---|
| **Agro-forestry** | In addition to providing fodder, fuel, wood, and other products, trees in agro forestry systems promote soil and water conservation, enhance soil fertility, and act as windbreaks for nearby crops. The shortfall observes in most cases is the limited knowledge to farmers in growing best mix of trees, crops, livestock etc [in practical terms] and other major limitations to these traditional agro forestry systems are land tenure system and their sustainability has been seriously hampered by over grazing beyond their carrying capacity. |
| **Afforestation through Tree planting** | Trees are important in harvesting carbon dioxide hence a potential mitigative measure; conserve environment; source of income through selling or beekeeping etc. |
| **Use of alternative energy like Biogas production, solar and utilization or use of Energy saving stoves** | Generate energy for cooking, lighting and to manage manure as well as reducing GHG emissions. Use of energy saving stoves will reduce forest invasions and deforestation. Biogas are sometimes expensive for an ordinary farmer [Lessson learnt in Kisarawe June 2014 showed that a $6M^3$ biogas plant costs over Tshs 2,000,000/=] |
| **Bench or ladder step terraces -** | The technology can contribute to increased production as well as preventing soil erosion; improve water penetration and concentration of organic matters. Recommended in highlands and sloppy areas. Farmers commented that, the construction of terraces is laborious at initial stages, but later the labour requirement is reduced as only maintenance is done when required. |
| **Contours/Contour furrow** | The furrows are used to trap rain water and are tied at the end to prevent water flow out of the furrow at the end of the furrows. The contour furrow are suitable for inter cropping especially cereal and beans. As for Terraces, contour bunds are experienced to be laborious to construct . |
| **Mulching** | In addition to reducing weed seed germination and emergence, mulch can improve the growth and competitiveness of established crops by conserving soil moisture and modifying soil temperatures. The comments by some farmers are that, in some circumstances, mulching can aggravate weed problems. Organic mulches, especially hay from off-farm sources, may carry seeds of new weed species into the field. |
| **None burning of residues** | Non-burning of organic/plant residues can conserve soil and moisture due to residues form a surface mulch to cover the soil while non-burning reduce GHG emission. |
| **Crop diversity** | Prevent soil erosion from wind and water, build soil organic matter (grass cover crop), suppress weeds etc. It is also a crop insurance practice. Farmers are constraint by knowledge on how to obtain and plant the best mix of crops especially in smallholder farmers environment |
| **Crop rotation** | Crop rotation is recommended to achieve crop diversity, reduce incidences of pest and diseases of particular crop. Smallholder farmers in most cases fail to have choice of crops to rotate as this needs to consider differences in growing habits, nutrient requirement, and disease and pests susceptibility/resistance to ensure maximum benefit of crop diversity |
| **Bee keeping in conserved areas** | Conserve the biodiversity, informally control invasion of forests and can be a good source of income from honey and their products. |

| | |
|---|---|
| **Rainwater harvesting** | Important in supplementing moisture during dry spell through [micro irrigation techniques] and source of water for livestock. Farmers observe that, depending on the scale of the catchment area, it is laborious to establish during initial stages and that, a degree of knowledge is required to establish right orientation and capacities |
| **In situ rain water harvesting.** | This practice harvests water over short distance, stores water in the soil profile to ensure water supply to crops. |
| **Micro-catchment** | The water collected in the reservoir can be used for irrigation. The water can also be for domestic use or livestock watering. This technology has great potential to take advantage of unreliable and erratic rainfall characterized by high intensity rainfall over short growing period. |
| **Introduction of alternative Income generating micro projects like keeping small stocks** | Spreading risks of income and food security in bad years. Some of these have been quite stable sources of income and nutrition. Farmers' views showed that, keeping small stocks requires adequate knowledge and skills for such projects to be beneficial. |

### 5.2 Climate smart agricultural technologies in the highlands

Kilosa which is one of the project area receive rainfall ranging from 400 to 1400 mm per year, the district have several agro-ecological zone differing in land characteristics, rainfall and temperature. The major agro ecological zones includes gently undulating to rolling plains and plateau, rolling plains at low altitude to strong dissected uplands, flat alluvial plains, and strong dissected mountains with steep slopes. The district is rich in many river networks. Kilosa resident communities mainly practice crop farming only, while most livestock keeping in the district are practiced by immigrants from pastoralist communities (Maasai and Sukuma).

The common and also traditional farming is clearing land by burning residues followed by direct seeding, and cultivation is done after germination to control weeds. In both lowland and highlands farming is practiced, where in lowlands crops such as rice, vegetables and maize are dominant. Irrigation is practiced in rice production and vegetable production during dry season. Common beans, potatoes, vegetables and maize are common crops in highlands.

Climate smart agricultural technologies options in highlands and in steep slope farms include:

- Bench or ladder step terraces - These can be done by stone terraces, fanya juu, or residue strips across the slope to reduce distance of runoff and capture eroded particles on the stone line, earth bund of fanya juu or residue strips, which over time develop a ladder-like step terraces.
- Contours – can be contracted by furrow and soil bunds up the hill (Fanya juu) on the relatively same altitude.
- Mulching – in Kilosa the biomass production is greater than Chamwino, hence there is abundant biomass that can be soil cover through mulching instead of burning
- None burning of residues
- Reduced tillage should be practiced to help increase in soil organic matters.
- Crop diversity to include crops other than maize and beans should be encouraged.

- In the highlands, cover crops establishment at the end of growing season to protect soils during dry season.
- Integrated soil fertility management and agro forestry using fertilizer trees
- Bee keeping in conserved areas
- Irrigation should be practiced using available river water during rainy season in case of prolonged dry spell.

Responses by the farmers on the technologies currently being applied in the highlands areas, are closely related to those of Semi arid areas ranging from some of technologies being laborious and some requiring high initial investments.

**6.0 Assessment of the current approaches used in promoting various technologies.**

| The current approach | Strength | Shortfalls |
|---|---|---|
| Field visits | Mostly done by individuals who are motivated | Fewer people can do this |
| Using the project groups | It is the right conduit for reaching wider communities | Groups are not sustainable due to many reasons |
| Farmer Field schools | Provides practical evidence on the performance of chosen technologies | Ownership of the technology is doubted |
| Government orders | Expertise is readily offered by extension officers freely | Most of the time this Top down – does not attract commitment and sense of ownership |
| Look and learn visits | Provide forums for experience sharing | Require keen preparations and focused objectives |
| Workshops/Seminars etc | Provide forums for experience sharing | Selection of stakeholders to participate is in most cases mistaken |

**7.0 Main challenges to implementation and up-scaling**

**Cropping pattern Lack of national framework for reporting**

There is no national framework for reporting results on climate change. This is largely related to lack of reference to climate change in the government's national development strategies and priorities. Climate change is therefore missing from the national results architecture. To date results on climate change have been captured either by bi-lateral donors reporting on their individual or joint programmes or through reporting on global funding triggered by international requirements. No joint reporting is currently done by government and donors.

A study on farmers coping strategies against climate change in Singida District, Tanzania concluded that, large households are able to practice multiple cropping whereas smaller ones tend to practice only mono-cropping with a livestock activity, whether under dry land or irrigation. This suggests that multiple cropping is more labour intensive.

**How labour affects adoption of CSA:** Technologies with less labor intensiveness are favored by most farmers (Tumbo et al., 2011). Availability of labor has double impact on reducing adoption of conservation agriculture especially reduced tillage

**Farmer's experience**

The more experienced farmers are more likely to adapt than the less experienced. It is experience rather than age that matters for adapting to climate change.

**Limited awareness**

Lack of awareness amongst wider government and citizens on climate change: this leads to limited capacity to hold government and donors accountable on the impacts affecting their livelihood

**Challenges presented by Farmers towards adopting and scaling up technologies**

- Poor economic status of smallholder farmers to enable them adapt to some of resource needy practices e.g. water harvesting, biogas, solar etc
- Practices are not well documented, disseminated and/or widely shared
- Practices are not sufficiently backed with scientific evidences
- Perception by the community that the practices are primitive ways of farming
- Limited access to information on agricultural related developments
- Lack of appropriate policies that safeguards the practices on sustainable application of agricultural related resources, promoting smallholder farmers innovative practices etc
- Institutional factors: e.g. land tenure – when one does not have ownership of land resource he/she live in, rarely is he/she show willingness to invest in conserving the land
- Low returns from some soil and water conservation practices
- Biogas technology so far has not been taken up widely because most farmers have low productive cows in extensive or semi extensive grazing systems, as well as due to high initial investment costs for the installation of biogas units.

## 8.0 Recommended technologies for scaling up

| CSA Practice | The Potential of practice to be scaled up |
|---|---|

| | |
|---|---|
|  | **Reduced tillage [using Magoye rippers]**<br><br>The technology has been effective in most parts of Tanzania, especially in semi-arid areas of Dodoma and Karatu since its introduction in 1990s using oxen (Tumbo et al., 2011). Lay Volunteer International Association (LVIA) introduced ripping in Chamwino district.<br>Many studies have shown that, in areas where rainfalls are low and unreliable there is great potential for adoption of this technology. Mkoga et al. (2010) reported greater ability of conservation tillage (ripping and crop residue cover) ability to reduce the acute and long intra-seasonal dry spells and increase productivity.  In Ijaka village Kongwa district farmers who adopted this technology witnessed increased in production three folds. It is within smallholder farmers ability in terms of costs and operationalisation. Tshs 13,000/= - 15,000/= per acre are common charges for hiring a pair of oxen. |
|  | **Cover crops - Crop cover or soil cover**<br><br>Several studies reported better performance of *lablab* in low rainfall than high rainfall areas, while better performance of *mucuna* in high rainfall areas than in low rainfall areas of Bukoba and Dodoma (Ndamugoba, 2006; Tumbo et al., 2012). The technology is feasible in scaling up as it only requires minimum investment and knowledge on what resources are required. |
|   | **Chololo pitsand Earth bunds/basins**<br>Earth basins are other in-situ rain water harvesting which can be circular, half cycle/moon, square or rectangle shaped with earth bunds intended to capture and hold rain traditional water harvesting These technologies has been practice mostly in Arid and Semi arid like Chamwino especially for cultivating high value crops such as vegetables. |
|  | **Crop residue strips**<br><br>Being made from available crop residues, the technology can be easily adopted by smallholder farmers especially in highlands and sloppy areas at quite minimum costs. |

| | |
|---|---|
|   | **Composting**<br>Can be easily made from locally available resources like crop residues, grasses animal faeces etc that are within smallholder farmers' reach. This also requires minimum investment |
|   | **Adaptive crops selection**<br>Crops like sorghum such as Wahi, Hakika, and Macia and millet such as Okoa have minimum water requirement than maize and beans. Hence, such crops are more preferred in areas with rainfall less than 600 mm per year. For maize production there is a need for using maize varieties that are more adapted to low and un reliable rains. Early maturing and open pollinated varieties(OPV) (short varieties) of maize such as TMV1, Katumani, Kilima, Kito, and Staha should be used in low altitude areas and low rainfall areas over hybrid maize. The prices of these adaptive crops are relatively affordable by small holder farmers e.g. in Dodoma 1 kg of macia is sold at Tshs 1,250/= |
|   | **Irrigation**<br>There are many options for Micro irrigation technologies [lift pump, small dams, shallow wells water harvesting tanks etc] that are affordable to smallholder farmers which can significantly compensate for crop losses due to moisture stress. |
|   | **Agro-forestry**<br>The technology has been picking up following awareness raising and capacity building initiatives to smallholder farmers. It is affordable and manageable within the smallholder farmer's contexts.<br><br>Fertilizer trees capable of fixing atmospheric nitrogen and with multipurpose use such as *Sesbania sesban, Crotalaria grahamiana and Tephrosia vogelii* are recommended and have been successful used in Kenya and Tanzania (Kitalyi et al., 2011). |
|  | **Afforestation through Tree planting**<br>This can done through conserving indigenous species or planting new trees the knowledge have been passed to most rural communities by many institutions. |

| | |
|---|---|
|  | |
|  <br><br>**Evidence:** Farmers practicing terraces alone in Arusha and Dodoma. reported greater average yields of maize in maize (1.3t/ha) than minimum tillage alone (0.8 t/ha) (Tumbo et al., 2012). | **Bench or ladder step terraces**<br>Terracing is another CA technology for soil and water conservation which is effective especially in steep slope areas (Tenge, 2005; Tumbo et al., 2011).<br><br>Terraces are least adopted in Dodoma because the problem is more on soil moisture deficit, hence rainwater harvesting technology such as chololo pit are more adopted.<br><br>Despite the fact that, the construction of terraces is laborious at initial stages, but later the labour requirement is reduced as only maintenance is done when required and production benefits are assured. |
|   | **Contours/Contour furrow**<br>The furrows are used to trap rain water and are tied at the end to prevent water flow out of the furrow at the end of the furrows.<br><br>Contour bunds are potential for production of high value crops such as vegetables. The pace of adopting this technology is on increase as it is within farmers' capacities. |
|  | **Mulching**<br>This technology also can apply the resources that are within farmers' reach. |
|   | **None burning of residues**<br>This requires only change of mindset to ensure residues are not burnt and exploit the advantage of the same |
|   | **Crop diversity**<br>This is within farmers capacities in terms of affordability and management aspects |

| | |
|---|---|
|  | **Bee keeping in conserved areas**<br>Requires minimum investment if one uses improved beehives but the other option is to use traditional beehives that can be made by normal community members. |
|   | **Rainwater harvesting (RWH) - In situ rain water harvesting - Charco/malambo dams**<br>Ordinary farmers are now making hand dug water damns that are used for both watering the crops and as fish ponds |
|  | **Micro-catchment**<br>In Tanzania sunken beds/earth bunds known as majaruba is common rain water harvesting technology used in rain fed flooded rice production in semi-arid areas especially in heavy clay soils (Hatibu and Mahoo, 1999). The contour bunds have been used on the steep slopes of Uluguru Mountain in Mgeta, where vegetable production is practiced. |
|   | **Introduction of alternative Income generating micro projects like keeping small stocks:** Its potential is based on the fact that:<br>• The practice spreads risks of income and food security in bad years, some of these have been quite stable sources of income and nutrition and they can be easily turned into a family enterprise benefiting both family members |
| | **Crop rotation**<br>The technology if adopted, have many benefits and it only requires knowledge and skills to be imparted to smallholder farmers. |

**9.0 Recommendations on approaches to improve the technologies dissemination**

The CSA technologies and practices scaling up strategies should be participatory and may involve critical stages like awareness raising on the need to go for CSA where the potential and benefits of CSA to increase agriculture adaptation and mitigation of climate change should also be emphasized.

In its study Lengali consulting company, referred SUSTAINET which clustered scaling up into four types:

1) Quantitative up scaling: Here a **large number** of farmers either from same village or from different villages are **directly or indirectly enabled to adopt** a technology,
2) Functional up scaling: Where **same technology or a new activity** is adapted to suit a new situation, which is particularly relevant in technologies such as CSA that are related and dependent on other aspect like socio-economic benefits e.g. value addition, diversify farming activities
3) Political scaling up – **influencing how government provide services** or **changing policies** to favor adoption and use of technology, this can be achieved at local (through by-laws, village

committees), national (through policy briefs, conferences/workshops) , regional, or international level, and

4) Organizational scaling up – increasing **capacity in governance and management;** human resource development; and communication to make organization more efficient, e.g. build capacity of staff, increase number of technical staff, strategic planning.

The consultant managed to meet with diverse of CSA stakeholders [including farmers] who shared their views on how best can technologies be up scaled. The recommendations include:

**At higher levels, the proposal includes:**

- Adopt inter sectoral approaches and consistent policies/bylaws across agricultural, food security and climate change at all levels.
- CSA being mainstreamed in National policies and/or programmes with its inclusion in District development plans. This is important as CSA cross cuts a range of development goal.
- Increased investment in building knowledge base and developing technology. This should also be linked to financial support or opportunities from both public and private sectors to farmers and forest dependent communities to make transition to climate smart agriculture.

**At lower or farmer's levels:**

- Development of CSA Information Educational and Communication materials [user friend versions]. This tool and knowledge for information sharing. Some of the communication products can include (fliers, manual, and booklets), radios, classroom trainings to least few.

- Capacity building to impart knowledge and awareness through training. Training should target both farmers and extension services. The extension service is acknowledged to have great contribution to technology transfer; hence their correct and accurate understanding of CSA is important to successful scaling up of CSA. Farmers training focusing on the benefits of CSA, change of mind set, entrepreneurship in farming business, and record keeping are essential for scaling up CSA.

- Establishing pool of resource CSA oriented farmers, Farmer Motivators etc. this a community based activists highly skilled in CSA related technologies that can be used as local facilitators at community levels.

- Documentation, wide sharing and dissemination of CSA success stories and best practices.

- Studies and experiences have shown that, the most preferred scaling up approach by small scale farmers to include **field days**, **famers field school** and **fellow farmers** whereas the least preferred is print materials, radio, and *baraza i.e.* village meeting (Murage et al., 2010). This can also include interventions like establishment of Farmer Field Schools, Local exchange visits etc.

- Murage et al (2010) further reported that, farmers with low education level preferred **field days**, farmers in groups prefers **FFS**, farmers with small farm size prefers fellow farmer/trainers, while young and educated farmers preferred print materials.

- Organize and facilitate learning visits and/or farmer field days/shows for farmers and policy and decision makers to learn by seeing [Acquisition of knowledge and raising awareness]. Combination of classroom and practical training is important to up scaling technologies.

    - In Kilimanjaro, a combination of classroom and field practical training on CA was used to impart knowledge to farmers, village leaders, and extension staff to enhance adoption of CA, where 67% (760 farmers) of trained farmers were the first to adopt CA (SUSTAINET, undated).

- Integrate Indigenous knowledge to enhance adoption of CSA. Most often, agricultural research and extension tends to overlook the existing technical knowledge (indigenous knowledge) of farmers in particular area, which is based on generation of experience and field testing. Taking advantage of existing knowledge and experience related to agriculture tends to enhance adoption of improved version of indigenous.

- Government support to Indigenous knowledge also plays a significant role in adoption and scaling up of agricultural technologies. Farmers in Chololo district claimed lack of government support on their efforts in adopting *chololo* pits [an indigenous CA technology] (Tumbo et al., 2011).

- **Changing mindset** can be achieved through emphasizing the **importance of IK that are compatible with CSA**, and supported with scientific knowledge in scaling up through communicating research findings on IK and through training.

- Promote mechanism to improve access of required implements/equipment – promoting local manufacturing of equipment and maintenance/service of equipment or facilitating purchase of those equipment. Partnership/collaboration with institutions/companies like SIDO, CARMATEC etc. will be useful to improve access of required implements such as rippers, biogas plants, *ngwamba* hoe etc.

- Farmers groups are effective in dissemination of agricultural technologies. The preference of dissemination pathway also differs among gender groups, where young and educated farmers prefer receiving information through print materials such as booklets, fliers, extension manuals (Murage et al., 2010).

  Therefore, gender issues should be mainstreamed from all aspects related to technology implementation, products and pathways of technology dissemination.

- Support formation of community voluntary climate change societies or clubs that may be used as a conduit to support facilitation of knowledge and technology transfer between higher levels and smallholder farmers.

### 9.1 Incentives for adopting and scaling up the technologies

**Sound policies**
Policies aimed at promoting farm-level adaptation need to emphasize the critical role of providing information (through extension services) and the means to implement adaptations through affordable credit facilities. Policies, Laws, Procedures need to recognize local innovations by farmers and promote them e.g. use of certified local seeds for wider use

Community involvement on enabling legal environment, where farmers as end users are involved in planning and implementation of project activities is crucial. Community empowerment and facilitation to communicate their views and influence policies to improve land tenure, input access, communal, land management, at local and national level should be given special attention.

**Enhanced communication**
Improved communication networks and emerging media interest around climate change expected to raise awareness and increase domestic demand for climate change activities, although this will be a gradual process.

**Awareness**
Strengthened climate change awareness would allow climate change activists to support local communities to adapt to climate change through existing activities focused on priority areas such as food security and water availability, both of which are closely related to climate change.

**Access to extension services and credits**
Better access to extension and credit services seems to have a strong positive influence on the probability of adopting adaptation measures and abandoning the relatively risky e.g. mono-cropping systems.

## 10.0 Conclusions and Recommendations

- The major constraints facing the two agro ecological of Chamwino and Kilosa districts are soil erosion, excessive loss of soil moisture, and loss of soil productivity.

  Therefore, affordable and context based climate smart agriculture technologies that conserve soil moisture, supply soil water (water harvesting), improve soil fertility, use of adaptive crop varieties and types are highly recommended

- Improved productivity and food security are goals to be prioritized in climate-smart projects, as well as fostering the resilience of the agro-ecosystem and the livelihoods.

## References

Lengale consulting company Ltd April 2013 final report documentation of the lessons and the best practices for climate smart small-scale agriculture

Mugera, H and P. Karfakis 2013. Land distribution and economic development: small-scale agriculture e in developing countries. Available at

http://www.ecineq.org/ecineq_bari13/FILESxBari13/CR2/p251.pdf. Accessed Sept 2013
Nyambilila Amuri1 Technical study prepared by and submitted to CCAP Members

Faida Mali: [September 2012]; Assessment of Climate Change Adaptation and Mitigation Practices Suitable for Smallholder Farmers