

THE UNITED REPUBLIC OF TANZANIA MINISTRY OF AGRICULTURE LIVESTOCK AND FISHERIES

CLIMATE-SMART AGRICULTURE: TRAINING OF TRAINERS MANUAL

JULY, 2017





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LIST OF ABBREVIATION AND SYMBOLS

ASDP	Agriculture Sector Development Programme
BRN	Big Results Now
CAADP	Comprehensive African Agriculture Development Programme
CH ₄	Methane
CO ₂	Carbon dioxide
CSA	Climate-Smart Agriculture
CSO	Civil Society Organization
ERPP	Expanding Rice Production Project
FAO	Food and Agriculture Organizations of United Nations
GHGs	Green House gases
IPCC	Intergovernmental Panel on Climate Change
M & E	Monitoring and Evaluation
N ₂ O	Nitrogen oxide
NAMA	National Appropriate Mitigation Actions
NAPs	National Adaptation Plans
NGOs	Non-Government Organizations
RWH	Rain Water Harvesting
SUA	Sokoine University of Agriculture
SRI	System of Rice Intensification
URT	United Republic of Tanzania

INTRODUCTION

Climate-smart agriculture is "Agriculture that sustainably increases productivity, resilience (adaptation), reduces or removes Greenhouse Gases (GHGs) (mitigation) where possible, and enhances achievement of national food security and development goals" (FAO, 2010). However, in the Tanzanian context, the adapted definition of Climate-Smart Agriculture is "agriculture that sustainably increases productivity and income, increases the ability to adapt and build resilience to Climate Change and enhances food and nutrition security while achieving mitigation co-benefits in line with national development priorities" (National Task Force Planning Workshop Report, 2016). CSA aims to achieve food security and broader development goals under a changing climate and increasing food availability using different practices and technologies. CSA practices and technologies on crop, livestock and fisheries aims at addressing tradeoffs and synergies between the three pillars: productivity, adaptation, and mitigation. By addressing challenges in environmental, social, and economic dimensions across productive landscapes, CSA practices and technologies also embrace priorities of multiple countries and stakeholders in order to achieve more efficient, effective, and equitable food systems.

In understanding the importance of CSA in crops, livestock and fisheries production; practices and technologies were identified and mapped according to Agro-Climatic Zones of Tanzania. These Practices and technologies may serve as tool for deciding options within which the three pillars of CSA can be achieved.

It is because of the importance of CSA in the Tanzanian context that this Training of Trainers (ToT) Manual has been developed, in order to guide agricultural stakeholders on how to accelerate the uptake of CSA practices and technologies within the agricultural sector. This manual is divided into five chapters where by chapter 1 aims at helping users to understand some of the potential impacts of climate change and possible solutions for addressing climate related risks with regard to agriculture. It also provides an understanding of how changes in climate can affect agriculture and subsequently identifies best practices that will help farmers to adapt in their respective agroclimatic zones. Chapter 2 introduces in detail the concept of CSA practices and technologies in crop, livestock and fisheries production. Chapter 3 provides guidance on identification, roles and engagement mechanisms of different stakeholders on implementation of CSA related activities. Chapter 4 helps elaborate on issues related to mainstreaming of CSA into agricultural plans, programmes and budgets. Lastly, chapter 5 give guidance on how to carry out monitoring and evaluation of CSA related activities and interventions.

1 CLIMATE CHANGE AND ITS IMPACT ON AGRICULTURE

1.1 DEFINITION OF TERMS

Climate change and climate variability

Climate change is defined as the long-term continuous change to average weather conditions. Specifically, it is the rise in average surface temperatures on earth. The way climate fluctuates yearly above or below a long-term average value is climate variability

Risk

Risk can be defined as a probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action.

Vulnerability

Vulnerability is the state of being open to injury, or susceptibility to harm and lack of capacity to cope and adapt

Adaptation

Adaptation is defined as an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Mitigation

Mitigation refers to effort that seek to prevent or slow down the increase of atmospheric Green House Gases (GHGs) Concentration by limiting current and future emission and enhancing their potential sinks .

1.2 THE CONCEPT OF CLIMATE CHANGE

Climate refers to the average weather conditions in a certain place over many years. Climate encompasses temperature, humidity, atmospheric pressure, wind, rainfall, atmospheric particle count and other meteorological elements in a given region. The average climate around the world is called global climate.

Rising global temperatures lead to other changes around the world, such as melting glaciers, submerging of islands, rising of sea levels and the loss of wildlife habitats. Many places have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves. That's because the Earth's air, water, and land are all related to one another and to the climate. This means a change in one place can lead to other changes somewhere else. For example, when air temperatures rise, the oceans absorb more heat from the atmosphere and become warmer. Warmer oceans, in turn, can cause stronger storms. As these and other changes become more pronounced in the coming decades, they will likely present challenges to our society and our environment.

Climate change is largely caused by human activities, and it presents a serious threat to nature and people now, and in the future. It affects the plants and animal populations and distributions of species, the composition of ecological communities, and nature's provision of goods and services – such as food, fuel and clean water. Climate change also compounds other major threats to biodiversity, such as invasive alien species, habitat fragmentation and over exploitation.

The principal drivers of climate change are variations in atmospheric concentrations of greenhouse gasses (GHG, including water vapour, carbon dioxide, methane, nitrous oxide, and ozone) and aerosols, as well as changes in land cover and solar radiation, all of which alter the energy balance of the Earth's climate. Terrestrial and marine ecosystems currently sequester carbon, acting as 'sinks'. Changes to atmospheric carbon dioxide (CO_2) concentrations could shift the global carbon cycle towards annual net emissions, turning these ecosystems into 'sources'. Concentrations of other greenhouse gasses, including methane (CH_4) and Nitrogen Oxide (N_2O), which have similar effects, have also increased markedly as a result of human activities. Without ambitious mitigation efforts, global temperature rise this century could exceed four (4) degrees Celsius above pre-industrial levels, with catastrophic impacts.

1.3 THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURE

There are several impacts associated with Climate change in Agriculture:

• Lowering crop production

This is due to either erratic rains prolonged drought, changing temperatures, and nutrient constraints due to erosion or leaching. This may counteract the potential increases in yield. For example, if temperature exceeds a crop's optimal level, if sufficient water and nutrients are not available, yield may be adversely affected. Extreme events, especially flooding and drought, can harm crops and reduce yields.

• Lowering livestock production

Climate change is expected to further shrink rangelands which are important for livestock production. Climate change and variability are expected to lead to pasture and water shortages.

• Persistent Poverty

The majority of rural poor farmers depend on seasonal rainfall that could be unreliable for agricultural production causing them to get low yields that perpetuate the cycle of poverty.

The prevalence of crop and livestock pests and diseases

This situation has been exacerbated by a conducive environment influenced by the change in climate. Many pests and diseases thrive under warmer temperatures, wetter climates, and increased CO_2 levels. Farmers will spend more money to fight pests and diseases. The spatial and temporal distribution of pests and diseases is likely to increase with climate change. This could cause new problems for farmers' crops previously unexposed to these species.

· Water stress affecting agriculture

This is due to changes in temperature and rainfall patterns. Although increased irrigation might be possible in some places, in other places water supplies may also be reduced, leaving less water available for irrigation.

Reduced nutritional value of most food crops

Some laboratory experiments suggest that elevated CO_2 levels can increase plant growth. Though rising CO_2 can stimulate plant growth, it also reduces the nutritional value of most food crops. Rising levels of atmospheric carbon dioxide reduce the concentrations of protein and essential minerals in most plant species, including wheat, soybeans, and rice. This direct effect of rising CO_2 on the nutritional value of crops represents a potential threat to human health. Human health is also threatened by increased pesticide use due to increased pest pressures and reductions in the efficacy of pesticides.

1.4 THE IMPACTS OF AGRICULTURE ON CLIMATE CHANGE

- Industrial agriculture is a huge carbon contributing factor. It has a hugely negative impact on global warming. Figures from the Intergovernmental Panel on Climate Change (IPCC) say that agricultural land use contributes 12 percent of global greenhouse gas emissions. Supporting industrial agriculture perpetuates these disturbing practices.
- Greenhouse gas emissions from fertilizer and pesticide use; manufacture and use of pesticides and fertilizers, fuel and oil for tractors, equipment, trucking and shipping, electricity for lighting, cooling, and heating, and emissions of carbon dioxide, methane, nitrous oxide and other greenhouse gases significantly bumps the impact to the climate.
- Land use changes significantly contribute to climate change. Large-scale changes such as deforestation contribute to increased carbon dioxide concentrations in the atmosphere. Soil erosion by water, wind and tillage affects both agriculture and the natural environment. Soil loss, and its associated impacts, is one of today's most important environmental problems.

1.5 CLIMATE CHANGE RISKS AND VULNERABILITIES IN AGRICULTURE

The Agriculture sector faces many risks that could pose potentially serious consequences for all stakeholders. Volatility in the prices of agricultural commodities and "inputs" such as fertilizer, pesticides and equipment, as well as impact from pests, diseases, droughts and floods which have become more frequent and severe due to climate change—can negatively affect farmers and others involved in the agriculture industry. They can also put a severe fiscal strain on government. Malnutrition, gender inequality and bad governance also curb productivity and raise vulnerability over the long term.

The extent of vulnerability can be determined by undertaking assessments. Agricultural risk and vulnerability assessment helps identify appropriate risk management strategies, which often include:

- Mitigation such as Improved water management; Use of drought and flood tolerant seeds, Early warning systems and other activities that reduce the likelihood of adverse events and the severity of losses
- Risk transfer: Insurance and other arrangements
- Coping: Savings and targeted safety net programs, risk financing

These are accompanied by appropriate agricultural investments, policy support, and technical assistance activities to make the agriculture sector more resilient.

1.6 ADAPTATION AND MITIGATION OF CLIMATE CHANGE

Climate change and its associated impacts on agriculture sectors is a major concern in Tanzania. It has far-reaching consequences for agriculture that keeps disproportionately affect the poor. Greater risks of crop failures and livestock deaths are already imposing economic losses and undermining food security and they are likely to get far more severe as global warming continues. More than 80% of the population in Tanzania depends on climate sensitive rain fed agriculture as source of livelihood. Reducing vulnerability of agriculture to climate change will significantly contribute to socio-economic development and ensure food security. Adaptation measures are needed urgently to reduce the adverse impacts of climate change, facilitated by concerted international action and strategic country planning.

The National Climate Change Strategy (URT, 2012) sets out strategic interventions for climate change adaptation measures and greenhouse gas emissions reductions. The goal is to enable Tanzania to effectively adapt to and participate in global efforts to mitigate climate change with a view to achieving sustainable economic growth in the context of the Tanzania's national development blueprint, Vision 2025; Five Years National Development Plan; and national cross-sectoral policies in line with established international policy frameworks. The National Climate Change Strategy has outlined objectives for all sectors and proposed strategic interventions in those sectors and themes that are highly vulnerable to climate change such as agriculture.

The Agriculture Climate Resilience Plan (URT, 2014) has been developed to implement strategic adaptation and mitigation actions in the crops sub-sector. The Climate-smart Agriculture Programme for Tanzania (2015 – 2025) aims to build resilience of agricultural farming systems for enhanced food and nutrition security through six programmatic result areas namely: Improved Productivity and incomes; Building resilience and associated mitigation co-benefits; Value Chain Integration; Research for Development and Innovations; Improving and Sustaining Agricultural Advisory Services; and Improved Institutional Coordination. The Climate change agriculture (CSA) programme enhances the implementation of the Comprehensive African Agriculture Development Programme (CAADP) and responds to the 23rd Ordinary African Union Assembly Decisions and Declaration (Malabo Declaration), This CSA guideline has therefore been developed to support the implementation of Tanzania CSA programme.

1.6.1 Adaptation Options

Potential adaptation options that can help to integrate resilience in agricultural policy decisions, influence planning processes, and implement investments on the ground include:

- Improving agricultural land and water use and management through proper land use planning and management
- Accelerating uptake of climate-smart agriculture
- Strengthening knowledge on Early warning and community preparedness and establish early information systems
- The potential adaptation in the livestock sector include promoting climate change resilient traditional and modern knowledge on sustainable pasture and range management systems; enhancing development of livestock infrastructure and services; promoting development of livestock insurance strategies; strengthening weather forecast information sharing for pastoralists; promoting livelihood diversification of livestock keepers; and promoting improved traditional livestock keeping systems
- In fisheries promote aquaculture and enhance protection and conservation of aquatic ecosystems.
- In forests and ecosystems; application of best practices in soil and water conservation; promotion of fast growing tree species; farmer and pastoralist managed natural regenerations and use of alternative sources of energy

- As a major source of greenhouse gas (GHG) emissions, agriculture also has much untapped potential to reduce emissions through reduced deforestation and changes in land use and agricultural practices
- Better climate information is another potentially cost-effective way of adapting to climate change.
- The greater uncertainty from climate change can be best addressed through contingency planning across sectors and identify immediate priorities to improve preparedness for climate change.
- Mainstreaming climate change in the broader economic agenda, rather than taking a narrow agricultural perspective
- Devise new mechanisms to provide climate information and forecasting, research and development of diverse crops adapted to new weather patterns, and techniques to reduce land degradation.
- Diversify livestock types and varieties to address the environmental variations and economic risks associated with climate change.
- Change the intensification of production to address the environmental variations and economic risks associated with climate change.
- Change timing of farm operations to address the changing duration of growing seasons and associated changes in temperature and moisture.
- Diversify source of household income in order to address the risk of climate-related income loss.

1.6.2 Mitigation Actions

- Agriculture is also a major contributor of lowering carbon sequestration (storage) through land use change (the loss of soil organic matter in cropland and pastures, and forest conversion to agriculture), although quantitative estimates are uncertain. Emissions of carbon dioxide from changes in agricultural land use can be reduced by slowing deforestation.
- Promote carbon trading to reduce emission of Green House Gases this will motivate communities living adjacent to forest reserves to conserve trees and other biota. Carbon financing can support mitigation; the emerging market for trading carbon emissions offers new possibilities for agriculture to benefit from land uses that sequester carbon.
- Changes in agricultural land management (conservation tillage, agroforestry, and rehabilitation of degraded crop and pasture land, promoting afforestation and reforestation), overall improvement of nutrition and genetics of ruminant livestock
- Storage and capture technologies for manure, and conversions of emissions into biogas (production of valuable by-products, such as bio energy) is a better management of natural resources
- Development of low-emission crop varieties and livestock breeds.

Therefore, it is important to put in place strategies aiming at adapting to climate change and reducing its impacts through research, awareness raising, advocacy, mobilization and empowerment of most vulnerable communities. Adaptive strategies have to be implemented from household, community, and national levels in order to enhance already existing adaptation strategies while designing new ones. One of these strategies is to promote Climate-**Smart Agriculture**.

2 CLIMATE-SMART AGRICULTURE

2.1 INTRODUCTION

Climate-Smart Agriculture (CSA) addresses climate change related risks. Contrary to conventional agricultural development, systematically integrates climate change into the planning and development of sustainable agricultural systems (Lipper *et al.*, 2014). Also, CSA integrates multiple goals and manages trade-offs. Frequently, when it comes time to implement CSA, trade-offs must be made. This requires identification of synergies and weighs the costs and benefits of different options based on intended objectives (CSA guide, 2016).

By definition (FAO, 2010) CSA defined as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals". In this definition, the principal goal of CSA is identified as food security and development; while productivity, adaptation, and mitigation are identified as the three interlinked pillars necessary for achieving this goal.

However, in Tanzanian context the adopted definition of Climate-Smart Agriculture is "agriculture that sustainably increases productivity and income (profitability), increases the ability to adapt and build resilience to Climate Change and enhances food and nutrition security while achieving mitigation co-benefits in line with national development priorities" as defined at the National Climate-Smart Agriculture Task Force Planning Workshop Report of 2016.

2.2 THE THREE PILLARS OF CSA

2.2.1 Productivity

CSA aims to sustainably increase agricultural productivity and incomes from crops, livestock and fish, without having a negative impact on the environment. This, in turn, will raise food and nutritional security. A key concept related to raising productivity is sustainable intensification.

2.2.2 Adaptation

CSA aims to reduce the exposure of farmers to short-term risks, while also strengthening their resilience by building their capacity to adapt and prosper in the face of shocks and longer-term stresses. Attention is given to protect the ecosystem services, whereby these services are essential for farmers on maintaining productivity and enhances our ability to adapt climate changes.

2.2.3 Mitigation

Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each calorie or kilo of food, fibre and fuel that we produce and that we avoid deforestation from agriculture, we manage soils, crops, livestock and vegetation in ways that maximizes their potential to acts as carbon sinks and absorb CO₂ from the atmosphere.

2.3 CSA PRACTICES AND TECHNOLOGIES

In agriculture practices refer to management activities at the farm and landscape level while technologies are highly productive, high quality, efficient and resource-saving (water, energy, labour) techniques and expertise for agricultural production. It also refers to techniques appropriate for the protection and improvement of the environment

In view of the observed climate change impacts, different strategies are being employed to adapt to the changing climate. These strategies vary from place to place and includes early land preparation, early planting, dry planting, planting of drought tolerant crops, planting of early maturing crops, mulching, irrigation, tree planting, and the use of indigenous knowledge. Other strategies include re-planting, intercropping, crop rotation, minimum tillage, use of water harvesting technologies, digging irrigation trenches and terracing. Livestock farmers also adapt by growing grasses and perennial fodders, using farm by-products and doing additional activities such as crop farming. Fish farmers uses practices and technologies such as Pond Aquaculture/Fish Ponds, Integrated fish farming, Cage culture, Seaweed Farming and Mariculture.

2.3.1 Key characteristics of CSA

- **CSA maintains ecosystems services**: Ecosystems provide essential services, including clean air, water, food and materials.
- **CSA has multiple entry points at different levels**: CSA has multiple entry points, ranging from the development of technologies and practices to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains and strengthening of institutional and political enabling environments. As such, it goes beyond single technologies at the farm level and includes the integration of multiple interventions at the food system, landscape, and value chain or policy level.
- **CSA is context specific:** What is climate-smart in one-place may not be climate-smart in another, and no interventions are climate-smart everywhere or every time. Interventions must take into account how different elements interact at the landscape level, within or among ecosystems and as a part of different institutional arrangements and political realities. The fact that CSA often strives to reach multiple objectives at the system level makes it particularly difficult to transfer experiences from one context to another.
- **CSA engages women and marginalized groups:** To achieve food security goals and enhance resilience, CSA approaches must involve the poorest and most vulnerable groups. These groups often live on marginal lands which are most vulnerable to climate events like drought and floods. Gender is another central aspect of CSA. Women typically have less access and legal right to the land which they farm, or to other productive and economic resources which could help build their adaptive capacity to cope with events like droughts and floods.
- **Stakeholder Involvement**: CSA strives to involve stakeholders at local, regional and national stakeholders in decision-making. Only by doing so, it is possible to identify the most appropriate interventions, form of partnerships and alliances needed to enable sustainable development.

2.4 CROP SUB SECTOR PRACTICES AND TECHNOLOGIES

2.4.1 Rain Water Harvesting and Storage

Rain water harvesting (RWH) involves collecting, storing and conserving local surface runoff for agriculture (Boers and Ben-Asher, 1982). In crop production systems, RWH is composed of a runoff producing area normally called the Catchment Area (CA) and a runoff utilization area normally called Cropped Basin (CB) as explained by Hatibu and Mahoo (1999). The Rain water Harvesting and Storage Practices are highly recommended in semi-arid regions where there is limited water availability and storage capacities such as Dodoma, Singida and parts of Manyara and Shinyanga.

Water shortage affects more rural women since it is their cultural role to provide water for the family. They are more concerned with rainwater harvesting as compared to men. Therefore, small-scale rainwater harvesting can ensure a significant and steady supply of water for farming even in times of drought, and permit year-round vegetable cultivation with significant nutritional impacts on families.

2.4.1.1 Types of rain water harvesting practices and technologies

• In-situ rain water harvesting

Is a method of increasing the amount of water stored in the soil profile by trapping or holding the rain where it falls such as bunded basin (*Majaluba*). In essence, in situ rainwater harvesting technologies are soil management strategies that aim at maximum infiltration and minimize surface runoff to achieve better yields where soil moisture is a constraint. This technology often serves primarily to recharge soil water for crop and other vegetation growth in the landscape.



Farmers learning how to prepare bunds (Majaluba)



Transplanted rice in bunds – Mbarali, Mbeya

Chololo pits

This is harvesting technology initiated by a farmer in Chololo village, Dodoma. They are made during land preparation (before rains) and the soil is heaped below the pit. Crop seeds (millet seeds) are planted in the pits and part of the soil (sometimes mixed with manure) is returned to cover the seeds. The pit holds and conserves runoff water during the growing season. Contour bunds are constructed on the upper side of the farm to control excessive runoff'.

Chololo pits consist of pits of about 0.2 – 0.25m deep and 0.2-0.25m diameter dug in a line across the slope spaced at 0.5m within line and about 1.0m between lines. The adjacent line of pits is set such that the pits are dug in a middle position to the above ones so as to tap runoff that has drained through the first line of pits.

• Dam

Construction of dam is a system that involves the collection of runoff from large areas, which are at an appreciable distance from where it is being used. This may involve traditional water harvesting technologies e.g. Ndiva system in Pare Mountains, or Kitivo in Usambara Mountains.



Rain water harvesting at Mbigiri Village in Kilolo District, Iringa

2.4.2 Irrigation Practices and Technologies

• Irrigation canal lining

Canal lining is a process of reducing seepage loss of irrigation water by adding an impermeable layer to the edges of the trench. Seepage can result in losses of 30 to 50 percent of irrigation water from canals, so adding lining can make irrigation systems more efficient. Canal linings are also used to prevent weed growth, which can spread throughout an irrigation system and reduce water flow. Lining a canal can also prevent water logging around low lying areas of the canal. The most commonly used types of lining include: concrete, concrete blocks, bricks or stone masonry, sand cement, plastic; and compacted clay.



Lined canals at Lower Moshi irrigation scheme

• Drip/trickle irrigation

Drip irrigation is a technology of using water efficiently, reducing evaporation and enhancing infiltration and moisture retention in the soil profile through soil organic matter (SOM) management combined with the use of more drought-resilient species

Drip irrigation, also known as trickle irrigation, is an irrigation method that saves water and fertilizer by allowing water to drip slowly to the plant roots, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. It is easy to design, install and much less water is wasted during irrigation. The farmers can use low cost drip irrigation system, which will enable them to produce high value crops especially vegetables.



Drip irrigation system

• System of Rice Intensification (SRI)

SRI is a technology of increasing productivity of irrigated rice by changing the management of plants, soil, water and nutrients. It is a water saving technology for lowland (paddy) rice farmers, it involves controlled irrigation, (rice fields are alternately flooded and dried and fields monitored via simple, perforated tube). SRI

technology allows weed control by using hand tools such as push-weeders. It improves farmers' livelihoods; decreases costs of (water-related) inputs and increases resilience to both price shocks (e.g. increased energy costs) and weather variability. Paddy rice cultivation is a primary source of non-CO₂ GHG emissions from the agriculture sector

Therefore, SRI is widely accepted as climate-smart technology for its potential to significantly reduce methane emissions and increasing yields. SRI is now well used by farmers in Mcholi 1 ward in Ruvuma River Basin and Dakawa in Wami River Basin.





Farmers at KATC practicing on use of push-weeder

ERPP SRI Demonstration plot at Kigugu, Morogoro

2.4.3 Soil and Water Conservation Practices and Technologies

Soil and water conservation practices and technologies reduce run-off and eventually soil erosion, conserve the soil productivity and therefore help to increase yields, especially on sloping farmlands. There are different types of soil and water conservation practices, which can be used under specific conditions such as low rainfall, high rainfall, steep slopes, gentle slopes, deep soil, shallow soil etc.

• Ridging

Ridging is the farming practice of ploughing or placing stones across the slope following its contour line for the purpose of controlling soil erosion and enhancing water infiltration. This practice is mostly adopted in gentle slopes to control run-off and retain moisture and nutrients. Ridging creates a water break, which reduces the formation of rills and gullies during the times of heavy water runoff which is a major cause of soil erosion. The ridges should traverse the slope to capture the rainfall rather than running downhill, channelling water and soil away. The ridges can be tied (Tie-ridging) with small earth ties within the ridge/furrow to collect and store runoff in the soil to be used by crops planted on the ridges.



Contour Ridges in Kibwaya village, Morogoro

• Water Retaining/Harvesting Pits

A series of pits are dug into the ground where runoff normally occurs to allow seepage, minimize soil erosion and nutrient loss to improve soil fertility. The soil from the pit is used to make banks around the pits where by four ridges are tied together. Furrows carry excess water from one pit to the next. Traditionally, this system is mainly practiced by the Matengo tribe of Mbinga District, living on the steep slopes of the Matengo highlands. The pits are locally called Matengo pits or Ngoro. The system is suitable for steep slopes of 20% - 50%, which are prone to erosion.



Matengo (Ngoro)pits in Ruvuma

Terraces

Terrace farming is a method of farming using "steps" that are built into the side of a mountain or hill. On each level, various crops are planted. When it rains, instead of washing away all of the nutrients in the soil, the nutrients are carried down to the next level. Terraced fields decrease both erosion and surface runoff, and may be used to support growing crops that require irrigation. Small terraces with the size of a ladder are dug on steep slopes for the purpose of breaking the slope and controlling soil erosion. They are used for growing mainly vegetable crops such as cabbage, onions, green pea and beans.

• Fanya Juu terraces

Fanya juu terraces are made by digging a trench along the contour and throwing the soil uphill to form an embankment. The embankments are stabilized with fodder grasses and in between cultivated portions. Over time, the Fanya Juu develops into bench terraces. FanyaJuu is a very versatile technology - ideally suited to smallholder farms, especially in sub-humid areas where the land is sloping and erosion a threat

Fanya juu terraces are useful in semi-arid areas in harvesting and conserving water. The measure is suitable for soil too shallow for level bench terracing and moderate slopes below 20%. Fodder grasses may be planted on the bunds and fed to livestock. In the dry areas, water harvested from roads is directed into the trenches which allow production of bananas and fruits. However, they are not applicable on stony soils.

• Fanya chini terraces

Fanya chini terraces are made by digging a trench along the contour and the soil is put on the lower side of the contour trench. It is used to conserve soil and divert water. The embankment can be used to grow fodder. This is applicable on slopes of up to 20%.

Bench terraces

Bench terraces are level or nearly level steps constructed or formed on the contour and separated by embankments known as risers. They are formed by excavation or developed from grass strips or Fanya Juu terraces. They are suitable on slopes up to 55%.

• Stone terraces

Stone terraces are useful in areas with steep slopes but high population density and scarce land. The terrace risers are made of stones collected from the land. Stone terraces are suitable where there is abundant availability of stones.

2.4.4 Agro forestry Practices and Technologies

It is a dynamic, ecologically based, natural resource management system that, through integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits. Agroforestry systems include both traditional and modern land-use systems where trees are managed together with crops and/or animal production systems in agricultural settings.

Agroforestry play important roles in increasing the resilience to climate change impacts for small scale farmers and

in larger landscape approaches. Trees help fight climate change by storing carbon. Carbon, sequestered by trees intercropped with food and fodder crops and stored in above ground biomass and soil, contributes to reducing greenhouse gas concentrations in the atmosphere. Trees buffer against weather-related production losses, such as reducing soil erosion through e.g. hedgerow and contour planting - thus enhancing resilience against climate impacts. Trees bring nutrients from deeper soil layers, or in case of legume trees, through nitrogen fixation, and decomposition of leaf litter into fertilizer for crops. Trees on farms provide additional income and diversity of food sources through tree-based products. Agroforestry with Indigenous fruits trees can provide women with significant income. The combination of trees, crops and livestock mitigates environmental risk, creates a permanent soil cover against erosion and minimizes damage from flooding and acts as water storage, benefitting crops and pastures.

Agroforestry serves to enrich farmers through the harvesting of diverse products at different times of the year. It also brings job opportunities from the processing of tree products, expanding the economic benefits to rural communities and national economies. Planting of heavy feeder trees (e.g. some of Eucalyptus spps) is discouraged in crop lands.

2.4.4.1 Common Agroforestry Practices

• Tree in crop land

This is the practice of growing crops in association with trees left during land preparation or planted for their economic, social or cultural value. Among the common values include production of fruits, fuel wood, timber, medicine, fodder and shade or soil fertility improvement. Some of the common species found on cropped lands include Leucaena spps.



Faidherbia albida agroforestry in Mbarali (Source – ICRAF Tanzania)

Rotational woodlot

The rotational woodlot is an agroforestry practice which involves alternating arable crops with improved tree fallow on the same piece of land over time. The practice is intended to simulate the effects of shifting cultivation systems, with tree species carefully selected for their fast growth rates, high wood yields, and/or soil enrichment capacity. The practice involves three phases namely; tree establishment phase (crop and young trees), fallow phase (woodlot) and the post-fallow phase (clearing for cultivation).

Improved fallow

This is a practice of improving a farm which after continuous cultivation is rested (fallowed) for one or two seasons to regain fertility by introducing fast growing, high fertility enriching plants normally herbaceous legumes, grasses and/or shrubs. Some of the species used to improve fallow land are Sesbania sesban (sesbania), fish poisoning plant (utupa), Chick Peas (*Cajanus cajan*/mbaazi), Marejea (*Crotalaria ochroleuca*) and herbaceous legumes like Lablab.

Fodder bank

The practice involves growing of high quality fast-growing and high-yielding trees, shrubs, grass and herbaceous legumes in small homestead plots in order to provide low cost fodder supply to alleviate shortages of fodder and nutrition deficiencies to sustain livestock production. The animals are given supplements of protein-rich feedstuffs during the dry season when other good-quality fodder is scarce. The fodder may be cut, carried and fed to livestock in their enclosure (kraal). The kraal manure in turn is applied to crops thus enhancing nutrient cycle (soil resilience). The amount and quality of manure increase with good feeding of the animals. Some species used in fodder bank include; Leucaena leucocephala, Panicum maximum and Acacia spp.

• Tree planting / afforestation

It involves planting seedlings over an area of land where the forest has been harvested or damaged by fire or disease or insects. Trees contribute to climate change adaption by reducing wind speed, and decreasing damage to crops and degradation/erosion to the soil. They contribute to climate change mitigation by removing CO₃ from the atmosphere. Trees provide shades to mitigate the impact of climate induced temperature rise. Reforestation provides other benefits by reducing land degradation and soil erosion, and improving water infiltration. Also forests provide multiple benefits for local communities such as wood and non-wood products, timber, fruits, fibre, medicines and honey, all of which can be important for the livelihood.

2.4.5 Conservation Agriculture (CA)

Conservation Agriculture is a set of soil management practices that minimize the disruption of the soil structure, composition and natural biodiversity and has a potential to improve crop yields, while improving the long-term environmental and financial sustainability of farming. It encompasses farming practices which have three key characteristics:

- First, minimal mechanical soil disturbance (i.e. no tillage and direct seeding);
- Second, maintenance of a mulch of carbon-rich organic matter covering and feeding the soil (e.g. straw and/ or other crop residues including cover crops); and
- Third, rotations or sequences and associations of crops including trees and legumes which are nitrogen-fixing.

CA offers climate change adaptation and mitigation solutions while improving food security through sustainable production intensification and enhanced productivity of resource use. Management of soil fertility and organic matter, and improvement of the efficiency of nutrient inputs, enable more to be produced with proportionally less fertilizers. It also saves on energy use in farming and reduces emissions from the burning of crop residues. Moreover, it helps to sequester carbon in soil. CA contributes to adaptation to climate change by reducing crop vulnerability and protects crops from extreme temperatures. Hence, CA offers opportunities for climate change adaptation and mitigation solutions, while improving food security through sustainable production intensification and enhanced productivity.

2.4.6 Common CA practices and technologies

Cover cropping

Cover cropping is a technology that aims to maintain or cover soil surface during and between cropping operations. It is well known by farmers and extension agents. It can be achieved by planting leafy legumes between the plants of the main crop, providing shade, suppressing weeds, reducing ground temperature and evapo-transpiration, and thereby retaining soil moisture. It has also been used for reducing effects of raindrop impact and aggregate disintegration from slaking. Ground cover also prevents raindrops from directly striking the soil surface and allows rainfall to slowly penetrate the soil surface. Ground cover helps to sequester carbon dioxide in the soils but also control soil erosion.

Mulching

Mulching is a technology of applying a protective covering, usually of organic matter such as grass, leaves, straw, or peat, around plants or on the surface of the soil. Mulching helps to conserve moisture, improve the fertility and health of the soil and reduce weed growth. When applied correctly, mulching can dramatically improve soil productivity. Maintenance of a mulch layer provides a substrate for soil-inhabiting microorganisms which helps to improve and maintain water and nutrients in the soil. This also contributes to net increase of soil organic matter - derived from carbon dioxide captured by photosynthesis in plants, whose residues above and below the surface are subsequently transformed and sequestered by soil biota.

Crop Rotation

Crop rotation is a practice of growing different crops in a field each year or season. The new crop planted during the succeeding season will be from a different family. The idea behind this is to change what soil nutrients the crop uses, and the insects it attracts. So, the pests never get used to one field because crops are constantly changed. In terms of soils, each crop needs different nutrients. Changing the crop every year prevents depletion of any one nutrient in the field. Crop rotation is also effective in suppressing weeds because of regular changes in the root zone composition and patterns of nutrient absorption. Rotations and crop associations that include legumes are capable of hosting nitrogen-fixing bacteria in their roots, which contributes to optimum plant growth without increased gas emissions induced by fertiliser's production. Crop rotation over several seasons also minimises the outbreak of pests and diseases.

Intercropping

Intercropping is a multiple cropping technology involving growing two or more crops in proximity in the same field. The farmers commonly use a cereal-legume intercrop, mixing of crops for example millet, sorghum or maize with cowpeas or groundnuts. Farmers acknowledge leguminous crops such as beans, cowpeas, lablab and pigeon peas are suitable for intercropping as they contribute nutrients to the soils by biological nitrogen fixation. In this case, intercropping reduces depletion of individual soil nutrients. It can also involve new crop varieties (e.g. drought resistant).



Maize-Pigeon pea intercropping in Babati, Manyara

The most common goal of intercropping is to produce higher yields on a given piece of land by making use of resources that would otherwise not be utilized by a single crop. It provides a family with a balanced diet of staple grains, protein-rich beans, and green leaves for essential vitamins. It also reduces risk of total crop failure by having two crops instead of one. Also intercropping increase resilience to drought and reduced pest and diseases

• Minimum / Zero Tillage

Minimum Tillage means reducing tillage operations required to plant a crop that usually involves scratching or ripping along the row where the crop is to be planted and leaving the rest of the land untouched until weeding is required. Alternatively, farmers may just dig holes or pits where the seed will be sown (such as chololo pits in Dodoma and basins in Newala). It is a practice that minimizes run-off and increases infiltration rates. It actually ensures enough moisture is stored in the soil for plant growth.

Avoidance of tillage minimises occurrence of net losses of carbon dioxide by microbial respiration and oxidation of the soil organic matter and builds soil structure and bio-pores through soil biota and roots. Zero tillage has many advantages among others including minimal soil disturbance; retention of crop residues; seeds planted directly into previous crop's residue; and crop rotation. It reduces erosion; improves soil quality and structure, soil biota; reduces evaporation of water, helps retain nutrients. In addition, depending on rotation, no-till reduces greenhouse gas emissions of nitrous oxides.

• Crop Residue Management

Crop residues management is the practice where by crop residues are left in the field /farm after the crops have been harvested. These residues include sticks and stubble/stems, leaves and seed pots. Crop residues can also be used as animal feed outside the crop field. The protective soil cover of leaves stems and stalks from the previous crop protect the soil surface from heat, wind and rain, keeps the soil cooler and reduces moisture losses by evaporation. In drier conditions, it reduces crop water requirements, makes better use

of soil water and facilitates deeper rooting of crops. In extremely wet conditions, crop residues management facilitates rain water infiltration, reducing soil erosion and the risk of downstream flooding.

2.4.7 Soil Fertility Management Practices and Technologies

A healthy soil is fundamental for sustained agricultural productivity and the maintenance of other vital soilmediated ecosystem processes. To cope with climate change, specific management practices need to be adapted. Management practices that increase soil organic carbon (SOC) content from year to year through organic matter management will bring benefits. Soil Fertility Management Practices and Technologies include:

• Manure Application

Farm Yard Manure (FYM) - is an appropriate technology to enhance nutrient availability for ensuring high yields. FYM is also good for improving soil structure and control evaporation. Use of FYM increases croplivestock integration such that crop residues from well managed crops are fed to livestock. The livestock manure is then returned to the fields at the start of the cropping season.

A large proportion of the mitigation potential of agriculture (excluding bio-energy) arises from soil carbon sequestration, which has strong synergies with sustainable agriculture and generally reduces vulnerability to climate change. With regard to CO₂ sequestration in soils, use of FYM can achieve high carbon and improve soil structure and quality, because the accumulated carbon is in the organic form of humus. This will improve climate adaptation by reducing the impacts of flooding, droughts, water shortages and desertification, thereby also improving food and water security.

Compost manure - refers to a mixture of organic matter, from leaves and manure that has decayed or has been digested by organisms, and can be used to improve soil structure and provide nutrients. It helps dry soil to absorb and retain more water, compacted soils to regain their elasticity and poor soils to bring forth abundant farm produce; they provide plants with nutrients which they require to grow to their full potential.

Harvesting crops removes carbon from the soil that would otherwise return to the soil when the plant dies and decomposes. Compost returns organic matter to the soil. The nitrogen in compost can increase soil productivity, which can lead to increased crop residues and an increased return of carbon to the soil. Composting increases the formation of stable carbon that remains bound in the soil for long periods of time. Applying organic matter to soils is one of the most effective ways to divert CO₂ from the atmosphere and convert it into organic carbon in the soil.

Compost use can supply at least some of the mineral nitrogen that would otherwise have to be provided through mineral fertilisers, as well as most, if not all, of the crop's phosphorous, potassium and trace element requirements. Substituting the use of mineral fertiliser through compost use offers an opportunity of reducing GHG emissions caused by the manufacturing and transportation of fertilisers.

Efficient Use of Fertilizer (Micro Dosing) - involves the application of small and affordable, quantities of fertiliser onto or close to the seed at planting time, or a few weeks after emergence. This can be done by filling a soda bottle cap with fertiliser and applying it directly to the root of the crop. The micro-dosing technique increases the efficiency of fertilizer use, and helps improve productivity. For efficient use of Fertilizer soil status need to be known through soil testing.

Integrated Soil Fertility Management (ISFM) - aims to make available required soil nutrients by balancing different on-farm soil organic sources (amendments) with nutrients from mineral fertilizers (to address deficiencies) and reducing nutrient losses through soil and water conservation. It is advised that use of fertilizers should be under the concept of ISFM which is a set of agricultural practices adapted to local conditions to optimise the efficiency of nutrient and water use and improve agricultural productivity.

ISFM aims to optimise the use of organic matter that provides nutrients, sequesters C and enhances water storage (e.g. compost, animal manures or green manures); and enhance nutrient efficiency through crop rotations or intercropping with nitrogen-fixing crops and judicious/precision use of inorganic fertilizer to reduce losses. Also ISFM minimize GHGs emissions (reduced traffic and tillage and efficient use of organic and inorganic fertilizers).

ISFM strategies centre on the combined use of mineral fertilizers and locally available soil amendments (such as lime and rock phosphate) and organic matter (crop residues, compost and green manure) to replenish lost soil nutrients. This improves both soil quality and the efficiency of fertilizers and other agro-inputs. In addition, ISFM promotes improved germ-plasm, agroforestry and the use of crop rotation and/or intercropping with legumes (a crop which also improves soil fertility). Farmers who have adopted ISFM technologies have more than doubled their agricultural production and increased their farm-level incomes.

ISFM improves resilience of soils and agricultural production to weather variability; increases soil organic matter and soil organic carbon; improves soil health and fertility leading to increased yields and; lowers potential for nitrogen leaching and greenhouse gas emissions, potentially increases soil carbon. Other soil fertility management practices include; mulching, crop rotation (see under CA).

2.4.8 Crop Management Practices and Technologies

Adapted crops and crop varieties

Adapted crops and crop varieties involves improved seeds for high yielding, fast maturing, drought tolerant, salinity tolerant and flood tolerant. Climate change affects the agricultural yield directly through changes in temperature and precipitation, and indirectly through changes in soil quality, pests and diseases.

One key technology is improved seeds which are early maturing and drought tolerant crop varieties. It is noted that farmers understand and are using improved seeds in their crop production with the main objective to grow high yielding varieties as an adaptation strategy to climate change. Improved, high-yielding varieties include grain, legume, fruit and vegetable varieties that have been bred to improve and increase yields. Early maturing crop varieties enable the crop to escape stress at the end of the season and are ideal for intercropping as they provide less competition for moisture, light and nutrients as compared to late maturing varieties. In addition, they offer flexibility in planting dates, which enables multiple plantings in a season to avoid risk of losing a single crop due to drought and avoidance of known terminal drought periods during the cropping season. These advantages make the early maturing crop varieties more remunerative and less risky to climate change impacts. Drought tolerant crops bred specifically to be adapted to climate challenges in a particular region escape drought through early maturity.

Integrated Pest Management (IPM)

Integrated Pest Management (IPM) is a broad-based approach that integrates practices for economic control of pests. It aims to suppress pest populations below the Economic Injury Level (EIL). It is a strategy that promotes a safer and more sustainable management of pesticides. IPM lies at the centre of insect, disease and weed control. The combination of farming strategies, biological control agents, and necessary pesticide (e.g. herbicide, fungicides and insecticides) use can help farmers address pest problems using a variety of methods.

IPM reduces the need for pesticides by using several pest management methods; shields the environment from excessive or unnecessary pesticide applications; fosters clean water supplies; and promotes sound structures and healthy plants.

IPM contributes to climate change adaptation by providing a healthy and balanced ecosystem in which the vulnerability of plants to pests and diseases is decreased. By promoting a diversified farming system, the practice of IPM builds farmers' resilience to potential risks posed by climate change, such as damage to crop yields caused by newly emerging pests and diseases.

However, the multiple impacts of climate change could significantly reduce the effectiveness of current IPM strategies, leading to higher crop losses. Better knowledge and understanding of pest behaviour under different projected scenarios are required to adopt and develop new IPM technologies to respond to threats resulting from climate change.

• Timely or early planting/sowing

Timely or early planting/sowing (in some places also dry sowing) is a practice of adapting to climate change. The practice ensures optimal use of the short rain season and makes efficient use of accumulated nutrients from organic sources during the dry season (nitrogen flush). The use of this practice can be strengthened by climate services through timely provision of weather information.

• Crop Insurance and Safety Nets

Crop insurance is purchased by agricultural producers, including farmers, ranchers, and others to protect themselves against either the loss of their crops due to natural disasters, such as hail, drought, and floods, or the loss of revenue due to declines in the prices of agricultural commodities. The two general categories of crop insurance are called crop-yield insurance and crop-revenue insurance.

Safety nets are a form of social insurance comprising programmes supported by the public sector or NGOs that provide transfers to prevent the poor from falling below a certain poverty level. These programmes include cash transfers, food distribution, seeds and tools distributions, or conditional cash transfers (Devereaux, 2002). Safety net programmes can actually be a form of social investment into human capital (e.g. nutrition, education) and productive capital (e.g. allowing households to adopt higher risk and higher productivity strategies; (SOFI, 2010). Safety nets are increasingly being linked to rights based approaches to food security moving from a charity to entitlements.

2.5 LIVESTOCK SUBSECTOR PRACTICES AND TECHNOLOGIES

2.5.1 Improved Livestock Breeds

One key technology in livestock production is improving the genetic potential of cattle, poultry, pigs, sheep and goats to produce livestock which grow bigger and faster and at the same time resistant to stress (e.g. water, heat, diseases stress etc). This can be achieved by combining the desirable traits of the exotic breeds with the hardiness, and disease resistance of local breeds through cross-breeding or upgrading. The aim of cross-breeding is to improve local breeds to improve production (e.g. meat, milk and eggs), maturity time, resistant to stress etc. In this way, livestock keepers increase incomes by selling more Livestock products and by-products.

Different livestock types and breeds require specific environmental conditions. Climate determines the type and quality of pasture, availability of water, livestock pests and diseases and therefore overall livestock types and their productivity. Adapted livestock types and breeds often survive and do well under extreme climatic conditions. Under the changing climate, care should be taken in deciding the appropriate livestock enterprise for any particular area.

2.5.2 Improved Feeds

Improved feeds includes pastures, concentrates formulated using agro industry by products (molasses, brewers waste, maize/rice/wheat bran, oilseed cake). These feeds can be altered to improve its digestibility and provide needed nutrients. Addition of feed additive can also be used to improve digestibility and nutritive value of feeds. Such Feed improvement aims at reducing methane (CH₄) emissions. Climate change mitigations result from a more efficient absorption of nutrients, with a consequent reduction in gaseous losses, and the ability to produce comparable amounts of dairy and meat with fewer animals.

Feed supplements are required in small amount but are very important in enhancing productivity of livestock. Examples of feed supplements are urea-molasses multi-nutrient blocks, low bypass protein, lipids, and calcium hydroxide.

Succulent plants can offer an alternative source of water as well as feed to grazing animals especially during the dry season. Example of succulent plants includes Commelina spps, Pyrenacantha malvifolia and Water melons (Citrullus vulgaris) locally known as "mahikwi".

2.5.3 Livestock Improved Feedings

Improved feeding strategies include; cut and carry; rotational grazing by paddocks, fodder crops, and grassland restoration and conservation may be adopted to improve Livestock productivity. This entails storing animal feeds (stover, grass, grain) and making better use of feed (by combining types of feed), growing grass varieties specifically suited to the agro-ecological zone, and many other practices, such as fodder conservation and animal fattening.

The strategies also involve managing paddocks and/or pastures for ensuring enough fodder for livestock feeding at home, especially under zero grazing. Keeping livestock under zero grazing and in paddocks helps in improving manure management practices.

2.5.4 Pasture and Grazing Land Management

• Pasture Management

Pasture management is a practice of growing healthy grass and related plants to profitably sustain forage availability and livestock production while ensuring ecological health. Pasture management can provide significant benefits including improved forage yields, lower feed costs and improve livestock performance.





Pasture spps African fox tail grass (left) and Elephant grass (right)

Good pasture management tends to decrease carbon release to the atmosphere. The key to reducing GHG emission is to maintain healthy and high quality pastures. High quality feed means higher feed efficiency and more nutrients absorbed by the animal. The rate of consumption by animal (e.g. cattle) is influenced with high quality forage, increasing the efficiency of digestion and reducing the amount of time needed to graze. Faster digestion and greater feed use efficiency means less production of methane.

Improved pastures also have numerous indirect benefits to reduce GHG production from animal production. Perennial forages trap atmospheric CO₂ with their extensive root systems, storing carbon meters below the ground. Grasses and alfalfa not only improve the soil by increasing organic carbon, but are capable of absorbing excess water, lowering the water table and helping to control soil salinity. Reducing soil moisture also limits the risk of N losses by de-nitrification, cutting down the amount of nitrous oxide (N₂O) creation. Pastures also provide soil cover, protecting against erosion, and maintain or improve water quality.

• Grazing Land Management

Different methods can be employed to manage grazing land depending on indigenous knowledge in regard to natural resources management, human and animal diseases relative to their environment. Both traditional and improved grazing land systems can be employed managing grazing lands.

Under, traditional grazing land Management system, the communities control resource use pattern, and conservation using the traditional knowledge of the ecosystem and the biological diversity of the areas. Some of the traditional grazing land Management systems are Ngitili and Olelii.

Ngitili - is a traditional fodder conservation system that was developed by the Sukuma agro-pastoralists (Shinyanga) as a means of alleviating acute dry season fodder shortage. Ngitili encompasses retaining of an area of standing hay until the rainy season ends, the area remains closed to livestock and other activities at the onset of the rainy season and is opened up at the peak of the dry season to allow the livestock get dry season fodder. Grazing under ngitili normally starts from July/August after crop residues and forage in fallow areas has been depleted. Animals also removed from ngitili after all the fodder is exhausted or when fodder becomes available outside the ngitili.





Ngitili System in Shinyanga

Olelii -is a traditional fodder conservation system developed by the Maasai pastoralists (Arusha) as means of conserving fodder for the dry season or for the calves, sick animals and/or milking herd. The vegetation is left to grow and regenerate during wet season and livestock are allowed to graze in dry season. The elder groups oversee and directs on management and use of resources such as grazing pattern and conservation of fodder for dry season grazing. The Traditional ecological and farming knowledge (TEK) systems such as grassland and forest conservation and use, uses of biological diversity (including ethno-veterinary, nutritional and medicinal uses) is practiced and passed from one generation to another through the traditional institutions

2.5.5 Improved Grazing Land Management

Zero Grazing

A zero-grazing system is where grass is mechanically mown and brought to livestock. Its appeal is that it allows livestock to consume forages from fields that are too far away, or are separated by busy road, to be included in the grazing rotation. Zero-grazing can also play a role when utilizing fields too wet for grazing, provided the machines employed have sufficiently wide wheels to safely distribute their load. This system increases productivity to livestock due to minimum energy utilization, also there is no land trampling so controlling soil erosion realization.



Livestock kept under zero grazing

2.5.6 Manure Management

Major emissions from manure come in the form of methane (CH₄) from anaerobic decomposition of manure during storage as well as N₂O formed during storage and application. The creation of these gases is influenced by a variety of factors: temperature, oxygen level, moisture or amount of nutrients. In turn, these factors are affected by manure type, animal diet, the type of manure storage and handling and manure application techniques. To help reduce GHGs creation and work with large amounts of excess manure, it is important that manure management in the area concentrates on disposing manure in an environmentally and economically friendly manner. One of the economic and environmental friendly systems of managing manure is the use of Biogas digester

On Farm Biogas Production

This aims at reduce Greenhouse Gases (GHGs) emissions and develop more sustainable livestock operations. The GHGs are reduced by production of renewable energy as a substitute for fossil fuels via reduction of fugitive GHGs emissions from stored and land applied manures, as well as by reduction in use of chemical fertilizers in crop production. Utilization of livestock droppings (residue) in this way is important for preventing environmental pollution, also decomposed manure (slurry) is rich in nutrients and hence applied to crops be it food crops and pasture increases productivity.





Biogas plant

Cooking using biogas

2.6 FISHING AND AQUACULTURE ACTIVITIES

The main elements of climate change that could potentially impact fishing and aquaculture production are mostly associated with water level changes in water bodies and temperature fluctuations. These changes are triggered by the impacts of climate change such as changes in rain seasons and patterns, an increase in extreme events such as prolonged dry spell periods, drought and flood, water stress which results in changes of oxygen levels, solute concentration and water pollution through algae proliferation. However, there some fishing and aquaculture practices which are considered climate-smart based on their ability to ensure sustainable productivity in the face of climate change.

2.6.1 Pond Aquaculture/Fish Ponds

It is a common technology which uses pond to raise fish for domestic or market purposes. It is commonly practiced in areas with easy access to water, though it can also be practiced in dry areas where water can be harvested and stored for fish farming. Inland finfish culture which uses ponds is a dominant form of aquaculture in Tanzania. The Size of pond used in this type of aquaculture ranges from a few hundred square meters to a few hectares and are often shallow ponds.





Cement Fish pond

Earth fish ponds in Kalenga, Iringa

The practice of culturing more than one species of fish in the same pond is known as Polyculture and is known to have higher yield through proper food utilization, because different species of fish exploit food at different trophic levels in the pond.

Proper management of fish pond is critical to reduce production of noxious gases and mitigate risks of disease outbreak. It is advised to consider species of fish which are adaptable to changes in oxygen, temperature and saline species such as Nile Tilapia and catfish. In Marine milk fish is known to be tolerant to oxygen, temperature and poor water quality.

Planning of pond management based on the knowledge of climate change impact such as water availability, temperature changes, flooding events and periods of prolonged dry spell are critical on ensuring sustainable fish production.

2.6.2 Integrated Aquaculture and Cage Culture

Integrated aquaculture practice involves an integration of fish with another production system such as rice which is known as rice cum fish culture or integration of aquaculture with animal husbandry. In this way, the integrated aquaculture practice may exist in different forms. Though, in most cases fish species cultured are those which feed at low trophic levels of food chain. The practice is mostly practiced by a single-family unit, conducted at small-scale level and takes various traditional forms.

The practice is considered climate-smart as it contributes to food security and diversification, fish species are less susceptible to temperature changes and contribute on carbon sequestration





Integrated fish farming with crops

2.6.3 Sustainable Fishing

This include fishing practices which uses passive fishing gears such as gill nets, pots, hook, lines and traps with minimal destruction to aquatic environment, fish reproduction sites and ensure sustainability in productivity. Such practices may involve use of bio-degradable materials and use of innovative technologies such as echo-sounders in vulnerable or sensitive habitats. The practices are climate-smart because they focus on increasing productivity and sustainability of production systems even under the impact of climate change.

2.6.4 Seaweed Farming

Seaweed farming is the practice of cultivating and harvesting seaweed. In its simplest form, it consists of the management of naturally found batches. In its most advanced form, it consists of fully controlling the life cycle of the algae. It is practiced mainly along the sea shores and in Tanzania is practiced widely in Zanzibar and along the shore. The culture of seaweed requires minimal energy inputs and, therefore, has a relatively small carbon footprint. The rapid turnover in seaweed culture of approximately three months per crop (in the tropics) makes one of the climate-smart practices. This is because its carbon uptake potential far exceeds that obtained through other agricultural activity of the same comparable area. Additionally, sea weed farming systems can filter nutrients and provide a "cleaning service" to coastal marine environments and thus contributing on enhancing ecosystem service.





Seaweed farming

2.7 OTHER CSA PRACTICES AND TECHNOLOGIES

2.7.1 Bee-keeping

Beekeeping or apiculture is the maintenance of honey bee colonies, commonly in man-made hives. A beekeeper (or apiarist) keeps bees in order to collect their honey and other products that the hive produces (including beeswax, propolis, pollen, and royal jelly), to pollinate crops, or to produce bees for sale to other beekeepers. Hence, bee keeping contributes in increasing agricultural productivity through pollination, protection of surrounding environments as bee keepers need to maintain vegetation or forest cover and enhance resilience as source of income.



Beekeeping in Iringa

Traditional beehives are hung on trees close to a nearby forest. They are made by cutting a cylindrical log, carefully scooping inner content to make a hollow structure and sealing the two ends with small holes for exit and entry. Contrast to traditional hives, modern hives have straws to test honey is readiness before harvesting. By opening the hive and taking out the straw, the farmer will know whether the honey is ready to harvest. This method helps beekeepers to increase productivity.

2.7.2 Climate Information Services

Timely communication of climate information helps prevent the economic setbacks and humanitarian disasters that can result from climate extremes and long term climate change. Climate information also plays a crucial role in national development planning, for managing development opportunities and risks as well as for mitigation and adaptation. Efficient application of climate services requires that climate information become available to stakeholders. Availability of climate information services offers great potential to enable farmers to make informed decisions, better manage risk, take advantage of favourable climate conditions, and adapt to change.

2.7.3 Improved Post-Harvest

Appropriate post-harvest practices and technologies are important on ensuring sustainable applications of CSA practices by ensuring produces are sold in good quality and condition. Practices and technologies such as winnowing, drying, improved storage facilities, cold room transportation vans and other processing methods are key for sustainable productivity and market linkages of agricultural produce. This in turn increases community resilience to the impact of climate change by ensuring food and nutrition security.

2.8 UPSCALING CSA PRACTICES AND TECHNOLOGIES

Agriculture is considered climate-smart when it sustainably increases agricultural productivity and incomes, builds resilience to climate change and reduces greenhouse gas emissions. To achieve this, there is urgent need to upscale CSA practices which can be facilitated through;

- Proof of concept at sites/field established based on clear objectives set by farmers, extension officers and possibly researcher where possible using inclusive and participatory multi stakeholder planning approach.
- Creation of innovative CSA practices toolbox customized to an area, will allow farmers extension officer, researchers and other relevant stakeholders to identify CSA technologies and practices prioritized based on yield, resilience potential and other beneficial features customized to an area.
- Promotion of holistic approaches which are cross-sectoral will foster linkages between relevant stakeholders across value chain for sustainable and profitable CSA practice adoption at all levels and scales by farmers.
- Promotion of climate-smart agricultural innovative CSA financing arrangements and business models needs
 to be encouraged by policy and decision makers such that agribusinesses, SACCOS, banks and farmers based
 organization can spread risk and develop substitutes for collateral through multi-party financing mechanisms
 (PWC, 2012).
- Ensure equitable land access to men and women alike, increase investment in agriculture, promote sustainable use of inputs and ensure availability of reliable markets of the produce.
- Improve knowledge management system –by strengthening farmers knowledge of CSA practices, facilitate sharing the techniques and provide the greatest support to local knowledge system

2.8.1 The challenges in upscaling CSA

While CSA technologies and practices are generating significant benefits, their adoption often faces a variety of challenges or barriers by famors such as:-

- Insufficient information on potential gains of adopting new technologies, training and extension
- Limited availability and access to inputs
- Limited capacities on implementing improved practices
- Significant upfront expenditure required on adopting new technology
- Limited number of CSA projects

3 CLIMATE-SMART AGRICULTURE STAKEHOLDERS INVOLVEMENT

3.1 INTRODUCTION

Successful CSA implementation requires strong institutional support to: promote inclusivity in decision making; improve the dissemination of information; provide financial support and access to markets; provide insurance to cope with risks associated with climate shocks and the adoption of new practices; and support farmers' collective actions. In this regard, there are specific roles to be fulfilled by different stakeholders, also there are series of approaches and methods that should be considered based on local situation and the characteristics of the target group.

3.2 IDENTIFICATION OF STAKEHOLDERS

Multi-stakeholders' participation and active community involvement in projects/program design and development are critical for successful climate-smart agriculture implementation and upscaling. Different stakeholders have been identified with different roles to play in the CSA implementation among them are; Government, NGOs, Development and Research Partners, Private Sector, Farmers and Media.

3.3 ROLES OF DIFFERENT STAKEHOLDERS ON IMPLEMENTATION AND UPSCALING OF CSA

Different institutions have different roles to play in order to make CSA Implementation successful and sustainable for agriculture development. The following are some of the roles of stakeholders in different levels;

3.3.1 Government

• Sensitization and Awareness Creation at all levels

This can be done using various means such as Policy briefs, mass media (radio, TV, newspapers, social media and drama groups), farmers' exhibitions and resource centers (demonstrations), workshops, incorporating CSA concept in curriculums at different levels of education.

• Amendment and enforcement of related agriculture policies

Climate-Smart Agriculture is an initiative adopted from abroad, and it has got specific principles, practices and technologies, but also it is globally implemented under UN agencies such as FAO. Due to that, the need for the Government to amend Agricultural related Policies to accommodate CSA concepts where it is found necessary to speed up CSA up-take, is a core responsibility, and ensures their enforcement.

• Capacity Building of Extension agents

The Government has to organize and conduct workshops and meeting for capacity building for the extension agents to enable them understand and then engage in disseminating and promoting the CSA guideline appropriately

• Establish Partnership with Other Institutions

The government should establish partnership/collaboration with institutions and the private sector that will help and improve access of required implements/equipment including promoting local manufacturing of equipment and maintenance/service of equipment or facilitating purchase of that equipment such as rippers and biogas plants, for upscaling identified CSA technologies and practices

• Distribution on incentivizing agricultural subsidies

The government has to help the implementation of CSA by providing subsidies to agricultural inputs that support CSA practices and technologies to open a door for economic disadvantaged farmers to adopt CSA.

• Establish Monitoring and Evaluation Systems

To ensure CSA good performance and sustainability, the Government, in relation with other CSA stakeholders has to develop monitoring systems which will help to evaluate CSA achievements basing on the temporal and spatial scales, but also will merge a door for mistake correction towards higher CSA achievements

• To establish link to connect farmers with markets and service providers

In relation with other CSA stakeholders the Government has to provide suitable atmosphere on legal and policy aspects which will allow farmers to be linked easily and assuredly with markets and other service providers. To have Investments that support agricultural marketing and the food system, including roads and market infrastructure

• To Develop and provide improved early warning information (weather and climate)

The concept of Climate-Smart Agriculture, refers, agriculture activities to be carried out with great achievements by making farmers smart by being aware and make adaptation of the on-going changes of weather and climate. This requires developing reliable and trusted systems of early warning information

3.3.2 NGOs

NGOs are typically strong in providing social services, especially when supporting poor communities. For example, building social capital by organizing farmer groups to articulate their own needs and formulate solutions collaboratively, brings immediate positive effects at the local level.

- To fast up-take of CSA technologies by Improving the quality and relevance of research on CSA through local participation.
- Promote Indigenous CSA Knowledge, Practices and Technologies which are identified as CSA practices and technologies.

3.3.3 Research partners

Research Institutions can help in bringing together different stakeholders using Learning and Practice Alliance (LPA) approach which engages key stakeholders including policy makers, practitioners and farmers to join and work together in addressing existing problems and identify potential solutions. The LPA approach has the capacity to influence change in attitude, strategies, planning and resource allocations for upscaling CSA best technologies and practices. Some of the roles of research partners include;

- Participatory Research on Improved Technologies and Practices
- Strengthening capacity of agricultural research systems for linking with other actors (e.g. through stakeholder platforms, alliances and consortia, technology transfer and commercialization
- Bring Together Stakeholders Through Learning and Practice Alliance

3.3.4 Private Sector

As markets become increasingly important in developing economies, private sector actors also become significant providers of research and development, education and extension services.

When seeking private sector support for CSA initiatives, it is important to bear in mind that the private sector's main priorities are profit and public perception. CSA works to establish a 'triple win' scenario in which innovative practices produce higher yields, build resilience to climate change (reducing long-term risks) and lower carbon emissions all along the supply chain. By contributing to CSA, private businesses can enhance their brand recognition among key suppliers and consumers. Key private sector actors and the possible support they might provide to CSA initiatives include:

- Strengthening of informal agricultural Markets (e.g. certification and training of traders)
- Develop and Implement Risk Management Strategies such as productive social safety nets (e.g. cash transfers, food distribution, and seed and tool distribution, conditional cash transfers, food for work

3.3.5 Farmers

Farmers should form groups but also identify champion farmers who are very effective in obtaining and disseminating knowledge of CSA technologies and practices. Establishing farmers' groups and champion farmers should of course consider social dimensions due to the fact that the preferences of dissemination pathways always differ among gender groups

Farmers should engage in farmer field schools (FFS), which will include demo plots to help learn and disseminate practical knowledge on CSA packages. Learning visits and/or farmer field days/shows should be organized and facilitated for farmers. In addition, extension staff, private sector and policy and decision makers should learn by seeing. This will help farmers share knowledge and experiences of CSA practices among themselves, but also with policy and decision makers, extension agents and private sector

Knowledge sharing products (KSPs) should be designed to suit each category of stakeholder. Those with low education level, field days could be more appropriate mode of dissemination; farmers with small farm size prefer fellow farmer/trainers field visits; while young and educated farmers, print materials, electronic knowledge sharing such as use of media and mobile phones could be appropriate

3.3.6 Media

Mass media can reach large audiences with messages about CSA. Broadcast and electronic media include radio, television, film and the internet; print media includes newspapers, journals, publications; outdoor media includes posters, billboards and other materials placed in public view. An important channel for disseminating informative and educational contents, media can both reflect public opinion and shape it. In recent years, more and more people, even in rural areas have gained access to media hardware such as radios, televisions, computers and smart phones. Innovative technologies, such as solar-powered electronic devices, are also becoming increasingly important in mobilizing the media for development purposes.

3.3.7 Development Partners/Inter-governmental Institutions

Development partners are very crucial stakeholders in CSA implementation in Tanzania. They help in changing the mind-set of policy makers, practitioners and also farmers by emphasizing the importance of Indigenous Knowledge (IK) that is compatible with best CSA technologies and practices, and supported with scientific knowledge in scaling up through communicating research findings on IK and through training. Some of their roles are; Provide technical assistance, Provision of sourcebook, Provide financial assistance in promoting CSA and facilitate capacity building to increase knowledge and skills on upscaling best CSA technologies and practices

3.3.8 Religious institutions and communities

The term 'institutions' does not merely refer to types of organizations; it also encompasses cultural and social norms and conventions. An awareness of public opinions and values is therefore important when formulating a CSA strategy. While religious institutions or issue groups are unlikely to provide CSA-related advisory services, they can offer indispensable insights into prevailing beliefs and values. They can be mobilized as powerful tools for advocacy and endorsement

3.4 STAKEHOLDERS ENGAGEMENT MECHANISMS

Basing on the provided roles of stakeholders, mechanisms for implementation are very important; hence the need to identify stakeholders' engagement mechanisms is crucial for effective implementation of Climate-Smart Agriculture. Establishment of different platforms at all levels will be used as the main mechanism to engage different stakeholders to be involved in the CSA implementation, for example creation of CSA Networks and convening for national/regional events. Also the stakeholders have to be aware on how they engage in the implementation of CSA basing on their roles. For example Government through mainstreaming of CSA initiative in policies and strategy is one of the mechanisms for its engagement.

3.5 APPROACHES FOR CSA INTEGRATION

The agricultural extension approach in Tanzania involves farmers' groups in the planning and implementation process. It is also integrating different extension providers, allowing room for pluralistic extension approaches and empowering farmers organizationally and financially to demand for appropriate services. The extension services use a combination of dissemination pathways such as

• Gender responsive approach

Social inequality and social inclusion, particularly in reference to gender, have been recognized as a

foundational issue in development .The successful of CSA practices requires institutional and behavioral change, which is not possible without social analysis (including gender analysis) influencing policies, projects, and other interventions aimed at achieving sustainable CSA.

• Community Based Approach

This is the approach whereby a practicing farmer or livestock keeper selected by their community and trained to a standard where they can offer credible advice and services in a specific area of production. A sizeable proportion of those trained 5-10 years ago have built a loyal client base by charging affordable fees for their services, and plan to continue in the role indefinitely

• Farmer Field School Approach

It is used throughout the country and is incorporated within DADPs. It uses experiential learning and group approach and currently its successes have been seen especially in smallholder's irrigated rice farms where production has increased, key farmers train others. The impact of the approach is an increase in production seen in FFS members compared to non-FFS. Agricultural resource centres are permanently established in each District/ward used for demonstration of good agricultural technologies/practices.

• Farming System Approach

This is the approach where by farmers priorities are incorporated into the research agenda & user-friendly technologies are developed.

• Farmer to Farmer Extension Approach

This is the approach whereby there are trained farmers who can train others.

• Champion Farmer Approach

This is the approach whereby extension services choose farmers to work with them in implementing their programs. Those farmers selected to lead "farmer-to-farmer" extension are often called model, master, or lead farmers and are chosen according to their agricultural expertise

• Landscape and Ecosystem Services Approach

This approach deals with large-scale processes in an integrated and multidisciplinary manner, combining natural resources management with environmental and livelihood considerations, It is also factors in human activities and their institutions, viewing them as an integral part of the system rather than as external agents

Payment of Ecosystem Services Approach

These are incentives offered to farmers or landowners in exchange for managing their land to provide some sort of ecological service. They have been defined as "a transparent system for the additional provision of environmental services through conditional payments to voluntary providers.

• Nucleus and Out Growers Approach

Formal arrangement between agriculture companies and farmers (contract farming), the private sector facilitates farmers' access to credit, improved inputs, pooling of farmers' produce, processing and developing market links

4 MAINSTREAMING OF CSA INTO AGRICULTURAL PLANS

4.1 INTRODUCTION

This topic addresses the issue of mainstreaming Climate-Smart Agriculture (CSA) into development plans at different levels. The first part of the topic looks at awareness and sensitization on CSA. The second part addresses the CSA related activities. Finally, the third part focuses on budgeting for CSA activities and how climate change affects investment needs for agricultural development to support food security, poverty reduction and economic growth.

4.2 AWARENESS CREATION AND SENSITIZATION ON CSA

4.2.1 Meaning of awareness

Awareness is having knowledge that something exists, or understanding of a situation or subject at a given time based on information or experience (in simple term is knowing what is going on). Creating awareness is letting the right people know that the information/service exists and is available. To raise awareness is to inform and educate people about a topic or issue with the intention of influencing their attitudes, behaviours and beliefs towards the achievement of a defined purpose or goal.

4.2.2 Meaning of sensitization

Is the process of making someone react to something that previously had no effect. Basing on CSA dissemination, sensitization aims at making all stake holders to be responsive to their roles and contributions on the implementation of CSA practices and technologies

4.2.3 How to create awareness

Many African smallholder farmers and farm communities experience low crop and animal yields but they are not aware that, this is partly a result of climate change. Most of them are not aware of what to do to remedy the situation. The current climate change discourse is very much promoted by international NGOs and some CSOs with little contribution from local farmers and communities. Other stakeholders such as CSOs can be consulted to be involved in awareness creation.

Awareness raising is an important stage for effective dissemination of knowledge and technologies, to be successful, it needs to use all appropriate communication channels such as radio, television, print media, leaflets, brochures, oral communication, and traditional communication.

Training

Training of key stakeholders in climate change and climate-smart agriculture is important in order to increase knowledge and understanding, which eventually contribute to change or shape their mind-sets in their undertakings. Training should therefore be done based on the roles of the stakeholders at different levels. Training can be offered through different ways such as; technology-based learning, on field training, coaching, lectures, group discussion, films and videos.

Likewise, training should also take into account the specific role of each target group (stakeholders). Relevant training manuals should be prepared for the target group, which will also serve as a reference during the implementation stage.

• Integration of CSA in the Syllabus

Educational institutions actually prepare and shape future working force of different professionals including the rural agrarian community. Most of the agrarian communities use knowledge and skills acquired at different stages of their education. Introduction of CSA in the syllabus would therefore help building capacity of not only future farmers but also future stakeholders of CSA (Policy maker, Researcher, Planner, Economist, Engineer, and Doctor etc.). The government should take up the agenda and oversee possibilities of mainstreaming it in the curriculum or syllabus.

4.2.4 Target for Awareness Creation

Awareness raising targets different groups such as, government authorities, central and local administrative authorities, religious, traditional leaders, opinion leaders, NGOs, civil society, donors, media and community. Planning for awareness raising strategy should therefore take into account the target group, the message for each target group (preferably specific to the group), and the appropriate channels for communicating those messages.

4.3 CSA RELATED ACTIVITIES AND THEIR JUSTIFICATION

CSA activities can range over a very broad range, depending on the relative importance of its three pillars – food security (productivity), adaptation, and GHG mitigation.

4.3.1 CSA Related Activities

The table below shows some of the CSA related projects/activities together with the Practices and its related pillar(s);

CSA RELATED ACTIVITIES	CSA PRACTICES OR INTERVENTION	RELATED CSA PILLAR(s)
Soil and water Management	 Water use efficient (drip irrigation, lining of canals) Rain water harvesting and storage Land and catchment management System of Rice Intensification Conservation agriculture(Cover cropping, Crop residue management, crop rotation, agro forest and Mulching 	Productivityadaptation
Research	 Resilient crop varieties (Drought tolerant varieties, Early maturing varieties and Water efficient varieties) 	ProductivityAdaptation
crop production & land preparation	Resilient crop varietiesPest and diseases controlPost harvest and storage facilities	ProductivityAdaptationMitigation
Livestock	Improved livestock breedImproved FeedingEfficient manure management;	ProductivityAdaptationMitigation
Fisheries and aquaculture	 Pond aquaculture integrated aquaculture cage aquaculture, seaweed farming 	Productivitymitigation
Disaster and risk reduction	crop insuranceproductive social safety nets	• Adaptation

4.3.2 Justification for CSA activities

The changes in agricultural systems needed to achieve agricultural growth for food security, nutrition, and economic development under climate change are largely built upon sustainable agricultural intensification activities. Building an evidence base to identify the most suitable activities is an essential part of developing CSA strategies, investments and financing plans. Innovative financing mechanisms that link and blend climate and agricultural finance and investments from public and private sectors are a key means of implementing CSA. New climate financing instruments such as the Green Climate Fund are currently under development and could be a way of spurring sustainable agricultural development. Strong and all-encompassing Nationally Appropriate Mitigation Actions (NAMAs) and National Adaptation Plans (NAPs) are key national policy instruments important in creating links to national and international sources of finance. National sector budgets will continue to be the main sources of funding, climate integration into LGAs planning and budgeting is therefore a prerequisite for successfully addressing climate change.

4.4 PLANNING CSA ACTIVITIES WITH GENDER CONSIDERATION

Gender is pertinent to CSA, hence the need to put emphasis on the importance and ultimate goal of integrating gender in CSA activities is inevitable. The aim for integration is to reduce gender inequalities and ensure that men, youth and women can equally benefit from CSA related interventions in the agricultural sectors, so that to reduce risks linked to climate change. Taking a gender responsive approach to CSA, means that particular needs, priorities and realities of youth, men and women are recognized and adequately addressed in the design and application of CSA activities. Gender transformative CSA interventions seek to transform gender roles and promote more genderequitable relationships between men and women.

Planning of CSA activities must be flexible enough to reflect gender priorities and needs (specific to women). The active participation of women in the planning process, development of funding criteria and allocation of resources for climate change initiatives is critical, particularly at local levels. Gender analysis of all plans, budget lines and financial instruments for CSA is needed to ensure gender-sensitive investments in programmes for adaptation, mitigation, technology transfer and capacity building.

4.4.1 Mainstreaming Gender into CSA Planning Process

The adverse impacts of climate change have disproportionate bearing on youth, men and women. It is therefore important to consider gender specific concerns and subsequent solutions in climate change adaptation planning processes. Women are not only differently vulnerable to climate change but they are also crucial in implementing adaptation solutions and building resilience. Similar to mainstreaming climate change adaptation development activities, gender integration in climate change can be internalized through systematic integration in policies, programmes, projects and activities.

4.4.2 Gender Analysis

In order to support women's and men's equal uptake of and benefit in site-specific CSA practice or technology, gender analysis as well as equal participation and engagement of women and men are the key actions to be taken at the outset of any CSA intervention. In the longer term, broader changes are needed in order to reduce the constraints women and men may face in terms of accessing resources, services and information.

Gender analysis of how women are differently affected by climate change and identification of gender specific responses during the planning stage can help make CSA activities and outputs gender sensitive. Socio-economic vulnerability assessments, assessing the CSA activities to address woman's access to resources (e.g. finance, information, etc.) can help to set up gender specific objectives at an initial stage of the planned CSA related activity, project or programme.

4.5 BUDGETING FOR CSA RELATED ACTIVITIES

Significant progress in addressing climate change in the agricultural sectors can only be achieved if climate concerns are considered in the context of all agricultural investment decisions, rather than in climate change specific projects. The need of adaptation to climate change in the near, medium and long term implies that, changes in agricultural investment needs, ranging from the farm scale up to the national and international levels. Current agricultural investment flows are insufficient to adequately finance sustainable agricultural development. This financing deficit is due not only to a lack of overall funds, but also to the fact that, the activities which are currently allocated resources do not generate the highest returns for sustainable agricultural growth. The main sources of agricultural investment

finance are the farmers, herders, fishers and foresters themselves. For this reason, public investment that enables agricultural producers to make investments in CSA is a priority.

4.5.1 Gender responsive budgeting

Gender-responsive budgeting aims to address the lack of resources for gender mainstreaming activities by translating gender commitments into fiscal commitments through the application of a gender lens to the entire budgeting process. In addition to making the work undertaken by women economically visible, gender-responsive budgeting is advocated as a means of increasing transparency and accountability by delineating the amount of the budget allocated to women that is actually spent.

Gender budgeting can be used as an important tool to allocate resources for implementing gender specific adaptation actions. Adequate financial resource allocation is key to the achievement in the gender mainstreaming process, and is one of the biggest challenges in efforts to implement gender mainstreaming across climate change related and other activities.

4.5.2 Potential Costs of Maladaptation

Important issue to consider is the potential costs of maladaptation (e.g. agricultural investments that increase vulnerability to climate change or increase risks of economic losses associated with unsustainable and unprofitable investments). Investments, particularly large fixed capital investments with significant lifetimes, are particularly vulnerable to being maladaptive if climate risks are not considered. An example that is likely to be maladaptive and essentially add to the adaptation deficit is a case where major capital expenditures on irrigation systems use outdated estimates of water demand and supply in areas where climate change is predicted to have major impacts. Screening agricultural investment plans for their degree of "climate smartness" is a simple first step that can be taken to identify the potential overlap between adaptation and development investments, as well as potential maladaptive agricultural investments. The screening methodology considers the potential contribution of planned activities to various aspects of adaptation as well as mitigation.

This suggests that climate-smart agricultural investments with mitigation co-benefits should be identified within the context of existing agricultural investment strategies developed for the purposes of agricultural growth for a specific context.

4.5.3 Source of Finance for CSA

Financing options specifically targeting CSA are still limited, necessitating a strategic use and combination of existing funding sources. The basis for any CSA activity should be the identification of a country's opportunities and vulnerabilities, corresponding needs and preferred options for CSA activities. After priorities have been defined, a strategic approach to sources of finance based on an understanding of available channels will not only increase the chances for approval, but also enhance the fit between the finance option and the country's overall approach to climate change in agriculture.

• Internal Finance

The Government through the national budget is the main funder of the agricultural sector, supplemented by Development Partners (DPs), private sector and CSOs thus making significant contributions to the sector. In addition, the Government in collaboration with DPs and private sector have put in place measures

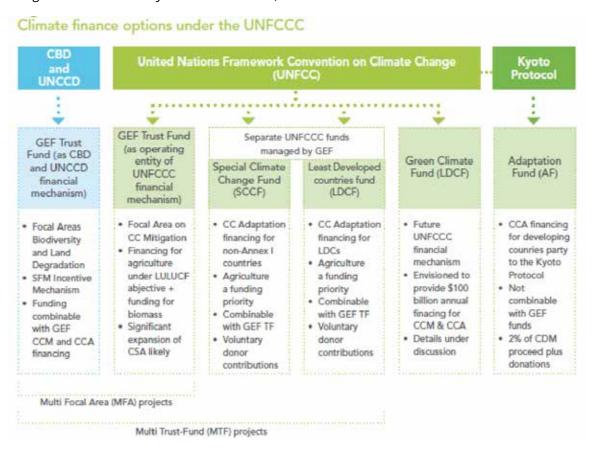
aimed at improving the flow of finance and investment to the agriculture sector such as: the Export Credit Guarantee Scheme, USAID Guarantee for Input Scheme, Private Agriculture Sector Support (PASS), the Agro-Dealers Scheme and the Agriculture Input Trust Fund (AGIFT). Other initiatives that enhance Public Private Partnerships include the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) and Big Results Now (BRN).

ASDP2 is the potential source for funding especially at the local level as it aims to increase resilience of agricultural systems to climate change and variability. ASDP-2 interventions will be undertaken with climate change considerations factored into the interventions, including Climate-Smart Agriculture in sustainable landscapes and appropriate climate change mitigation strategies. Farmers' adaptive capacities will be strengthened to ensure the impact is understood and integrated into their farming systems/activities. Capacity building programmes for FFSs, extension officers and subject matter specialists on current climate related issues will be developed, implemented and periodically updated

• External Finance

Main sources of external public financing for climate change adaptation and mitigation include the following:

i. Financing mechanisms directly under the UNFCCC;



ii. United Nations (UN) organizations or programmes;

UN Agencies and Programmes play a central role as implementing agencies for the activities financed through the funding channels under the UNFCCC. In addition, UN Agencies also provide climate financing directly, primarily through multi-donor trust funds financed by member states e.g. the UN REDD programme.

iii. Multilateral Development Banks (MDBs);

The primary function of MDBs is to provide loans under conditions and objectives based on their overall principles as well as the specific agreements between a specific country and the respective development bank. The agricultural sector remains one of the primary target sectors of MDB loans. As MDBs are increasingly incorporating environmental sustainability criteria into their agricultural lending practices, their loans play an increasing role as a financing option for CSA activities

iv. Bilateral public financing channels

Bilateral instruments remain one of the primary sources of climate finance. Bilateral Financial Institutions play a central role as intermediaries disbursing climate funding to developing countries. Examples include Japan International Cooperation Agency (JICA)

v. Compliance and voluntary carbon markets

Compliance carbon markets are marketplaces through which regulated entities obtain and surrender emissions permits (allowances) or offsets in order to meet predetermined regulatory targets. The voluntary carbon markets function outside of the compliance market. They enable businesses, governments, NGOs, and individuals to offset their emissions by purchasing offsets that were created either through the CDM or in the voluntary market

vi. Private sector actors and philanthropy.

Looking at the entire landscape of climate finance, the private sector is an international private sector funding that contributes to catalysing this transition. It is in fact the single largest source of financing.

5 MONITORING AND EVALUATION OF CSA INTERVENTIONS

5.1 INTRODUCTION

Monitoring and Evaluation (M&E) aims at evaluation of CSA interventions in order to understand their performance, challenges, potentials and opportunities for upscaling and adoption. Also helps to determine the extent to which a CSA intervention has been achieved, its effectiveness and provide recommendation for consideration in other endeavour.

Through M&E framework it is easier to track progress at different levels of the CSA implementation by looking at:

- Impact on people's livelihood and the environment
- Effect on behavior and institutional change, and CSA mainstreaming in plans
- Output reflecting on the CSA pillars
- Multidisciplinary involvement of the stakeholder and gender mainstreaming

5.2 BASELINE INDICATORS FOR CSA RELATED

A baseline indicator is a value of a performance before the implementation of projects or activities, while targeting a specific level of result to be achieved within an explicit timeframe. In order to monitor and evaluate an impact of CSA intervention a baseline indicator(s) needs to be identified.

The process of identifying indicator(s) is always done at the early CSA intervention planning stage to get knowledge of the current status of an item. For CSA interventions this is important because baseline result will show how different aspects have changed as a result of implementing CSA Practices and Technologies.

Baseline indicators is recommended to come from officially recognized sources of information national statistics, policy documents, budget speeches, local plans, comparison between seasons, food reserve and market price. Targets need to be established and agreed against the selected baseline indicators. The classification of baseline indicators for CSA interventions can be set according to the three CSA pillars which are Productivity, Adaptation and Mitigation or mitigation co-benefit.

5.3 PERFORMANCE INDICATORS

A Key **Performance Indicator** (KPI) is a measurable value that will demonstrates how CSA intervention has been achieved considering key objectives of the intervention and respective baseline indicator(s). The key characteristics of the indicator is that; it should be **SMART, specific** to the objective, **Measurable** either quantitatively or qualitatively, **Available** at an acceptable cost, **Relevant** to the information needs and **Time-bound** so that it is easier to monitor and evaluate against expected objective or targets to be achieved.

The Performance indicators in most cases differ between project and interventions based on set targets or goals. However, the process of indicators identification is similar by starting with clear identification of goals to be achieved, mechanism to reach the goal and metrics to achieve. Contrary to baseline indicators, the key performance indicators are extracted from the intervention plan to correlate with baseline indicator(s) identified.

5.4 MONITORING TOOLS AND RECORD KEEPING

Monitoring tools are continuously used to keep track of the status of agreed plan on implementing CSA intervention in order to identify defects or problems and give early warning signs on failure or successes. Selection of monitoring tools for a certain project depends on the nature and type of indicators, also type of metric data needed. In the case of CSA interventions, the tools are such as record keeping data sheet, Checklist, field observation and documentation of evidence.

5.5 CREATION OF EVIDENCE FOR CSA INTERVENTIONS

This is the process by which evidence of project succession or failures are compiled together in an easy manner with the aim of sharing lessons learnt with others. The effectiveness on compiling the evidence depends on the baseline and key performance indicators identified in the intervention plan. However the monitoring tool identified, quality of data collected and analysis will determine the influencing power of evidence created. Hence, for effective upscaling or sharing of lesson learnt from implementing CSA intervention, identification of baseline indictor, KPI and appropriate monitoring tools are essential.

For example, a farmer in Kiroka Village in Morogoro after receiving high-yielding and early-maturing banana cultivars he managed to document (see picture below) landscape transformation before and after. This is one way of creating evidence which would allow sharing of lessons learnt with others for upscaling and adoption.







The farm AFTER (Source: Henry Mahoo - SUA)

CONCLUSION

CSA practices and technologies aims at achieving food security and broader development goals under a changing climate and increasing food demand. By addressing challenges in environmental, social, and economic dimensions across productive landscapes, CSA practices and technologies can coordinate priorities of multiple countries and stakeholders in order to achieve more efficient, effective, and equitable food systems.

Effective use of this ToT Manual is an important step toward the achievement of the national goals of sustainable agriculture production in a changing climate through application of CSA practices and technologies. This manual compliments Government efforts and initiatives on implementation of sustainable development goals by creating awareness, identifying CSA practices and technologies and mainstreaming of CSA in plans and programmes.

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