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A Guide to Climate-Smart Agriculture

Volume 1: For Extension Workers

Fisheries Integration of Society and Habitats (FISH)

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Maize grown under conservation agriculture technology. Photo by: David Nthakomwa

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Abbreviations and Acronyms

ADC	Area Development Committee
AEDOS	Agriculture Extension Development Officers
CA	Conservation Agriculture
CH ₄	Methane
CO ₂	Carbon Dioxide
CSA	Climate-Smart Agriculture
DAESS	District Agriculture Extension Services System
DAHLD	Department of Animal Health and Livestock Development
DANIDA	Danish International Development Agency
DEC	District Executive Committee
DRR	Disaster Risk Reduction
DRM	Disaster Risk Management
EPIC	Economics and Policy Innovations for Climate-Smart Agriculture
FAO	Food and Agriculture Organization of the United Nations
FISH	Fisheries Integration of Society and Habitats Project
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
HH	Household
NRM	Natural Resource Management
MSCT	Malawi Social Cash Transfer
N ₂ O	Nitrate
REDD	Reducing emissions from deforestation and forest degradation
SLM	Sustainable Land Management
SLWM	Sustainable Land and Water Management
USAID	U.S. Agency for International Development
VDC	Village Development Committee

Glossary of Key Terms

Adaptation	Adaptation refers to responses by individuals, groups and governments to actual or expected changes in climatic conditions or their effects.
Adaptive capacity	Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behavior and in resources and technologies.
Agroforestry	Agroforestry is the practice of integration of trees, plants, and animals in conservative, long-term, productive systems.
Aquaculture	Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants.
Climate	Climate is statistical information, a synthesis of weather variation focusing on a specific area for a specified interval. Climate is usually based on the weather in one locality averaged for at least 30 years.
Climate change	Climate change is a large-scale, long-term shift in the planet's weather patterns or average temperatures.
Climate variability	Climate variability refers to variations in the mean state and other climate statistics (standard deviations, the occurrence of extremes, etc.) on all temporal and spatial scales beyond those of individual weather events.
Climate-Smart Agriculture	Agriculture that sustainably increases productivity and resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievements of national food security and development goals.
Conservation Agriculture	Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment.
Drought	A temporary reduction in moisture availability significantly below the normal for a specified period
Dry Spell	A period of dryness that have no or little effect on soil moisture or water levels.
Extension Services	Extension is a formal or informal educational process directed toward the rural population. This process offers advice and information to help them solve their problems. Extension also aims to increase the efficiency of farms, increase production and generally increase the standard of living of the farm family.
Fishery (capture)	Refers to all kinds of harvesting of naturally occurring living resources in both marine and freshwater environments.
Food Security	Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Global warming	A gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, chlorofluorocarbons, and other pollutants.
Greenhouse effect	Energy radiated by the sun converts to heat when it reaches the earth. Some heat is reflected back through the atmosphere, while some is absorbed by atmospheric gases and radiated back to the earth.
Greenhouse gas (GHG)	A gas that contributes to the greenhouse effect by absorbing infrared radiation.
Mitigation	Actions to reduce and avoid GHG emissions and enhance sinks.
Residue	Crop residue is plant material remaining after harvesting, including leaves, stalks, roots.
Weather	Weather is the day-to-day state of the atmosphere and its short-term (from hours to a few weeks) variations such as temperature, humidity, precipitation, cloudiness, visibility or wind.

Acknowledgements

This reference manual consolidates various training materials produced by Christian Aid between November 2015 and February 2016 and the FAO/EPIC Climate-Smart Agriculture manual. Further documents consulted can be found in the reference section.

How to use this manual

The manual aims to provide extension workers with a broad reference tool for topics related to Climate-Smart Agriculture (CSA) and its application in Malawi. Extension workers can use the manual to understand key topics of CSA in the local context. The manual indicates some of the necessary ingredients required to achieve a climate-smart approach to the agricultural sectors, including existing options and barriers.

This manual is volume 1 of the three-part Guide to Climate-Smart Agriculture. This volume targets extension workers, whereas Volume 2 is designed as a Training of Trainers tool. Volume 3 comprises information, education and communication materials.

The manual is divided into seven chapters, which address the following topics:

Chapter 1: Climate Change – An introduction. This chapter introduces the concepts of climate change, presents effects and outlines basic concepts of adaptation to and mitigation of climate change.

Chapter 2: Agriculture, Climate Change and Food Security. This chapter provides an outline of the linkages between agriculture, climate change, and food security.

Chapter 3: Fisheries, Aquaculture and the Impact of Climate Change. This chapter shows the differences between fisheries and aquaculture and discusses their relationship to climate change.

Chapter 4: Climate-Smart Agriculture Concept. This chapter introduces the concept of Climate-Smart Agriculture. It clarifies its meaning and outlines adaptation and mitigation strategies in the agricultural sector.

Chapter 5: Climate-Smart Agriculture Solutions. This chapter shows examples in different production systems such as agroforestry that address the challenges by building synergies among climate change mitigation, adaption and food security.

Chapter 6: Removing Barriers and Enabling the Environment for Adoption of CSA. This chapter explains various challenges and barriers to the adoption of CSA. It also describes the links between CSA and institutions that support farmers to undertake CSA activities.

Chapter 7: The Lead Farmer Concept. This chapter introduces farmer to farmer extension services as one tool to bring CSA to farmers.

Furthermore, the manual outlines abbreviations and acronyms used and provides a glossary of key terms.

Chapter 1: Climate Change – An Introduction

Overview

This chapter gives a brief introduction to the concepts of weather, climate and climate change and explains the linkages between greenhouse gas emissions, global warming and climate change.

1.1. Concepts

Weather describes whatever is happening outdoors at a particular time over a particular area. Weather is what happens from minute to minute – wind, barometric pressure, precipitation (rain or snow) or temperature. The weather can change a lot within a very short timeframe.

Climate refers to the average change of weather experienced in a place over a long period of time, typically 30 years. While the weather can change in just a few hours, climate takes years to change.

Any interference with an element of the climate system has the potential to lead to a change in the climate. However, change is not unusual as the atmosphere temperature has always fluctuated in the past over large time scales. Thus, the Earth's climate is not static but has changed many times in response to a variety of natural causes. The term "*climate change*" usually refers to changes that have been observed since the early 1900s.

Climate change is largely attributed indirectly or directly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

1.2. Effects of climate change

Human activities play a significant role in one of the key aspects of climate change: global warming. The aim of the following part of the manual is to illustrate the effects of climate change. This part shows the relationships between greenhouse gases (GHGs) effect and global warming. As a result of global warming, temperature and rainfall patters have changed and future trends are expected to change as well.

One of the key aspects of climate change is the increase of the global mean temperature, largely attributable to the **greenhouse effect**.

To understand the meaning of greenhouse effect it is useful to understand what a **greenhouse** is. A greenhouse is a house made of glass. It has glass (or poly) walls and a glass (or poly) roof. People grow plants in them. A greenhouse stays warm inside, even during winter. Sunlight shines in and warms the plants and air inside. But the heat is trapped by the glass and can't escape. So during the daylight hours, it gets warmer and warmer inside a greenhouse, and stays pretty warm at night too.

The **greenhouse effect** can therefore be described as follows: During the day, the sun shines through the atmosphere and heats the earth's surface. In turn, at night, Earth's surface cools, releasing the heat back into the air. But some of the heat is trapped by the greenhouse gases (water vapour, carbon dioxide, methane, etc.) in the atmosphere, keeping the earth warmer than it would be without them. Greenhouse gases arise naturally and are part of our atmosphere.

Part of what makes Earth so amenable is the naturally-arising greenhouse effect, which keeps the planet at a friendly 15 °C (59 °F) on average. But in the last century or so, humans have been interfering more and more with the energy balance of the planet, mainly through the burning of fossil fuels that give off additional carbon dioxide into the air. The level of carbon dioxide in Earth's atmosphere has been rising consistently for decades and traps extra heat near the surface of the Earth, causing temperatures to rise. This effect is referred to as **global warming**.

Climate change creates risks such as:

- Unpredictable weather patterns, including rainfall
- Water scarcity
- Flooding
- Droughts
- Short rainy seasons and prolonged dry spells during rainy season
- Drying up of rivers and lakes
- Low fish supplies
- Heat waves
- Landslides
- Increased prevalence of water-borne diseases
- Low and unstable hydro-electric production
- Declining flora and fauna

1.3. The concepts of adaptation and mitigation

The following part of the manual aims to define the concepts of adaptation and mitigation. As already outlined above climate change alters the basic parameters of productive ecosystems, especially temperature and rainfall; it also has an impact on natural resources, such as land and water availability. As a consequence, it negatively affects food production and food security. Farmers and fishermen face reduced yields, water shortages, increased weed and pest proliferation, and loss of agricultural biodiversity, to only name a few.

There are two different ways to address climate change and associated impacts. One is to adapt to climate change effects (adaptation), the other is to intervene on its causes (mitigation).

Adaptation

Adaptation refers to responses by individuals, groups and governments to actual or expected changes in climatic conditions or their effects. It is defined as activities that aim “to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and systems resilience (OECD-DAC, 2011).

To farmers, adaptation means adopting changes in farming systems to increase their ability to produce under anticipated or experienced climatic risks.

Mitigation

Mitigation is defined as the implementation of activities that contribute to efforts to reduce or emission of greenhouse gases.

The agricultural sector has a substantial potential for mitigation and will be discussed in more detail in Chapter 4 of this manual.

Box 1. Temperature trends and rainfall patterns in Malawi

- Temperatures have shown significant increases by 0,9 between 1960 – 2006
- Increases are most rapid in the rainy summer (Dec-Feb) and lowest in the hottest season (Sept-Nov)
- The average number of hot days increased significantly since 1960
- The beginning of the first rains is variable and has become more unpredictable
- The rainy season period has become shorter
- The total amount of rainfall varies over the years. There are wet and dry years
- Rainfall distribution varies from place to place and with a specified period of time
- Erratic rainfall has been observed

Chapter 2 – Agriculture, Climate Change and Food Security

Overview

This chapter aims to outline the linkages between agriculture, climate change, and food security. It outlines how these entities affect and influence each other.

2.1. Food security – A global challenge

Food insecurity and climate change are increasingly becoming interdependent – shaped also by a series of other pressures that converge within the agriculture sector - including population size, food demand, land, water, and energy and degradation of natural resources. There are many reasons why meeting the demand for food is increasingly becoming a formidable challenge. The following, some of the main factors to know.

Global population growth

Between now and 2050, the world's population is projected to increase by one-third with 2 billion people who will live in developing countries. In the case of Africa, the population has just passed 1 billion and is due to double by 2050. Sub-Saharan Africa of which Malawi is a part, has the highest proportion of undernourished people on the continent.

Climate change

Climate change will make the task of producing adequate food more difficult under a business-as-usual scenario, due to adverse impacts on agriculture, requiring spiraling adaptation and related costs. Climate trends are affecting the abundance and distribution of harvested aquatic species, both freshwater and marine, and aquaculture production systems in different parts of the world. The trends are expected to continue with negative impacts on nutrition and food security for especially vulnerable people, particularly in some tropical developing countries. The effects include the following:

- Changes in the species composition of marine capture fisheries catches related to changes in ocean temperatures
- Increasing temperature has reduced the primary productivity of some lakes in Africa. Lake Tanganyika for example, has experienced a decrease in yield by 30 %.
- Negative effects on wheat and maize production. For example, climate change is very likely to have an overall negative effect on yields of major cereal crops across Africa, with strong regional variability in the degree of yield reduction.

Africa will be the region most affected by climate change, due to both changes in mean temperatures and rainfall, as well as increased variability associated with both.

2.2. Climate change and the agriculture sector in Malawi

This part of the chapter highlights the importance of the agriculture sector in Malawi and describes the effects of climate change on agriculture in particular.

Importance of the agriculture sector in Malawi

Malawi's economy is driven by agriculture, which contributes 35 percent of GDP, 80 percent of the country's export earnings, and supports 85 percent of the population. Smallholder farmers contribute more than 80 percent of Malawi's agricultural production, which is dominated by maize, the country's staple food crop. The main cash crops are tobacco, tea, cotton, coffee, and sugar.

The well-being of the majority of Malawians is highly vulnerable to climate change because of the country's dependence on rain-fed agriculture. In addition, Malawi has among the highest deforestation

rates in the world because of agricultural expansion, growth of human settlements, dependence on wood for cooking, reliance on burnt bricks for construction, and low levels of reforestation. The situation is likely to get worse in the future as the population grows, and more people live in urban areas.¹

Effects of climate change on agriculture and livelihoods

Malawians are settling in fragile ecosystems, agricultural productivity is falling, there is low fish production, people's livelihoods are undermined, and environmental resources are reducing rapidly.

The *impacts of climate change* on agriculture and livelihoods are visible across the country:

- Short growing season forces farmers to switch to more expensive hybrid crops
- Frequent droughts and floods result in eroding assets and leave people more vulnerable to disaster
- Diminished crop growth or yield production
- Desertification and erosion due to dust storms.

The *effects on the agriculture* sector are dependent on a wide range of factors:

- Type of crop grown
- Local biological endowments such as soil content and biodiversity
- Extent of knowledge and awareness of expected changes in climate
- Extent of support from government and other private agencies
- Farming practices

Agriculture can accelerate climate change. Agriculture contributes to a loss of vegetation cover through expansion of cultivable area contributing to GHGs. Direct sources of GHG emissions from agriculture include carbon dioxide (CO₂), nitrous oxide (N₂O) mostly by soils and application of fertilizers, and methane, (CH₄) from livestock and rice cultivation. Increase in agricultural production projects could cause an increase in agricultural emissions.

2.3. Population, climate change and food security in Malawi

Population Change

Malawi's population is projected to 49.7 million by 2050 exerts enormous pressure on land and other natural resources, leading to fragmented land holdings and overexploitation of natural resources. Increased droughts and floods worsen the poverty levels leaving rural farmers trapped in a cycle of poverty and vulnerability as many farmers rely of rain-fed subsistence farming. With increased droughts and floods, smallholder farmers face limitations in adapting to climate change due to lack of capacity in form of knowledge, skills and money to appropriately respond to these effects.

Climate Change and Food Security

Food security is characterized by four dimensions:

1. *Availability* addressing the "supply side" of food security and is determined by the level of food production, stock levels and net trade
2. *Economic and physical access* to food, including incomes and access to markets
3. Food utilization, e.g. the way the body makes the most of various nutrients in the food and is influenced by people's health status and
4. *Stability* of food security.

¹ AFIDEP and PAI. 2012. "Population Dynamics, Climate Change and Sustainable Development in Malawi", Nairobi and Washington, DC: African Institute for Development Policy (AFIDEP) and Population Action International, pg. 8.

Climate change leads to increased floods, which impact food availability, access and utilization as follows:

- *Availability:* e.g. livestock and food stored for consumption and sale get washed away
- *Access:* e.g. Floods results in local market prices for many food items to go up. To manage the food needs, families decide to buy other cheaper products from the global market
- *Utilization:* The diet of the households becomes unbalanced due to lower quality of the cheap products.
- *Stability:* Is obviously discarded by the very occurrence of the flood.

Chapter 3 – Fisheries and Aquaculture and the Impact of Climate Change

Overview

This chapter will be used to outline the differences between fisheries and aquaculture and to discuss their relationship to climate change.

3.1. Importance of fish and the fishery sector

In a country where more than 85% of the population live in rural areas fish provides the most affordable source of dietary animal protein and a wide variety of vitamins and minerals, such as vitamins A and D, calcium, phosphorus and magnesium. Though in small quantities, fish also provide essential amino acids that are deficient in staple foods such as maize, rice or cassava. But fish is more than an alternative source of animal protein. Fatty fish are the richest source of Omega 3 fats, a type of fat which is essential for brain development.

Fish and the fisheries sector is also a source of income for local communities be it as a fisher employed by the fishery sector, or being involved in fish processing, fish marketing, net making, boat building and other related activities. Traditional fish processing methods include, boiling and sun-drying (mostly for very small fishes), sun-drying (for small fishes) and smoking for larger fishes.

3.2. Differences between fisheries and aquaculture

The fishery sector in Malawi can be divided into *capture fisheries* and *aquaculture*. Capture fishery, classified as either small-scale commercial or large-scale commercial is the major sector while the aquaculture sector is an almost entirely subsistence activity.

The following table provides an overview about the main characteristics of fisheries and aquaculture:

Characteristic	Fisheries	Aquaculture
Location	Widely variable, though specific nursery, migratory, feeding ground may be definable	Defined by site conditions, acceptability for intended stock; usually fixed, limited variation
Productive Investment	Vessels and catching gear, highly mobile, adaptable	Fixed in structures; management systems, only some mobile
Ownership	Means of production only; though increasingly conferred through access rights, licenses	Lease of property ownership of sites; access to water; plus means of production
Infrastructure	Port, specialist product handling, transport	Specialist product handling, transport may be shared with fisheries. Seed, feed, fertilizer
Management	External regulation of effort/efficiency to varying degrees, limited in situ management of catching decisions	Internal management of production process, some external regulation of resource access, management practices, etc.
Output	Highly variable within moderately definable stock/year-class boundaries	Original seasonal, increasingly controlled and extended, chosen species, size and quality

Market	Volatile, responding to wide range of supply and quality, simple transactions; pressure to sell	More stabilized, longer term supply trends; producer may control outputs, longer term contracts, future trades
Development	Identify/develop new resources better targeting, gear improvement, efficiency, selectivity, more effective management and ownership issues	Identify/manage more species lifecycles, equipment/systems; genetic improvement, feed and husbandry efficiency; disease control; environment management

Table 1 Main characteristics of fisheries and aquaculture

3.3. Consequences of climate change on fisheries and aquaculture and possible solutions

Climate change is predicted to have a wide range of impacts on fisheries and those who depend on them as fishes are sensitive to changes in their surrounding environment.

Consequences can be divided into *three impact categories*:

1. Ecological impact

This relates to changes in fresh water fish species community composition, distribution and migration due to changes in abundance of fish food like algae and plankton, salinity, oxygen levels, currents and circulation of water bodies.

Changes in hydrological conditions including reduced water levels and flow rates result in declining mud flows from upstream and consequently reducing silt loads to the lower reaches.

Reduced mud flows decrease the nutrient content of water bodies thereby affecting breeding and nursery grounds for fish.

Increased precipitation results in floods leading to excessive nutrient levels in water bodies due to washed in sewage and fertilizer causing excessive algal blooms resulting in low levels of dissolved oxygen.

On the other hand, *reduced precipitation* results in a reduced run-off from land, starving wetlands nutrients and thereby damaging local fisheries.

2. Direct impact: damaged infrastructure, increased danger at sea and lakes; flooding of fishing communities

3. Socio economic impact: increasing costs; reduced health due to diseases; loss of employment and income

Climate change adaptation need to go beyond restriction to catch size. There is a wide range of additional *adaptations measures* both from private as well as public actors:

- Promotion of fish stocks that exhibit regular fluctuations
- Diversification of livelihood systems, e.g. alternating farming and fishing in response to seasonal or annual variation in fish availability
- Decentralized fishery management to the communities in order to increase flexibility in implementation of policies, together with a greater sense of ownership and improved compliance therefore reducing enforcements
- Use of improved storage facilities e.g. refrigeration including post-harvest handling and processing to reduce losses due to deterioration of fish quality
- Provision of incentives for fishermen to switch to sustainable fishing gears and techniques
- Promotion of consumption of underexploited species of fish
- Enhancing capacity of fishers to monitor the environment and provide early warning of threats
- Increasing in/output ratios by using fishing practices that adhere to the Code of Conduct

Chapter 4 – The Climate-Smart Agriculture Concept

Overview

This chapter introduces the concept of Climate-Smart Agriculture. It clarifies its meaning and outlines adaptation and mitigation strategies in the agricultural sector.

4.1. The difference between conventional and Climate-Smart Agriculture

There are a wide range of conventional agriculture practices at field level. Figure 1 summarizes those which can be characterized as *unsuitable practices*.

Conventional agriculture often affects soil structure, moisture and fertility as well as contributing to erosion. On the other hand, keeping the soil bare allows weeds to grow unhindered. Planting the same crop year after year encourages among others certain weeds, pests and diseases.

The table 2 compares different aspects of conventional and Climate-Smart Agriculture.

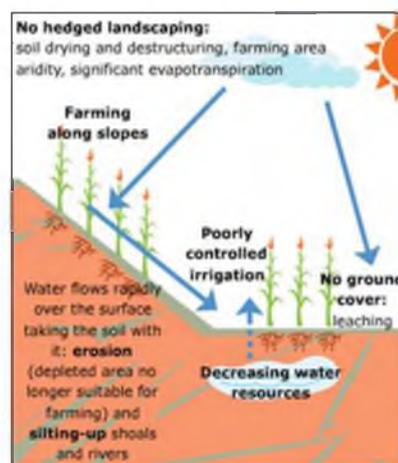


Figure 1 Unsuitable Practices

Aspects	Conventional Agriculture	Climate-Smart Agriculture
Technologies	Conversion of energy sources from human to animal and fossil fuel dependent machinery	Use of energy efficient technologies for agricultural power (irrigation or tillage)
Agricultural input	Increased use of fertilizer, pesticides and herbicides (also highly dependent on fossil fuels) generally very inefficiently applied	Increased efficiency of fertilizer
Land areas	Expansion of agricultural land area through deforestation and conversion from grasslands to cropland	Intensification on existing land areas as main source of production increase rather than expansion to new areas
Natural resources	Depletion of natural resources (e.g. land, water, genetic resources) used in the production systems.	Restoration, conservation and sustainable use of natural resources in agricultural production systems
Production and marketing	Increased specialization in agricultural production and marketing systems	Greater diversification in production, input and output marketing systems

Table 2 Conventional and Climate-Smart Agriculture

As agricultural production remains the main source of income for most rural communities in Malawi, adaptation of the agricultural sector to the adverse effects of climate change will be imperative for

protecting and improving livelihoods and thus ensuring food security. Crop production contributes to climate change, but it also presents opportunities for adapting to and mitigating.

Climate change is projected to negatively affect agricultural productivity, resulting from deterioration of the production environment.

4.2. The concept of Climate-Smart Agriculture

Climate-smart Agriculture (CSA) is an approach that moves away from unstable, conventional agriculture practices and systems and helps to restore degraded agro-ecosystems. Climate-Smart Agriculture contributes to the goals of making sustainable development tangible.

By seeking synergies wherever possible Climate-Smart Agriculture aims to:

- improve food security
- help communities adapt to climate change and contribute to climate change mitigation (e.g. reduce GHGs) by adopting appropriate practices, developing enabling policies and institutions and mobilizing needed finances.

Figure 2 shows some CSA practices which positively affect soil structure, soil moisture as well as soil fertility. Cover crops and mulch protect the soil surface from heavy rain, roots bind the soil together so it is less easily eroded. Cover crops or mulch smothers weeds, prevents them from growing quickly and breaks the life cycle of pests and disease mechanisms.

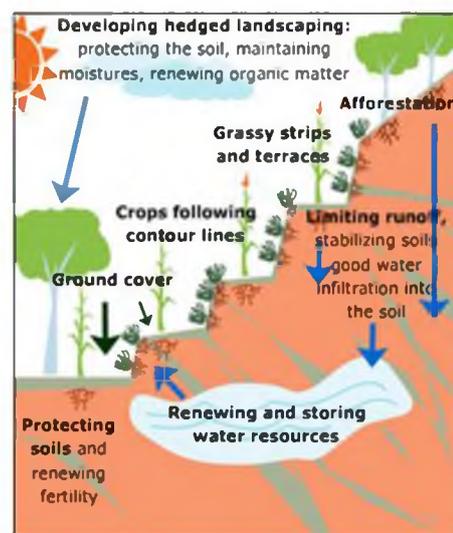


Figure 2 CSA Practices

4.3. The three pillars of Climate-Smart Agriculture

The following part of the manual outlines the three pillars of Climate-Smart Agriculture which contribute to enhance the achievement of national food security and development goals.

4.3.1. Strengthen resilience in agriculture (Adaptation)

Adaptation can reduce vulnerability by altering exposure, reducing sensitivity and increasing adaptive capacity. There are various adaptation strategies which can be considered when planning agriculture interventions. The following table outlines some of them:

Altering exposure	Reducing Sensitivity	Increasing adaptive capacity
Assess impacts and map hazard zones	Develop or adopt suitable crop, plant and animal varieties	Develop adaptive strategies and action plans
Conduct proper land and water use planning	Improve irrigation and drainage systems	Diversify sources of household income
Protect watersheds and establish flood retention zones	Enhance soil nutrition and on farm water management	Improve water and other infrastructure systems
Resettle humans and restructure agriculture	Diversify cropping and agricultural activities	Establish disaster and crop insurance schemes
Change cropping patterns	Adopt disaster-prevention	Promote technical transfer and capacity building

		Promote community based risk management measures (e.g. grain banks, self-help groups)
		Strengthen institutions in order to maximize responsiveness to change at all level

Table 3 Adaptation strategies

All adaptation strategies are based on a combination of

- specific actions (e.g. switching from one crop variety to another) and
- systemic changes (e.g. diversifying livelihoods against risks or an institutional reform to create incentives for better resource management).

Adaptation strategies include a broad set of activities ranging from activities that focus on reducing drivers of vulnerability to interventions aimed at confronting not yet experienced climate change impacts. Between addressing *Drivers of Vulnerability* and *Confronting Climate Change* there is a broad spectrum of activities with gradations of emphasis on vulnerability and impacts that aim to build response capacity and better manage climate risks. The following graphic describes this synergy.



Figure 3 The adaptation continuum

Addressing drivers of vulnerability

These are vulnerability-oriented adaptation efforts that overlap almost completely with traditional development practice. The activities take little or no account of specific climate change impacts and have many benefits in the absence of climate change (no-regret options). The activities buffer households (HH) and communities from effects of climate change from nearly all sources of harm.

Examples include but are not limited to:

- Diversification HH income sources
- Income stabilization programmes
- Initiatives that transfer income/assets to the poor
- Initiatives that enhance social status and rights of the marginalized
- Promotion of community based risk management measures to face crop failures and soaring food prices (e.g. grain banks, self-help groups)
- Developing innovative risk financing instruments and insurance schemes to reduce climate-related risks (e.g. weather/climate indexed crop insurance)

Building response capacity

In this zone of the continuum adaptation focuses on building robust systems for problem solving. Efforts focus more specifically on climate change hazards and their impacts.

Examples include:

- Developing communication systems and planning processes
- Improvement of hazard mapping and weather monitoring measures

- Natural resources management (NRM) such as:
 - o Reduction of soil erosion and land degradation through improved soil management
 - o Increase of water use efficiency and availability
 - o Improve water uptake and reduce wind erosion
 - o Conservation of genetic resources
 - o Change of farming practices to conserve soil moisture, organic matter and nutrients
 - o Adopt “best practices” that improve forest resilience and promote healthier forests
 - o Adopt livestock grazing practices that improve soil cover, increase water retention and promote natural soil forming processes
 - o Implement co-management systems to improve the governance of fisheries
 - o Strengthen institutions in order to maximize responsiveness to change at all levels

Managing climate risk

Efforts in this area focus more specifically on climate change hazards and impacts. Key entry point are areas under frequent threat of climate-related emergencies including disaster risk reduction (DRR) and disaster risk management (DRM).

Examples:

- Availability of short-cycle seeds in vulnerable areas for harvesting e.g. for a quick harvest following re-planting after floods thus increasing future resilience to hazard impacts
- Availability and access to good quality seeds enhance resilience of food production systems to climate-related hazards and other shocks while minimizing dependence on direct external assistance
- Establishing strategic and cyclone-proof seed stocks thus minimizing losses during hazards

Confronting climate change

This category includes highly specialized activities exclusively targeting distinct climate change impacts that fall outside the realm of development.

Examples include activities that explicitly confront climate change and target climate risks that are far outside of historic climate variability, such as:

- Relocation of communities due to sea level rise
- Responses to glacial melting
- Building large scale irrigation systems
- Plant breeding in response to shifting agro-ecological zones and new stresses.

4.3.2. Reduce agriculture's contribution to climate change (Mitigation)

Mitigation activities promote “efforts to reduce or limit GHG emissions or to enhance GHG sequestration” including “technological changes that reduce resource inputs and emissions per unit of output”.

There are *three major options* to mitigate climate change:

Reducing emissions

Reducing emissions aims at reducing fluxes of CO₂, CH₄, or N₂O through efficient management of carbon and nitrogen flows in agricultural ecosystems leading to less carbon dioxide, nitrogen and methane released.

Minimal soil disturbance (e.g. minimum and zero tillage) as well improved grazing management (stocking rate management, rotational grazing, and enclosure of grassland from livestock grazing) can reduce emissions from volatilization of organic soil carbon. Integrated nutrient management can reduce emissions by reducing leaching and volatile losses, improving nitrogen use efficiency through precision farming and improving fertilizer application timing.

Improving livestock feeding practices can increase efficiency of the digestive process thus reducing emissions from enteric fermentation. Examples include:

- Use of specific agents or dietary additives
- Improvements in forage quality and quantity
- Seeding fodder grasses or legumes with higher productivity and deeper roots
- Reducing fuel load by vegetation management

Maintaining a shallower water table, together with avoiding deep ploughing and cropping row crops and tubers will avoid the draining of organic soils, which would lead to high GHG emissions.

Committing forests for reducing emissions from deforestation and forest degradation (REDD) and the sustainable management of existing forests will also support emission reduction goals.

The adoption of improved aquaculture management can also reduce emissions. This can be done by:

- Selection of suitable populations of aquatic species
- Improving energy efficiency
- Increasing feeding efficiency
- Switching to herbivorous or omnivorous aquaculture species to reduce emissions from input use

Avoiding or displacing emissions

Avoiding or displacing emissions aims at improving the energy efficiency used in the agriculture sector. In some cases, biofuels can replace fossil fuel energy used in agricultural production. Greater use of wood products can also lead to displacing CO₂ emissions. Improved post-harvest handling and improved storage will also contribute to avoid emissions.

Removing emissions

Greenhouse gases can be absorbed from the atmosphere through *sinks*. A sink is any process or activity that removes a greenhouse gas from the atmosphere.

Improved agronomic practices such as the use of cover crops and incorporation of crop residue into the soil can generate higher inputs of carbon residue and lead to increased soil carbon storage.

Improved soil and water management: The construction of soil or stone bunds, irrigation and drainage systems increases available water in the root zone which can enhance biomass production, the amount

of above-ground and root biomass returned to the soil, and thus improve the soil organic carbon concentration.

Agro-forestry, afforestation/reforestation, forest restoration: Carbon storage can be further increased through:

- Combining crops with trees for timber and fodder
- Establishing shelter belts and riparian zones/buffer strips with woody species
- Conversion from non-forest to forest land use and from degraded forests to fully carbon stocked forests

Aquaculture areas: Replanting mangroves will create carbon sink in aquaculture areas

4.3.3. Sustainably increase agricultural productivity (Productivity)

Climate-Smart Agriculture 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 by increasing food production from existing farmland while minimizing pressure on the environment.

Chapter 5 – Climate-Smart Agriculture Solutions

Overview

Agriculture involves activities which contribute to global climate change. On the other hand, climate change affects agricultural production in terms of livestock, crops and aquaculture. Proper response to climate change threats needs focus on mitigation and adaptation strategies to support farmers to deal with the impacts.

This chapter will outline examples in different production systems that address the challenges by building synergies among climate change mitigation, adaptation and food security.

5.1. Agroforestry

Definition: Agroforestry is the practice of integration of trees, plants, and animals in conservative, long-term, productive systems.

Crops in this system can be grown together at the same time, in rotation, or in separate plots when materials from one are used to benefit another, which provides an all-year vegetative cover. Those covers reduce soil disturbance while providing habitat for wild species, including crop pollinators while animals provide manure. Agroforestry systems make maximum use of the land.

Importance of Agroforestry

The importance of agroforestry lies in the fact that this system improves land productivity by providing a favourable micro-climate, permanent cover, improved soil structure and organic carbon content, increased infiltration and enhanced fertility thereby reducing the need for mineral fertilizers. The practice of agroforestry is advantageous as it impacts all three pillars of CSA: adaptation, mitigation and productivity.

Mitigation of climate change

Trees on farms tend to sequester greater carbon quantities than agricultural systems without trees. Trees and shrubs can diminish effects of extreme weather events, such as heavy rains and droughts.

Supporting different forms of livelihood productivity

Tree products provide among others food and feed, construction materials, medicines, as well as income from sales of tree products.

Improved soil structure

Roots of trees contribute to an improved soil structure – reducing the risk of erosion, leaching and nutrient loss through improved microclimate. On the other hand, the biomass helps to protect the soil from wind and rain that otherwise can carry away the fertile topsoil.

Improved soil fertility

In order to improve soil fertility and increase crop yields nitrogen-fixing woody trees are simultaneously (intercropping) grown with annual crops on the same piece of land at the same time. The trees are left in the field throughout the year while the crops planted at the beginning of the rainy season dominate during the growing season. Species used include *G. sepium*, *Tephrosia candida*, *Sesbania sesban*, pigeon peas, *Faidherbia albida*. Unlike other intercropping strategies, simultaneous fallow intercropping with *G. sepium* requires one planting (coppiced up to 5 years) hence increasing long-term benefits while at the same time reducing labour and seed requirements.

Weed control

Fertilizer trees are effective on weed control, including witch-weed (*Striga*). Continued applications of organic matter improve the soil fertility hence the germination of *striga* is suppressed. Fertilizer trees shade out shallow-rooted weeds preventing them from outcompeting maize for factors of growth (water, nutrients & sunlight).

5.2. Local gene bank

Genetic make-up determines plant and animal tolerance to shocks such as temperature extremes, drought, flooding and pests and diseases. It regulates the production cycle and the response to inputs such as fertilizer, water and feed. The Gene bank project promoted by Bunda College, preserves genetic resources of crops and their wild relatives fundamental in developing resilience to shocks, improving the efficient use of resources, shortening production cycles and generating higher yields. The seeds that are conserved in the system are tolerant to drought and resistant to pest and disease, etc. The seed bank is situated in Dowa district and is primarily used for the conservation and storage of seeds. The system comprises a small structure constructed with bricks and roofed with corrugated iron sheets. One room serves as an office while the other room provides space for storage of the seeds in special containers. The building is designed in such a way that the room temperature is maintained and the germplasms are protected from damage by pests and excessive temperature extremes.

5.3. Livestock management practices

Livestock is impacted by climate change as well as contributes to it. Overgrazing is one of the major sources increasing vulnerability to climate change of semiarid rangelands.

Degraded or overgrazed land can be restored to produce more biomass by selectively planting grasses, adding phosphate fertilizers and alternating grazing with rest periods for the land.

Livestock manure is one of the main sources to GHG emissions in agriculture. Efficient treatment of manure can reduce emissions and raise the sector's productivity. E.g. anaerobic digestion of manure stored as a liquid or slurry can lower methane emissions and produce useful energy (e.g. biogas), while composting solid manures can lower emissions and produce useful organic amendments for soils. The substitution of manure for inorganic fertilizers can also lower emissions and improve soil condition and productivity.

Integration of livestock with crop activities, strategic location of intensive livestock production units and enhanced processing techniques to reduce production losses are also effective strategies for boosting productivity.

5.4. Conservation Agriculture

Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked *principles*, namely:

1. Continuous minimum mechanical soil disturbance.
2. Permanent organic soil cover.
3. Diversification of crop species grown in sequences and/or associations.²

Conservation Agriculture practices can increase farm system resilience and improve the capacity of farmers to adapt to climate change. At the same time, such practices may:

Box 2. History of CA in Malawi

- CA systems were introduced in Malawi in 1998 by Sasakawa Global 2000 and supported by the Government of Malawi and a number of donors
- The system was supported with more production inputs, however this proved to be unsustainable because of the top-down approach used
- Through the International Maize and Wheat Improvement Centre and the government of Malawi CA was re-introduced in 2004 in some targeted communities in Balaka, Mzimba and Dowa districts
- This was later expanded to other districts with the aim of further developing the CA concept. The aim was to initiate interactive communication of all actors in an innovation system that identified soil degradation as root cause of agricultural productivity decline
- The system focused on demonstration plots and later to farmer-experiments around CA-oriented technologies

² <http://www.fao.org/ag/ca/1a.html>

- Reduce carbon losses that occur with ploughing
- Further sequester carbon via residue incorporation
- Reduce erosion, and
- Increase carbon sequestration through reduced use of fossil energy.

Basin/pit planting

In some parts of Malawi, mostly in areas with low rainfall or unpredictable rains and subsequent crop failure, smallholder farmers practice basin/pit planting to adapt to dry spells and maximize the use of limited water. The construction of pits involves considerable soil disturbance and labour for digging. The size, spacing and density of basins per ha varies depending on equipment used. For the technology to be efficient, the right maize variety must be planted early enough to benefit from the rainfall available.

Contour ridging/vetiver hedgerows

To control soil erosion and conserve water at the same time, Malawi farmers use a ridge and furrow system known as contour ridging, which stores infiltration excess runoff and minimizes the velocity of surface runoff. Contour ridging is an effective soil and water conservation practice but establishing contour ridges and maintaining broken ridges after intense rainstorms are some of the labour-related concerns that make contour ridging less attractive. To stabilize ridges and overcome ridge breakage completely, farmers can use permanent vegetated hedgerows and agroforestry practices. Agroforestry systems that use permanently vegetated hedgerows between crop rows stabilize ridges and provide canopy cover, thus reducing the occurrence of ridge failure by establishing stable ridges.³

Swales

Swales are trenches that are dug along the contour at a depth of 1m and width of 1m. Swales are used to harvest rainwater to allow it to seep through the farm over time. The trenches are dug at a regular interval within the farm. The steeper the slope, the closer the trenches would be. The swales are dug at a length equivalent to the length of the ridges with breaks inside that are dug at a gradient to ensure steady flow of water. When the ridges in the field are too long, the trenches are dug with a 1m break in between.

Further conservation agriculture practices

Here are some practices that improve productivity or the efficient use of resources.

Land Preparation and Management of Crop Residues and Weeds after harvest. Burning or removal of crop residues should be discouraged. Instead, residues should be distributed evenly and left on the soil surface. If no residues are available minimum tillage and proper planning for next season is recommended. Instead of importing residues, residues from CA targeted areas should be used. Weeds and cover crops are controlled by slashing with a knife or strapped of by using hoe.

If feed for livestock is priority, some residues should be used as animal feed (30-50% residues to remain on land). In addition, planting of fodder crops and trees is recommended.

While implementing conservation agriculture *minimal soil disturbance* should take place while planting. The construction of any new ridges, dig basins or pits should be avoided.

Crop rotation is fundamental. It promotes adequate biomass levels for permanent residue cover and assists in control of weeds, pests and diseases. Rotations also improve soil physical conditions, recycle nutrients and can fix atmospheric nitrogen. In semiarid conditions, appropriate crop rotations involving deep-rooting crops can also make still better use of residual soil moisture. As a result, soil erosion is reduced and soil biological diversity maximized.

³ Yusuf M. Mohamoud 2012 Effect of contour ridging on runoff and soil loss. African Journal of Agricultural Research Vol. 7(46), pp. 6115-6124, 5 December, 2012. Available online at <http://www.academicjournals.org/AJAR>. DOI: 10.5897/AJAR11.2307

Where *biomass* is available it should be opened in intended lines to facilitate sowing. *Small planting holes* at correct depth and spacing are further recommended. Seeds should be sown directly into the planting holes.

Adequate *space between crops* will reduce competition for light, conserve water, and provide more soil nutrition to each plant thus contributing to healthy growth and a good crop. Good crop thus will contribute to increased productivity. There is a limit to the amount of nutrients in soil. By leaving plenty of room between plants, plants can have a wide area from which to draw their sustenance. Keeping the area *weed-free* will also allow more nutrients to be available for the plants you want to grow.

As plants grow, light will be reduced through the developing leaf canopy. This shade will slow plants down if plants are too crowded. Leaving more space between plants allows more sun and brighter light to hit expanding plants, and this will result in faster, more robust growth.

Unseen competition for root room can also slow plants down. Plants thrive when roots can freely spread in loose healthy soil. Roots will also draw more moisture if they have plenty of room.

The following table summarizes *general plant spacing recommendations for major local crops*:

Sole crops	Spacing in cm		Number of seeds/station	Population per Hectare
	Rows	Station		
Maize	75	25	1	53,333
Sorghum	75	25	3	160,000
Groundnuts	37,5	20	1	133,333
Soya beans	37,5	10	1	266,667
Cotton	75	60	2	44,444
Tobacco (Burley)	110	60	1	15,152
Tobacco (Flue/Dark Fired)	100	50	1	20,000

Table 4 Plant spacing recommendations for major local crops

Intercropping vegetables, that means raising different vegetables on the same patch of ground at the same time is a common feature in Malawi. This cropping pattern contributes to increased harvest and thus food security. On the other hand, it contributes to better utilization of land and in many case intercropped plants also returning organic matter to the soil thus increasing the soil's structural stability, erosion resistance, and water storage capacity⁴.

The following table summarizes appropriate plant spacing for intercropping of major cereals with legumes:

Intercropping legumes with cereals	Spacing in cm		Number of seeds/station	Population per Hectare
	Rows	Station		
Maize	90	25	1	44,444
Sorghum	90	25	3	133,333
Pigeon Peas	90	60	2	37,037
Beans and Cowpeas	90	25	1	44,444

Table 5 Plant Spacing for intercropping

⁴<http://www.scidev.net/sub-saharan-africa/farming/news/intercropping-boosts-maize-yields-by-50-percent.html>

Chapter 6 – Removing Barriers and Enabling the Environment for Adoption of Climate-Smart Agriculture

Overview

The promotion of sound agricultural practices to adapt to climate change faces a number of barriers and challenges. By the end of this chapter you will be able to explain various challenges and barriers to the adoption of Climate-Smart Agriculture. In addition, you will be able to describe the links between CSA and institutions that support farmers to undertake Climate-Smart Agriculture activities.

6.1. Barriers and challenges

Barriers that can prevent adoption of Climate-Smart Agriculture practices can be divided in two broad categories: *physical* or hardware (e.g. limited access to appropriate farm equipment and tools, inadequate farm inputs) and *non-physical* or software (e.g. inadequate knowledge and information, etc.) barriers.

Physical barriers

Although, CSA may not necessarily require more equipment and tools than conventional agriculture the adoption of CSA practices results in costs which can be divided into three categories:

- *Investment costs* for equipment, machinery or on-farm structure
- *Maintenance costs*, such as recurrent expenses to purchase inputs required to maintain climate-smart agricultural practices
- *Opportunity costs*, such as the income producers forego in order to adopt the practice

Limited access and ability to afford seeds, inorganic fertilizers, pesticides, and herbicides represents a constraint to the practice of CSA. However, one of the advantages of CSA is that it can increase yields by fostering biological processes and management practices that enhance soil fertility, pest and weed control where agrochemicals are not available or not affordable.

In addition to insecure prices of agricultural products upfront investments take time to bring about gains in productivity. Present markets often cannot accurately account for the value of the environmental benefits that CSA delivers.

For smallholder farmers to adopt CSA, there is need to provide infrastructure such as irrigation water supply, water management structures, transport, markets, communication infrastructure as well as storage and processing structures. Poor and inadequate infrastructure often limits adoption and options for adaptation, particularly for smallholder farmers. Social infrastructure such as farmers' organizations and effective marketing systems are also important.

Non-physical barriers

Many farmers have not been exposed to (or received) proper training on CSA and how to implement it in practice. Their lack of knowledge has been compounded by inconsistent and often conflicting extension messages on the principles and practices of CSA. Many farmers believe that for example CSA cannot be undertaken without specific inputs and tools (e.g. improved or hybrid seed, fertilizers, herbicides, knapsack sprayers, jab planters) thereby limiting the uptake of CSA and its scale on farms. Quality inputs and tools are important to maximize the benefits of CSA, but they are not a prerequisite and farmers have the flexibility to undertake the practice without them.

In addition, *culturally specific factors*, such as community norms, practices and tools of cultivation play an important role as well. The reluctance to try new practices is intensified by the fear of ridicule from communities for undertaking a different system of planting.

Inappropriate national and local political agendas, lack of operational capacity, overlapping and unclear demarcation of responsibilities, ineffective decentralization, lack of good governance as well as inadequate extension services constitute an *institutional set of barriers*. Often there are laws in favour of Sustainable Land Management (SLM), but they are not followed. Enforcement is difficult, costly and can create adverse relationships between government and land users.

Land tenure and user rights barriers include inappropriate land tenure policies and inequitable access to land and water. This creates insecurity about private and communal rights as modern laws and regulations do not consider traditional user rights, by-laws and social and cultural norms.

Smallholder farmers aiming to adopt CSA practices often are constrained by insufficient cash to invest in land, equipment, labor, seeds, breeds and other farm inputs. In addition, up-front financing costs can be high and benefits not realized until medium-long term (credit). Any up-front financing can be more easily solved using collective action in the form of farmer cooperatives.

6.2. Risk management

The following part of the manual will focus on tools and institutions that are relevant to risk management in Malawi.

Safety nets or insurance can decrease risk and thus enhance resilience in the face of shocks and is a form of adaptation. In Malawi safety net programmes implemented include the Malawi Social Cash Transfer (SCT), although this safety net program was not designed explicitly to address food insecurity due to climate change. Safety net programmes often operate in places where markets for financial services (credit/savings/ insurance), labour, goods and inputs are missing or do not function well, and where HH are most vulnerable to climate change.

For the adoption of CSA it is necessary to create a conducive environment by developing policies and strategies with typical national risk management components. Table 6 provides an overview about the different channels and related policies.

Channels	Crop and income loss risk management policies	Disaster Risk Management policies (flood, drought)
Farmer technologic/ strategic options	<ul style="list-style-type: none"> - Purchase of crop insurance to reduce the risks of climate-related income loss - Invest in crop shares - Diversity source of household income - Strengthen self-help groups involved in risk management 	<ul style="list-style-type: none"> - Diversify source of household income in order to address the risk of climate-related income loss
Public services and external/project support	<ul style="list-style-type: none"> - Establishment of weather/meteorological stations - Development of private insurance schemes - infrastructure and income - Participation in income stabilization programs 	<ul style="list-style-type: none"> - Development of early warning systems - Infrastructure investments to protect against asset loss - Protecting equipped areas from flood damage and maintaining drainage outlets
Support Policies	<ul style="list-style-type: none"> - Mobilize adequate community based risk managements tools - Modify crop insurance programs - Develop innovative risk financing instruments and insurance schemes to spread residual risks 	<ul style="list-style-type: none"> - Strengthen the meteorological department - Incentive policies to encourage better drought management programs - Policies to alter cropping patterns to suit drought - Planting more water-efficient and/or drought tolerant crop varieties

Table 6 Overview of different channels and policies

6.3. Actors of CSA and their role

There is a large variety of stakeholders and actors that influence the adoption of CSA:

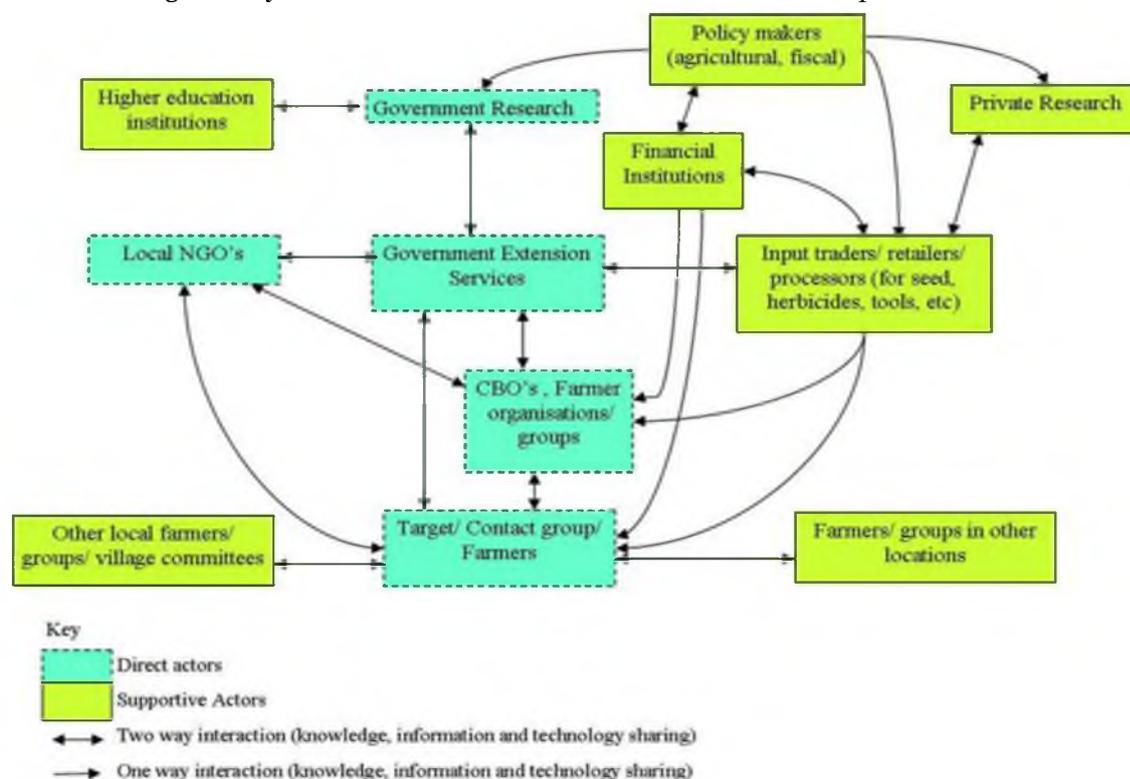


Figure 4 Actors of Climate-Smart Agriculture

There are three **main roles and responsibilities** that actors fulfil in the context of CSA.

Producing and sharing technical knowledge, which includes the identification of the main vulnerabilities in local agricultural and food systems as well as the most vulnerable households. In addition, actors consider and select the most locally appropriate innovations from the range of potential climate-smart practices. They relay new information on weather, climate and options for agriculture as well as improving the quality and relevance of research on CSA through local participation.

Actors for CSA channel micro-finance effectively to kick-start new practices, technologies and behaviours among farmers. They play an important role when it comes to credit provision, insurance, social safety nets, and payments or rewards for environmental services. As providers for *financial services and access to markets* they stimulate local markets, build links with national and international markets, and improve market literacy among smallholder farmers.

By *supporting the coordination of collaborative action* actors are responsible to encourage new cultural norms for practice in agriculture, food distribution and HH food management. They shift the focus of agricultural extension from delivering technology to working in partnership with local farmers to develop solutions. Also, they underpin the sustainability of CSA through locally workable mechanisms for benefit sharing, dispute settlements and other governance issues. Furthermore, they protect local interests from potentially discriminatory external pressures associated with climate change policies, such as land grabbing. In doing so, they ensure to include particularly vulnerable social groups, such as women, youth, in the benefits of CSA. In the aftermath of climate shocks they ensure that disaster relief reaches the right people quickly and effectively

6.3.1. Mainstreaming CSA in policies and strategies

To be effective Climate-Smart Agriculture needs to be mainstreamed into core government policies and programmes, including monetary policy. Priority needs to be given to practices that aim to bring productivity gains, enhance resilience and reduce emissions.

Coordination is mandatory between agencies across sectors at the national and local level and partnerships with non-state stakeholders play a key role in CSA. For better management of agricultural production and ecosystem services CSA requires a wider landscape approach.

Factors to consider for mainstreaming include among others:

Climate-Smart Agriculture expenditure and planning: There is a strong need for coordination for expenditure and planning between concerned agencies at the national and local levels

Land tenure regimes: Secure land rights are part of the enabling environment for investments in Sustainable Land and Water Management (SLWM) which are crucial elements of CSA.

Private Sector Investments: Taking into account the importance of improving the overall business environment through simple, transparent regulations and tax structures to incorporate climate-smart requirements into lending conditions.

Improve market accessibility, policy and financial instruments: Innovative institutional arrangements that address market constraints improve linkages and offer more stable and better prices to producers.

Incentives for Climate-Smart Agriculture investments: Incentive measures that focus on overcoming barriers to the adoption of CSA practices.

Development of policies to mobilize non-state actors: Civil society, private sector and financial institutions should all be involved in developing CSA.

Development of policies to link CSA with adaptation and mitigation measures to climate change and show synergies: There are links and synergies between CSA, adaptation and mitigation in agricultural activities. Clear policies and plans will better guide the implementation of CSA activities.

6.3.2. Agricultural governance structures at national and local level

In order to understand how farmers at local level can take advantage of governance structures on climate change issues, it is necessary to understand what structures are in place, what role they play and how local farmers can use them.

Malawi's national decentralization policy of 1998 promotes popular participation in the governance and development of districts. The policy seeks to "create a democratic environment for governance and development at local level which aims to facilitate participation of the grassroots in decision making."

The Decentralization Policy and Local Government Act provide the following structure to enhance participation and empowerment:

- the District Executive Committee (DEC)
- the Area Development Committee (ADC)
- the Village Development Committee (VDC)

The ADC and VDC are representative bodies through which farmers' voices are to be heard. The "voices" are in turn taken to the district council level for incorporation into the final programmes for decision making. The main functions of VDC and ADC are:

- To identify community needs
- Preparing project proposals for the community in question
- Acting as channels of communication between local people and government at district as well as central government level

In the agriculture sector, knowledge, information and technology transfer including CSA follows the structures at district level. Ideally, government has the central role to coordinate all agricultural activities and stakeholders at district level through the District Agricultural Extension Coordinating

Committee (DAECC). Additionally, platforms for interaction have been created including stakeholder and review meetings, field days, and agricultural launches where various stakeholders are invited to attend and participate. However, there are also some NGOs who just go straight to the farmers without going through the DAECC.

The graph below captures the technology transfer at local level.

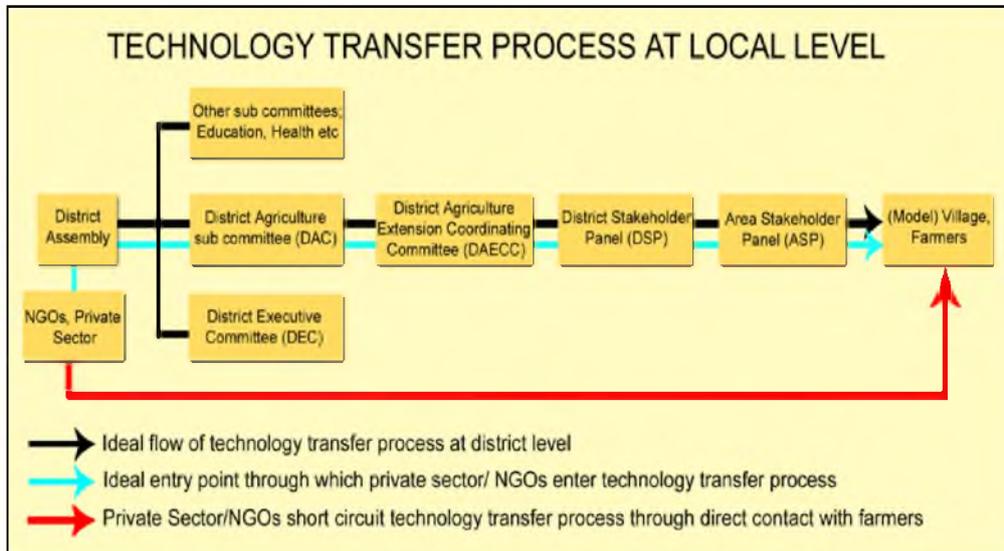


Figure 5 Technology transfer process at local level

Chapter 7 – The Lead Farmer Concept

Overview

The weaknesses associated with government extension systems mean that farmers organizations and other non-state partners will have to play a more active role in taking CSA to farmers. The Lead Farmer Concept is one tool to bring CSA to farmers. It involves farmer to farmer extension services. In the past farmers depended on public extension services for information, technical training and professional services. However, the dwindling capacity of public Agricultural Extension Services provision has necessitated the Ministry of Agriculture and Food Security to consider the implementation of the Lead Farmer Concept.

The concept uses a bottom – up and farmer centered approach which empowers farmers to express meaningfully their demand for services and legitimize ownership of the learning process. Farmer to farmer extension in Malawi started in 1990s with the DANIDA funded Agriculture Sector Programme Support II under the Department of Animal Health and Livestock Development (DAHLD) in implementing activities like stock dipping, livestock vaccination and artificial insemination.

It is envisaged that the concept will improve the quantity, quality and efficiency of extension services provision in the country. Therefore, the concept should be fully integrated into the extension service provision strategy involving various stakeholders.

The entry point of District Agriculture Extension Services System (DAESS) is the village. The lead farmer acts as a technology promoter in the village and s/he can mobilize the community to consolidate the priorities of the village to be responded to by various service providers. The extension workers will guide communities in the selection process and work closely with lead farmers and provide frequent training as well as supervision and backstopping. Extension workers provide new information to lead farmers and link them with other service providers. Also, lead farmers need to be included in planning and review meetings of the extension services.

7.1. Definition and role

Definition: A lead farmer is defined as an individual farmer who has been selected by the community to perform technology-specific farmer-to-farmer extension and is trained in the use of the technology.⁵

Lead Farmers are often called by different names by various stakeholders. These include but are not limited to: farmer trainers, farmer promoters, community educators, farmer extensionists, village technicians, volunteer extension workers, farmer technicians, key man, etc. The Ministry of Agriculture and Food Security has adopted the name Lead Farmer as an appropriate name because the farmer technically guides other fellow farmers.

Role: Lead farmers perform different roles:

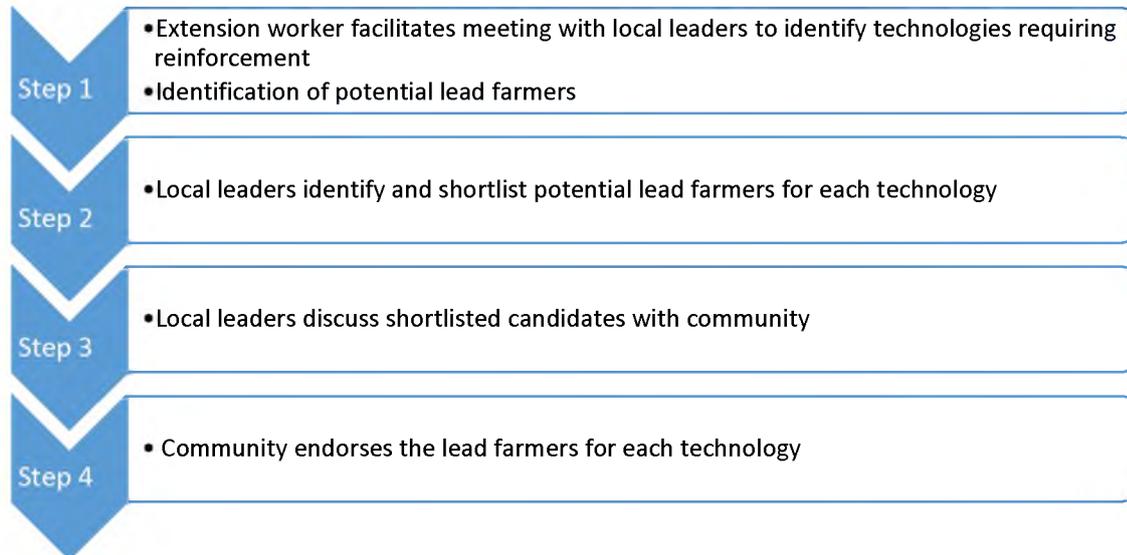
- Teaching other villagers and conduct demonstrations sessions
- Implementing new technologies introduced by the AEDOs and follow up on farmer's action plans
- Encourage other farmers to adopt technologies through follow ups, field days, local tours and by being a role model
- Provide feedback on problems faced during adoption of extension technologies through reports
- Link farmer's problems with relevant institutions
- Liaise with extension workers on farmer's needs
- Lead communities in community based monitoring and evaluation

⁵ Khaila S, Tchuwa F, Franzel S, Simpson S. 2015 The Farmer-to-Farmer Extension Approach in Malawi: A Survey of Lead Farmers. ICRAF Working Paper No. 189. Nairobi, World Agroforestry Centre. DOI: <http://dx.doi.org/10.5716/WP14200.PDF>, pg. 16.

7.2. Identification and empowerment

Lead Farmers need to bring a certain set of capacities and attitudes to fulfill their role. Candidates need to be able to lead others and have strong communication and facilitation skills. They should originate from the village and be socially accepted by the community. In addition to these personal skills they also need to have strong technical skills and be eager to adopt new technologies.

There are various steps in identifying lead farmers. These are as follows:



Selected lead farmers then need to be empowered to fulfill their role. This can be done by extension workers by:

- Training them on the lead farmer concept
- Training them on technologies to be re-enforced in the area at Residential Training Center
- Training them on specific technologies at a Day Training Center
- Providing them with a memorandum of understanding including their mode of operation
- Discuss with the communities on mode of operation of lead farmers
- Mobilizing lead farmers and the community to formulate work plans
- Conducting regular supervision to re-enforce implementation of work plan
- Distributing and orienting them on technical resource materials (e.g. leaflets and booklets)

7.3. Advantages and challenges

There are several *advantages* of lead farmers and these include:

- Easy and faster dissemination of technical information since the lead farmer lives in the community
- Enhanced communication because the lead farmer shares the same cultural beliefs and language as the community
- Easy adoption of agricultural technologies because the learning is from fellow farmers
- Farmers' problems are easily identified, understood and addressed since the lead farmer stays in the village

- Reduces the workload of extension worker because the lead farmers cover some technologies and areas which would have been the responsibility of extension worker
- Farmer coverage is improved because the lead farmer assists in imparting technologies
- Commands respect from the community since farmers trust one another
- Encourages ownership of agricultural programs by the community since the lead farmers are from within

The following are some of the *problems* which have been experienced with the lead farmer concept implementation:

- Extension Workers spend more time working with lead farmers than directly with the entire community
- The lead farmer prioritizes his/her own work before assisting others
- Inadequate professional training
- Lack of reliable transport especially if the village where the lead farmer is working is big and also if s/he needs to consult the extension worker
- Other farmers may not be assisted if they have personal grudges with the lead farmer
- The lead farmer can withdraw any time since s/he works on voluntary basis
- There is possibility of misleading farmers if not well trained

7.4. Sustainability considerations

The services of lead farmers need to be lasting in nature. Mechanisms need to be put in place for the services to be sustainable. Most importantly, local communities and leaders need to have a say and engage in the selection of a lead farmer. Also, the lead farmer needs to be well trained and have clearly defined roles and responsibilities. Extension workers need to provide continued supervision and backstopping for lead farmers and should encourage exchanges between lead farmers. Also, lead farmers should participate in planning, training and review meetings. Competitions and incentives like bicycles, T-shirts, identity cards can further contribute to the motivation of lead farmers. Communities should support lead farmers by attending their calls for meeting and adopting technologies and approaches promoted by lead farmers.

References

AFIDEP and PAI. 2012. "Population Dynamics, Climate Change and Sustainable Development in Malawi", Nairobi and Washington, DC: African Institute for Development Policy (AFIDEP) and Population Action International.

Barnard James, Manyire Henry, Tambi Emmanuel and Bangali Solomon. FARA (2015). Barriers to scaling up/out climate smart agriculture and strategies to enhance adoption in Africa. Forum for Agricultural Research in Africa, Accra, Ghana.

FAO EPIC, n.p., n.d., Climate-Smart Agriculture Training Manual.

Khaila S, Tchuwa F, Franzel S, Simpson S. 2015 The Farmer-to-Farmer Extension Approach in Malawi: A Survey of Lead Farmers. ICRAF Working Paper No. 189. Nairobi, World Agroforestry Centre. DOI: <http://dx.doi.org/10.5716/WP14200.PDF>

OECD (2016), OECD-FAO Agricultural Outlook 2016-2025, OECD Publishing, Paris. http://www.oecd-ilibrary.org/development/development-co-operation-report-2016_dcr-2016-en

Yusuf M. Mohamoud 2012 Effect of contour ridging on runoff and soil loss. African Journal of Agricultural Research Vol. 7(46), pp. 6115-6124, 5 December, 2012. Available online at <http://www.academicjournals.org/AJAR>. DOI: 10.5897/AJAR11.2307.

Please also refer to the FAO EPIC, Climate-Smart Agriculture Training Manual for further literature references.