global forum for rural advisory services
forum mondial pour le conseil rural
foro global para los servicios de asesoría rural

Republic of Rwanda
Ministry of Agriculture
& Animal Resources

Rwanda Customized Module

Climate Smart Agriculture in Extension and Advisory Services

Student Guide

Global Forum for Rural Advisory Services (GFRAS)
c/o Agridea, Eschikon 28, 8315 Lindau, SWITZERLAND
Phone +41 (0)52 354 97 64, Fax +41 (0)52 354 97 97
info@g-fras.org, www.g-fras.org

Acknowledgements

In 2016 the Global Forum for Rural Advisory Services (GFRAS) developed the New Extensionist Learning Kit (NELK) modules https://www.g-fras.org/en/knowledge/new-extensionist-learning-kit-nelk.html on functional skills for individual extension staff, in response to the demand from its network. GFRAS continues to develop new set of modules covering different technical skills. The Learning Kit contains modules designed for self-directed, face- to-face, or blended learning and can be useful resource for individual extension field staff, managers, and lecturers.

Responding to the growing demand from extension and rural advisory service providers worldwide to adapt the modules to the local contexts, GFRAS has embarked on the journey to support the NELK Customization process. NELK Customization is understood as a **guided process as permitted by GFRAS** aimed as adapting the original module to suit the local context. Details on this process can be found on the NELK Customization Guide.

This **Climate Smart Agriculture in Extension and Advisory Services Module** is development as part of the NELK Customized package adapted from *Module 13: Risk Mitigation and Adaptation in Extension and Advisory Services*.

Original Module

Lead author: Sepo Hachigonta

Technical writer: Herman De Bruin

Editor: Elmarie Kruger

Quality assurer: Margeaux Erasmus

Layout: Deborah Els

Coordinating team: Kristin Davis, Hlamalani Ngwenya, Lorenz Schwarz & Natalie Ernst

Financial support:

This module was made possible through the support of the Swiss Development Confederation (SDC). The contents of this module are the responsibility of the authors and do not necessarily reflect the views of Swiss Government.

Customized Module

Lead authors : Moussa Senge Kyembwa and Nicolas Uwitonze

Editor: Heather McLachlan

Layout: Deborah Els

Coordination team: Carl Larsen, Joep Slaats, Hlamalani Ngwenya, Kristin Davis, Lucy Mwangi, Max Olupot and Ingrid Oliveira

Advisory group: Jean Claude Izamuhaye, Gafarasi Isadore and Charles Murekezi

Financial support:

This customized module is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of the authors and do not necessarily reflect the views of USAID or the United States Government.

The customization process was in collaboration between the Feed the Future Developing Local Extension Capacity project, implemented by Feed the Future Rwanda Hinga Weze Activity, which co-funded the customization of this module.

2021

Contents

1. Before you begin

1.1 General instruction

This module should be used in conjunction with the workbook provided. As you read through the module, you will find different visual features that are designed to help you navigate the document.

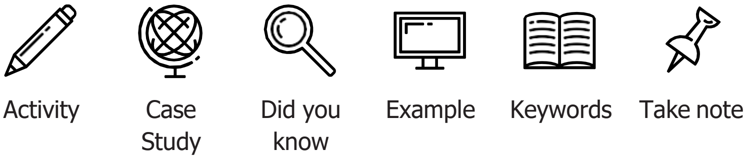


Figure 1: Icons used to highlight important information throughout the manual

The module makes use of keywords (difficult or technical words that are important for you to understand). To ensure that you receive the full benefit from the module, keywords will be marked the first time they occur and defined in a box containing the keywords symbol. Make sure that you read the definition of any words that you are unsure about.

1.2 Activities

Each session in the module will contain various types of activities to help you become knowledgeable and competent. The module contains three types of activities:

A **pre-assessment** is to be completed before reading through the module overview and introduction, and a **post-assessment** is to be completed once the entire module has been covered. This will measure the degree to which your knowledge has improved by completing the module.

Each session contains one or more **session activities** to be completed, in the workbook, where indicated in the module. These activities measure your ability to recall and apply theoretical knowledge.

At the end of each study unit a **summative assessment** needs to be completed. These assessments are longer than the session activities and will test your knowledge on all the work within the study unit.

1.3 Assessment instructions

Keep the following in mind before doing any of the assessments:

- All assessments are to be completed in the provided workbook.
- The manual contains all relevant information you will need to complete the questions, if additional information is needed, such as the use of online sources, facilities will be made available.
- Work through the activities in a study unit and make sure that you can answer all the questions before attempting the summative assessment. If you find that you are not certain of any part of the training material, repeat that section until you feel confident.
- The summative assessment must be done under the supervision of your trainer at the end of your learning period.

1.4. End users

This training module is designed to be used by public and private Rwandan extension agents that face and interact with lead farmers (farmer promoters, Farmer field school facilitators) and most particularly smallholder farmers. The targeted categories, from 1 to 11 are included in Box 1.

Box 1: Rwandan Extension Categories

1=Cell development officer (CEDO)/IDP
2=Sector agronomist
3=Sector livestock officer
4=District agronomist
5=District livestock officer
6=District veterinary officer
7=District director of agriculture, livestock and environment
8=Veterinary pharmacist
9=Crop/agronomic advisor for a private company
10=Crop/agronomic advisor for an NGO
11=Other field staff for an NGO
12=Farmer field schools facilitator
13=Farmer-promoter
14=Other

Climate Smart Agriculture (CSA) in Extension and Advisory Services (EAS) in Rwanda

Module outcomes

After completing this module, you will be able to:

1. Define the concept of climate change and climate smart agriculture (CSA) in Rwanda context;
2. Explain the concepts of risks, uncertainty, resilience and adaptation;
3. Understand the concepts and the use of climate Information services for agriculture;
4. Describe the various Extension and Advisory Service (EAS) approaches in Rwanda for advancing climate smart agriculture (CSA) adoption
5. Identify Climate Smart Agriculture (CSA) best practices and technologies to build smallholder farmers' resilience to climate change in Rwanda
6. Get familiar with gender mainstreaming and other adaptive options to climate change in Extension and Advisory Services (EAS)
7. Monitor and evaluate the implementation of Climate Smart agriculture (CSA) through EAS in Rwanda

Module overview

This module aims to familiarise you with climate smart agriculture (CSA) in Extension and Advisory Services (EAS) in Rwanda. You will be introduced to the concepts of climate change risks and uncertainty in order to better understand the impact of factors such as market and climate variability in the agricultural sector. You will also be provided with skills, tools and knowledge to address these factors through the use of CSA strategies. Remember that this module not only focuses on improving your own adaptive capacity to climate change but also focuses on your ability to improve the capacity of rural farmers; a primary goal of EAS.

Module introduction

Extension professionals and **Extension agents** in Rwanda work under complex and uncertain environments (**ecosystem**, socio-economic or political). Equipping **extensionists** with **Climate Smart Agriculture (CSA)** skills is key to minimising negative agricultural impacts triggered by unforeseen shocks such as a climate change. This module will focus on approaches to understanding climate change risk and climate smart agriculture, **climate information** services for Agriculture, **Agriculture Extension** and advisory services for climate smart agriculture and gender and other adaptive options to climate change.

The module presents selected EAS approaches and tools for adaptation to climate change risks. The material in this module draws on lessons learned from different regions and derived from various **open access** platforms..

Agriculture extension: Also known as agricultural advisory services plays a crucial role in boosting agricultural productivity, increasing food security, improving rural livelihoods, and promoting agriculture as an engine of pro-poor economic growth (IFPRI). FAO defines "extension as an informal educational process directed toward the rural population. This process offers advice and information to help them solve their problems".
Agriculture extension agent: Agricultural extension officers / agents are intermediaries between research and farmers. They operate as facilitators and communicators, helping farmers in their decision-making and ensuring that appropriate knowledge is implemented to obtain the best results with regard to sustainable production and general rural development.
(Commonwealth: https://commonwealth.gostudy.net/).

Climate smart agriculture (CSA): According to the WorldBank (www.worlbank.org), CSA is an integrated approach to managing landscapes—cropland, livestock, forests and fisheries--that address the interlinked challenges of food security and climate change.

According to USAID and FAO, CSA practices are:

- Ways to increase agricultural productivity sustainably, practices that protect the environment and reduce poverty (Food availability)
- Farming practices for individual farm families and communities to improve their resilience to climate change (climate adaptation)
- Practices that can reduce some of the causes of climate change-decrease greenhouse gases to avoid contributing to further climate changes (Climate mitigation).

Climate information: According to FAO refers to the different types of weather forecasts, climate data and agrometeorology products.

Societies: Linked groups of individuals living and interacting in an area.

Ecosystem: A grouping of organisms and their local environment.

Open access: Generally refers to research outputs that can be freely used and are not restricted by copyrights or licenses.

Complete the pre-assessment in your workbook.

Study unit 1: Introduction to risks, climate science and climate change in Rwandan context

Study unit outcomes

After completing this study unit, you should be able to:

1. Explain the concepts of risks, uncertainty, resilience and adaptation;
2. Define climate change terms, and climate change in Rwandan agriculture;
3. Describe Rwanda climate and its vulnerability to climate change
4. Explain the relationship between Climate change and agriculture, climate change and socio-economics as well as climate change and health

Study unit overview

This unit provides an introduction to the principles and concepts of risk, climate change Rwanda vulnerability to climate change; namely:.

- The concept of risk, uncertainty and risk management;
- Climate science, and climate change in Rwandan context
- Rwanda climate and its vulnerability to climate change
- Climate change and agriculture, socio-economics and health

Session 1.1: Understanding concept of risk, uncertainty and risk management

Session outcomes

After completing this session, you should be able to:

1. Explain the link between risk and uncertainty; and
2. Identify the various risk determinants.

Risk and uncertainty

Risk and uncertainty are often incorrectly used as interchangeable terms. In reality, risk is a measure of uncertainty, where uncertainty refers to situations in which the outcome is unknown. It is important to note that uncertainty does not differentiate between positive or negative outcomes, merely indicating the potential for more than one outcome occurring. Risk on the other hand, looks specifically at actions in which there is the potential for negative outcomes.

Complete Activity 1.1 in your workbook.

Risk exposure: The degree to which individuals are exposed to risk, see 'vulnerability'.

Risk determinants

The reality is that farmers face a variety of complex risks, with the degree to which they are exposed to these risks referred to as **risk exposure**. The most common risks affecting farmers can be categorised as production, market, financial and institutional risks and it could be easily assumed that preventing exposure to these risks would be beneficial to farmers, but many of these risks are a normal part of the economic process.

Fluctuations in the market value of crops is a common risk farmers are exposed to across the globe and is caused by:

- Changes in demand (such as during special calendar events);
- Increased competition from other producers driving down sales prices; and
- The amount of the crop available on the market and the amount already sold.

These aspects are related to supply and demand, the process in which shifts in public desire for specific crops change the perceived value of crops, either increasing or decreasing their selling price.

Vulnerability determines the level of risk the farmer is under from risk sources. One of the first steps in extension risk management is gaining the ability to identify which risks the farmer is exposed to and determine their vulnerability to these risks. Farmers who do not diversify their crops increase their vulnerability to market (crop price variation), production (disease and adverse weather) and financial risks. There is a lower likelihood of all crops losing market value if you plant multiple varieties, and diseases specific to certain crops will not affect other crops.

Complete Activity 1.2 in your workbook.

Risk analysis and evaluation

Activity 1.1 showed how a choice between a decision with a more favourable outcome (short path with higher profit) but a higher uncertainty, often needs to be weighed against a less favourable outcome that carries less risk. This process is known as a **risk assessment**, with the determination of the level of risk involved known as **risk evaluation**. Risk evaluation requires identifying the severity of risk **hazards**, the impacts associated with negative outcomes (also referred to as shocks and stresses) and the likelihood of these negative outcomes occurring.

Vulnerability: An inability to deal with or adapt to adverse effects.
Risk assessment: The process of comparing and identifying key risks.
Risk evaluation: The process of determining the degree of risk based on impact and likelihood.
Hazards: The negative outcomes associated with the impacts from risk.

A useful tool in risk evaluation is the risk matrix which allows to assign a severity and likelihood level to hazards. Generally, the risk matrix consists of a table with the likelihood in the left column and the severity of the outcome in the top row. The risk is given based on the likelihood and outcome as shown in Table 1.

Table 1: The risk assessment matrix

Negligible		Outcome				
		Minor	**Moderate**	**Major**	**Severe**	
Likelihood	**Very likely**	Acceptable	Medium	High	Very High	Very High
	Likely	Low	Acceptable	Medium	High	Very High
	Possible	Low	Acceptable	Medium	High	High
	Unlikely	Low	Acceptable	Acceptable	Medium	High
	Very unlikely	Low	Low	Acceptable	Medium	Medium

The risk matrix is useful because it can be adapted for different scenarios by modifying the meaning of the outcome levels as shown in Table 2.

Table 2: Modified outcome levels of the risk matrix

	Exposure	Environmental
Negligible	Almost no farmers affected	Low impact on environment
Minor	Isolated groups affected	Isolated cases of impact
Moderate	At least half of farmers exposed	Significant effect on environment
Major	Commonly experienced by farmers	Widespread impact
Severe	Most of farmers affected	Environmental disaster

Complete Activity 1.3 in your workbook.

Session 1.2: Understanding climate science, and climate change in Rwandan context

Session outcomes

After completing this session, you should be able to:

1. Explain and differentiate between the terms weather, climate, climate change, climate variability, extreme events;
2. Explain the elements contributing to the vulnerability of farm livelihoods to climate change;
3. Describe the Rwanda climate and its vulnerability to climate change

Introduction

In order to understand climate science, you will first need to become familiar with the terminology of the field. Climate variability and climate change are the main causes of stress on food production and availability. Climate change adds complexity to the challenge of meeting food demands subject to variable climate, while at the same time maintaining sustainability of agriculture. These challenges underline the importance of implementing sustainable agriculture practices to ensure food security in the future.

Climate and weather

When discussing climate change, weather refers to what is happening in the atmosphere at a given time for a particular place. This can be seen when looking at any weather forecast where specific atmospheric conditions such as temperature, precipitation, pressure and wind speed are given for specific locations and times. Normally, this is done for short periods of one day to a week.

Climate refers to conditions in the atmosphere over a longer period of time, usually specified for a much larger area and based on weather statistics gathered over a number of years. Over the years, daily weather data has been used to identify patterns in temperatures and rainfall between different months and seasons.

Variation, climate change and extreme events

Changes in temperature and other conditions that you can directly sense in a specific area is known as **weather** variation. In contrast, **climate variation** is the fluctuation of the climate for an area of any size over a longer period of time such as months or seasons. However, in the case of droughts or seasonal variation you are able to sense a change in climate, **climate change** can measure variations that are much harder to determine using your own senses.

Weather: The day to day variations in the climate parameter. Weather is the state of the atmosphere at a particular place and time as regards heat, cloudiness, dryness, sunshine, wind, rain.
Climate: The average weather conditions (taken over a period not less than 30 years), including seasonal to inter-annual extremes and variations locally, regionally and across the globe
Climate variability: The year to year fluctuation or the variation in mean state of climate on all spatial and temporal scales.
Climate change: Refers to a change in the state of the climate that persists for an extended period, typically decades or longer.

Climate variations in the short-term may be clues as to the direction in which climate change will occur. For example, reductions in rainfall and increases in temperature may suggest an increased potential for drought in the future.

Climate change is a change in climate over a long period of time (up to several decades). Climate change includes changes in temperatures, changes in precipitation, winds and other factors. Climate change can be caused by natural phenomena, such as variation in the Sun's orbit, and by human activities such as the production of greenhouse gases. Since the Industrial Revolution began around 1750, human activities have contributed substantially to climate change by adding carbon dioxide (CO_2) and other heat trapping gases to the atmosphere.

A greenhouse gas is any gas in the atmosphere which absorbs and emits heat in the form of thermal radiation. If it were not for the greenhouse gases trapping heat from the Sun in the atmosphere, the average temperature on earth would be roughly -18°C. Unfortunately, human production of greenhouse gases is increasing the levels above what is natural, risking future increases in the Earth's average temperature which will affect ecosystems, biodiversity and human populations across the globe.

Extreme events refer to atmospheric conditions which are expected, unusual or severe. Extreme climatic events refer to longer periods of atmospheric change such as drought or high rainfall periods, which significantly differ from the climate data of previous years. In contrast, extreme weather events are normally sudden, relatively short-lived changes in atmospheric conditions such as heat waves, periods of high temperatures often associated with forest/veld fires, cold snaps (sudden drops in temperature) or floods that arise from drastically increased rainfall levels.

Although the term global warming is often used when discussing humankind's negative impact on the environment, this term often leads to misunderstanding. The reality is that the name comes from the identification of unexpected rises in temperature through climate data to measure the effect of human activity in terms of greenhouse gases. Taking into account the fact that weather patterns and climate cycles in one area change those of neighbouring areas, it is reasonable to conclude that an area experiencing the coldest winter in 50 years could just as easily be linked to global 'warming' as an area experiencing a drought.

Vulnerability of farm households to climate change

Vulnerability to climate change is the degree to which the environment and humans are susceptible to, and unable to cope with adverse impacts of climate change. Three elements contribute to the vulnerability of farm livelihoods:

Livelihood vulnerability = (**exposure** x **sensitivity**) – adaptive capacity.

In other words, the vulnerability of a family's farming system is the result of its exposure to climate change risks multiplied by its sensitivity to those risks minus its capacity to adapt to climate change.

For example, if a family grows rice in a valley bottom that is starting to have higher floods that submerge their rice plants every 3 to 4 years for the first time in memory, the farm's exposure to climate change damages is increasing, resulting in yields that in flood years are less than half of past yields. Most rice varieties will die if completely submerged for more than a few days, so they are sensitive to deep

Note: We shall dive in more details in following sections, on how you can help improve the adaptive capacity of farm families and their communities.

flooding. When you recommend that the family adopt a new rice variety that can tolerate being submerged, the family can reduce its sensitivity to the new pattern of flooding. Your knowledge and work with the family has increased its adaptation to the changing conditions.

Exposure: Exposure to climate change is related largely to geographic location.
Sensitivity: The degree to which a system or community is affected by climate-related stresses. A cool-weather crop such as coffee will be more sensitive to increasing temperature than a heat-loving species such as banana.
Adaptive capacity: The ability of a system or household to adjust to climate change – including weather variability and extremes – to avoid or reduce potential damages, to cope with the consequences and to take advantage of opportunities.
Vulnerability: Vulnerability to climate change is the degree to which a system is susceptible to or unable to cope with the adverse effects of climate change. Vulnerability depends on the type, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and adaptive capacity.

Complete Activity 1.4 in your workbook.

Session 1.3: Understanding Rwanda climate and its vulnerability to climate change

Rwanda has a tropical climate moderated by hilly topography stretching from east to west. The country is divided into four main climatic regions: the eastern plains, central plateau, highlands, and regions around Lake Kivu. The eastern plains receive an annual rainfall of between 700 mm and 1,100 mm, with mean annual temperature oscillating between 20°C and 22°C. The central plateau region enjoys rainfall of between 1,100 mm and 1,300 mm, with an annual mean temperature of between 18°C and 20°C.

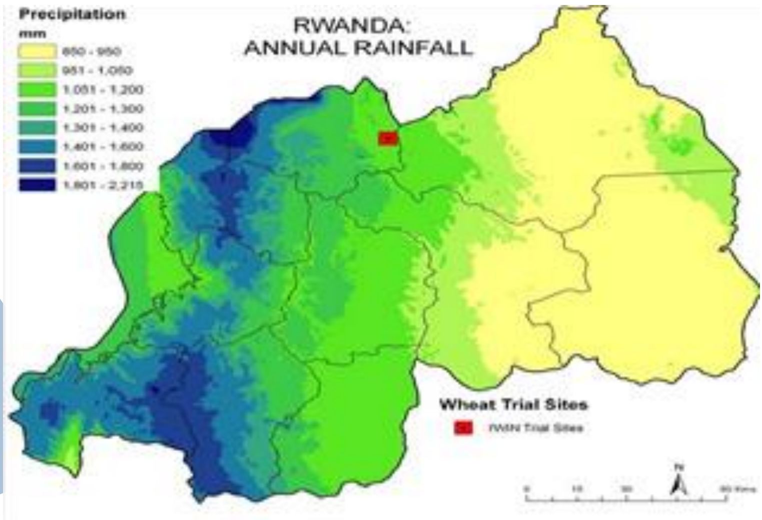


Figure 1: Map showing Rwanda climate

The highlands, including the Congo-Nile Ridge and volcanic chains of Birunga, benefit from an annual rainfall of between 1,300 mm and 1,600 mm, with annual mean temperature ranging between 10°C and 18°C. Regions around Lake Kivu and Bugarama plains have an annual rainfall of between 1,200 mm and 1,500 mm, with an annual mean temperature between 18°C and 22°C.

The 2020 revised Nationally Determined Contribution (NDC) to climate change action in Rwanda shows that the country is increasingly experiencing the impacts of climate change. For instance, rainfall has become increasingly intense and the variability is predicted to increase by 5% to 10%. Temperature increases have also been experienced, with records from 1971 to 2016 showing rises in mean temperature of between 1.4°C and 2. 56°C in the south-west and eastern regions of Rwanda.

Changes in temperature and precipitation and their distributions are the key drivers of climate and weather-related disasters that negatively affect Rwandans and the overall economy. The main risks/ impacts that adversely affect the population include droughts, floods, landslides and storms. These are associated with damages to infrastructure, loss of lives and property including crops, soil erosion, water pollution.

As an example, Figure 2 simulates the potential impact of a projected 2°C increase in temperature on yield potential of maize and beans as major crops in Rwanda.

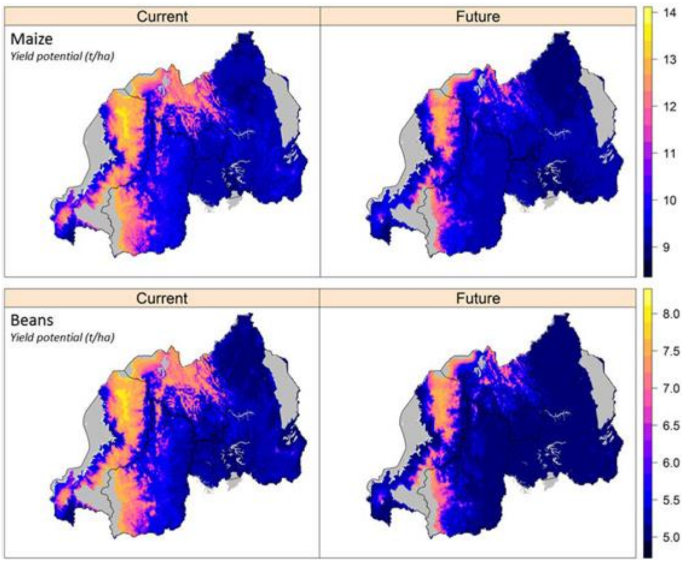


Figure 2: Changes in yield potential of maize and bean with 2°C increase in temperature compared to current yield potential

According to NDC, a rise in temperature is predicted across Rwanda in the coming years up to 2050, especially during the dry seasons. Furthermore, a decreasing trend in mean rainfall and number of rainy days is projected. This explains why increased dry spells are anticipated across the country, especially in the eastern region. Climate change will also upset the north-west highlands and south-western districts of Rwanda with a rise in rainfall intensities. In these regions, much of the land (>50% of the arable land area) is prone to erosion due to steep slopes, requiring soil retention measures.

As the bulk of evidence shows, Rwanda is highly vulnerable to climate change. The National Risk Atlas of Rwanda highlights that the country is highly prone to droughts, floods, landslides and windstorms. Other factors influencing the country's climate change vulnerability include socioeconomic drivers such as building in flood prone areas, high population density in prone areas, increased value of assets in flood-prone areas, and poor management of soil erosion.

Complete Activity 1.5 in your workbook.

Session 1.4: Climate change and agriculture, socio-economics and health

Session outcomes

After completing this session, you should be able to:

1. Describe how climate change affects agriculture and vice versa
2. Explain the concept of socio-economics and how it relates to climate change;
3. Explain the principle of capital and its importance for climate change
4. Provide examples of how climate change is influencing the spread of diseases

Climate change and agriculture

On one hand, the agriculture sector contributes to global warming through carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) gas emissions. In Rwanda, according to IPCC reporting categories for all GHG emissions sources summarised in Figure 2; the total emissions excluding forestry were estimated at 5.33 million tCO_2. The agriculture sector accounted for the largest share of the total (2.94 million tCO_2, 55% of total), followed by energy (1.68 million tCO_2e, 31% of total) and waste (0.64 million tCO_2, 12% of total). Emissions from industrial processes and product use (IPPU) represented just 0.08 million tCO_2, equivalent to around 2% of total emissions in 2015 and mainly associated with calcination CO_2 emissions from clinker production.

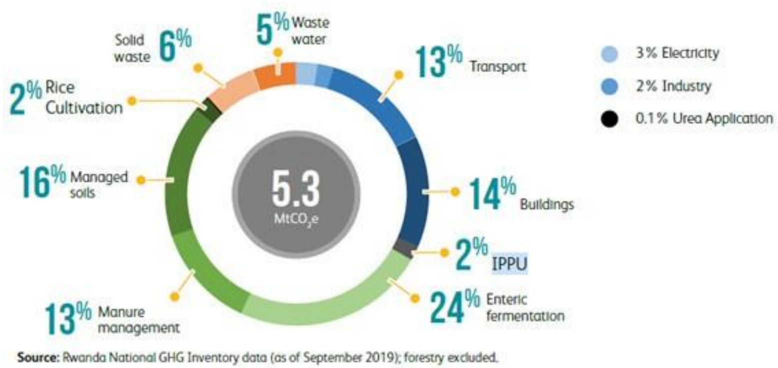


Figure 3: Rwanda's GHG emissions by source in 2015, MtCO2 emissions

On the other hand, agriculture contributes to the reduction of GHGs. A detailed assessment of GHG mitigation options for Rwanda conducted within NDC, identified that within agriculture sector are mitigation measures that account for 49% of the total potential, followed by energy (34% of total), waste (14%), and Industrial Processes and Product Use (IPPU) (3%). It was found that within agriculture, soil conservation measures (terracing, conservation tillage, multi-cropping and crop rotation practices) account for around half of the sector's mitigation potential. The bulk of the remaining mitigation potential includes measures to reduce enteric fermentation emissions from livestock, including the introduction of new species to replace local herds and improved husbandry, and the use of windrow composting.

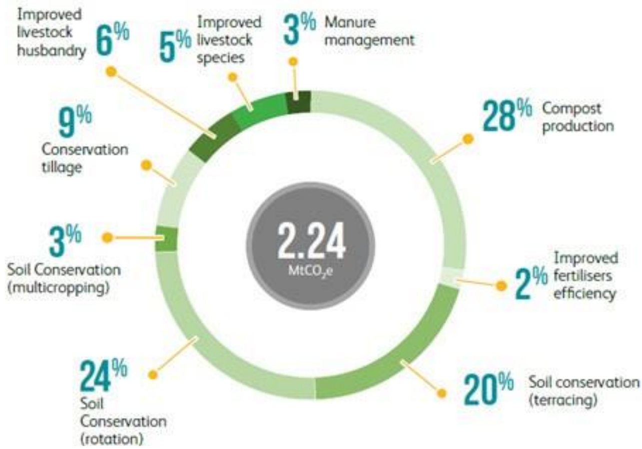


Figure 4: Estimated emissions reduction potential in 2030 for climate mitigation measures assessed from agriculture in Rwanda

Climate change and socio-economics

Agricultural production and income is dependent on climate due the direct effect of weather on crop yields. Extreme climate events can have a significant negative effect on rural households due to limited available resources that prevent farmers from fully recovering after these events. These impacts are most commonly described in terms of economic impact on a community, with the degree of impact based on the community in question. This is known as socio-economics, where 'society' refers to the aspects shared within a community such as work, home life, education and politics.

Climate change and capital

Socio-economics is important when looking at the effects of climate change due to the importance of capital in determining a group's ability to prepare for, adapt to, and recover from climatic events. In general, capital refers to a group's ability to produce goods and services, where groups with high capital are more able to adapt to changes and ensure production.

This capital can be divided into the following five categories.

1. **Human capital:** Human capital refers to the skills of individuals within a group that are necessary to achieve specific outcomes. A group with high human capital would, for example, be farmers who have been given the necessary training to identify risks and implement adaptation measures to deal with climate change.
2. **Social capital:** Social capital refers to the connections and relationships within a group. Groups with high social capital would be able to work well in the case of extreme events, organising relief operations and ensuring that everyone is taken care of.
3. **Natural capital:** Natural capital refers to the natural resources available to a group. This can include the quality of the soil, water sources, air quality and living organisms. The natural capital plays an important role in resisting climate change. An area with abundant water sources will be able to resist longer drought periods than an area with limited water sources.
4. **Physical capital:** Physical capital refers to man-made items such as buildings, machinery and other equipment. This can be in the form of warehouses, schools, hospitals, trucks and farming equipment to name a few. Since these items have an important impact on both the quality of life and production potential of communities, they are items of high socio-economic importance. A community with a hospital for example, is at lower risk of deaths due to heat waves and injuries from other extreme events than one without a hospital.
5. **Financial capital:** Financial capital refers to both the money available to communities in terms of aid from government or other organisations, and that of the individuals themselves. A large section of the rural community farmers have low financial capital with all their money invested in their current crops. As a result of this, they normally do not have the finances available to adapt to and recover from negative climate impacts. This

is by far one of the most important aspects that needs to be overcome when assisting farmers in adapting to climate change.

Climate change and health

The vulnerability of a community or individuals to increased disease burden is dependent on various factors such as:

- The severity of the exposure to the risk;
- The current level of disease burden (sensitivity); and
- The capacity of the health care system.

There is some evidence base linking health with climate change and variability

Malaria: There is significant evidence linking climate change to the distribution patterns of malaria in regions. Projections currently show that the suitable habitat for malaria transmitting mosquitoes is extending further south from the Equator. This is as a result of increases in temperatures making areas more favourable for mosquitoes which breed in warm regions.

Food- and waterborne disease: Instances of waterborne diseases are on the rise, resulting in an increase in cases of disease and poisoning as a result of water contamination. This is because of increases in temperature that promote the breeding of microorganisms and parasites related to diseases such as cholera, schistosomiasis and salmonellosis.

Similar to what is seen in mosquitoes, increases in other pest species such as flies and rats, which prefer warm environments, also pose a risk due to their roles in spreading disease.

Health and infrastructure: As water sources decrease, the risk of dehydration increases as well as the potential for disease due to the increased demands on sanitation systems to process waste. Improved infrastructure will therefore be needed to address the processing of waste and the supply of clean drinking water to people.

System improvement is also needed in cases where climate change results in increased rainfall and risks of flash floods. This is essential to prevent the buildup of standing water, a common breeding ground for disease-causing organisms, parasites and mosquitoes.

Additional considerations

The burden of disease due to HIV/AIDS will also increase, as exposure to some opportunistic diseases becomes more prevalent in people with compromised immune system.

Complete Activity 1.6 in your workbook.

Complete the summative assessment in your workbook.

Study unit 2: Understanding adaptation and climate smart agriculture (CSA) in Rwanda context

Study unit outcomes

After completing this study unit, you should be able to:

1. Explain adaptation in the context of climate change and the factors affecting adaptive capacity of farmers to climate change
2. Define the concept of climate smart agriculture (CSA)
3. Identify components of Climate smart agriculture
4. Provide specific examples of Climate Smart Agriculture practices applicable to be applied in Rwanda
5. Understand the concept of access and use of climate Information services for agriculture

Study unit overview

This study unit looks at the concept of climate smart agriculture, starting from the concept of adaptation in the context of climate change. You will be provided the skills needed to help improve the adaptive capacity of farm families and their communities. The study unit will introduce the concept and the use of climate Information services for agriculture as well as other examples of climate smart agriculture practices and technologies to build smallholder farmers' resilience to climate change in Rwanda.

Study unit introduction

Climate change poses serious wide-ranging risks to **economies**, **society** and **ecosystems**. These risks include:

- Damage to coastal **infrastructure** resulting from sea level rise and risk of frequent storms.
- Shifting patterns of infectious diseases as a result of increased temperature.
- Increased **food insecurity** resulting from increased risk of storms, droughts, and floods.

And thus, improving understanding Climate Smart Agriculture (CSA) is key to minimising negative agricultural impacts triggered by climate change. This study unit will focus on approaches to understanding climate change adaptation and CSA practices including climate information services for Agriculture.

Economies: The state of a region in terms of the distribution, production and consumption of goods and services.
Societies: Linked groups of individuals living and interacting in an area. Ecosystem: A grouping of organisms and their local environment. Infrastructure: Comprises the physical structures, systems and organisations that allow a system to operate.
Food security: The level to which individuals or groups are able to meet their minimum food needs to maintain their health.

Complete Activity 1.7 in your workbook.

Session 2.1: Understanding adaptation in the context of climate change

Session outcomes

After completing this session, you should be able to:

1. Explain adaptation in the context of climate change and the factors affecting adaptive capacity of farmers to climate change

Introduction

Agricultural adaptation to climate change depends on current access to, and development of technological potential (like irrigation technologies), water resources, biological responses, and the capability of farmers to detect climate change and undertake any necessary actions for adaptation.

Adaptation refers to how you respond to (or prepare for) change within an ecosystem, socioeconomic or political space, in order to reduce the negative impacts and take advantage of opportunities arising from abrupt change. Adaptation has been and will continue to be a strong component of human survival as the effects of natural variability and climate change manifest themselves.

Some communities demonstrate incredible resilience through their ability to absorb disruptions caused by extreme climate change and market forces requiring the need to make adjustments while still retaining their functionality, structure and identity. The response to these changes is associated with the households or communities' vulnerability and their ability to cope with negative impacts. Some examples of adaptation are:

- Developing alternative methods of farming such as greenhouse gardens;
- Installation of nets in windows to allow air flow in hot season while keeping out mosquitoes;
- Construction of all-weather roads;
- Sharing resources and information about risks and solutions

There are two main types of adaptation:

1. Reactive adaptation is your immediate response to change. This type of adaptation is often used to regain stability. It is sometimes not the best response when your past understanding doesn't correspond to current environmental and socio-economic conditions.
2. Proactive adaptation is more likely to reduce long-term damage, risk and vulnerability caused by change. Proactive adaptation involves long-term decision making, which improves your ability to cope with future climate change. Periodic assessment and risk management strategies help make this response the most effective.

Factors affecting adaptive capacity of farmers to climate change

Adaptive capacity depends on many factors other than technical practices. In addition to technologies and management practices, adaptation also depends on whether:

- The farmer is aware that patterns of weather – the climate – have changed and that she/he needs to adapt.
- The farm family has enough people to do the work (family labor) needed to make changes and adopt new farming practices.
- The farm family has money and other resources (their assets) to invest in making changes.
- The farm family or group has ownership or control over key resources (tenure) necessary to make changes.

- Their community is willing to work together to make the necessary changes that improve all of their lives (working together at different scales).
- Their community receives government support services, such as extension.
- They live in a country that has agricultural policies and strategies to increase national climate change resilience.
- Agricultural research and extension services support adaptation, especially for rainfed farming (national systems and structures).
- Social and economic systems support fair access to water and land, education, information, financial services and infrastructure.

Complete Activity 2.1 in your workbook.

Session 2.2: . Understanding the concept of Climate Smart Agriculture (CSA)

Session outcomes

After completing this session, you should be able to:

1. Define the concept of climate smart agriculture (CSA)
2. Identify components of Climate smart agriculture
3. Provide specific examples of Climate Smart Agriculture practices applicable to be applied in Rwanda

Introduction

Climate variability and change, of whatever direction or degree, will therefore exacerbate livelihood vulnerability and its impact is already being felt in Rwanda. Thus, a need to: (i) mitigate climate change by undertaking actions that reduce GHG emissions; (ii) implement adaptation measures to protect the population from climate change effects; and (iii) stimulate adoption of climate-smart technologies and practices

The concept of climate smart agriculture defined

Climate-smart agriculture (CSA) is an approach for developing actions needed to transform and reorient agricultural systems to effectively support development and ensure food security under climate change.

Climate Smart Agriculture aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible.

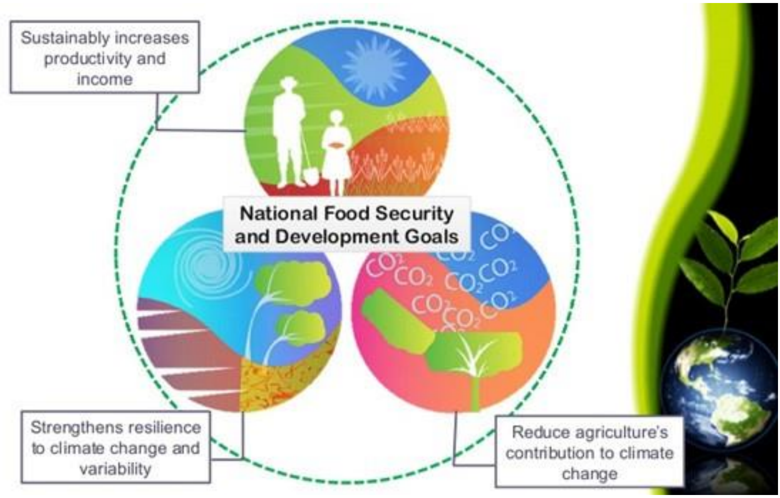


Figure 5: Components of climate smart agriculture

Practical methods for climate smart agriculture include:

- Ways to increase agricultural productivity sustainability – practices that protect the environment and reduce poverty.
- Farming practices for individual farm families and communities to improve their resilience to climate change.
- Practices that can reduce some of the causes of climate change – decrease greenhouse gases to avoid contributing to further changes in the climate.

Table 3: Examples of Climate Smart Agriculture practices applicable in Rwanda

CSA category	Example of CSA practices that are applicable to be adopted in Rwanda
Integrated Soil Fertility Mgt (ISFM)	• Compost making and green manuring • Efficient fertilizer application techniques (time, method, amount). e.g: more precise matching of nutrient with plant needs

CSA category	Example of CSA practices that are applicable to be adopted in Rwanda
Conservation agriculture	• Reduced tillage/ minimal mechanical soil disturbance • Crop residue Management-Mulching, intercropping • Crop rotation/Intercropping
Water management practices	• Application of water harvesting techniques,(e.g: Dams, pools, etc) • Efficient water utilization through small-scale irrigation to address irregularity of rainfall patterns • Water retention and erosion control techniques (e.g: pits, retaining ridges, etc)
Agro-forestry systems	• Home gardens (e.g: Kitchen gardens) • Growing multipurpose trees and shrubs, including fruits • Boundary trees planting ; Windbreaks , Contour hedges • Plantation & Crop combinations (Scattered trees in farm and pasture)
Sustainable management of Pests & diseases	• Integrated Pest Management (IPM) e.g: FAW on Maize, other pests & diseases • Accurate and safer application of pesticides in control of pests & diseases
Crop diversification	• Popularization of crop varieties with high nutrition content, trees and other plants • Pest resistant, high yielding, drought tolerant, short season crop varieties

CSA category	Example of CSA practices that are applicable to be adopted in Rwanda
Other	• Early warning systems (e.g: for FAW and other pests & diseases) and Weather information • Improved post-harvest practices • More efficient cooking stoves • Crop and livestock insurance • Livestock diversification (api/aquaculture)

Complete Activity 2.2 in your workbook.

Session 2.3: Overview of select Climate Smart Agriculture best practices and technologies for smallholder farmers

Session outcomes

After completing this session, you should be able to:

- Understand climate smart agriculture practices and their benefits.

Introduction

Most farmers in Rwanda lack adequate knowledge of climate-smart agriculture and sustainable environmental practices, which further increases their vulnerability, as well as the risks to agriculture and the environment. Many smallholders continue to follow environmentally harmful practices, i.e., cutting down trees, slash and burn, flood irrigation and forest degradation.

The problems the country is facing in the agricultural sector mainly stem from climate change, unsustainable farming methods and the lack of training for extension officers on enhancing productivity, climate change adaptation and mitigation—i.e., climate-smart agriculture.

Examples of climate smart agriculture practices:

1) Conservation agriculture

Conservation agriculture is an approach to agricultural management based on three principles:

a. Minimum soil disturbance Zero tillage is ideal, but the system may involve controlled tillage in which no more than 20 to 25% of the soil surface is disturbed.

b. Retention of crop residues or other soil surface cover Many definitions of CA use 30% permanent organic soil cover as the minimum, but the ideal level of soil cover is site-specific.
c. Use of crop rotations Crop rotation helps reduce build-up of weeds, pests and diseases. Where farmers do not have enough land to rotate crops, intercropping can be used. Legumes are recommended as rotational crops for their nitrogen-fixing functions.

Conservation agriculture practices—no-till in particular—have been promoted for their potential to mitigate climate change. The potential for no-till alone to mitigate climate change by sequestering carbon may be less than previously thought, but other aspects of CA have mitigation potential.

2) Agroforestry

Agroforestry has the potential to contribute to both climate change mitigation and adaptation by sequestering carbon and enhancing resilience. To provide the services needed to combat weather extremes and other climate change associated impacts, agroforestry, like other management options in the climate change toolbox, ought to be practised proactively. For example, in the case of trees, this means planting several years prior to the benefits. In this regard, these practices should be able to offset lost opportunity costs by providing non-climate change mitigation and adaptation services that are valued by farmers, in the meanwhile. This partially constitutes agroforestry's appeal as a climate change mitigation and adaptation tool.

The accruing agroforestry benefits (favourable microclimates, enhanced biodiversity, providing windbreaks, improved soil fertility, diversification of production, and reduced nutrient runoff and erosion) are the elements that can be tagged without losing sight of the ultimate goal of combating climate change through mitigation and adaptation.

Concepts and principles of agroforestry

Agroforestry is distinguished from traditional forestry by having the additional aspect of a closely associated agricultural or forage crop. Agroforestry systems and practices vary with the needs of different farmers, and outcomes may also differ considerably, depending on the conditions under which agroforestry is practised. To be called agroforestry, a land-use practice must satisfy four key criteria—the 4 I's:

- **Intentional.** Combinations of trees, crops and/or animals are intentionally designed and managed as a whole unit rather than as individual elements in order to yield multiple products and benefits;
- **Intensive.** Agroforestry practices are intensively managed to maintain their productive and protective functions. These practices often involve annual operations such as weeding, cultivation, pruning, pollarding and fertilisation;
- **Interactive.** The biological and physical interactions between the tree, crop and animal components are actively manipulated to yield multiple products and benefits; and;
- **Integrated.** The tree, crop and/or animal components are structurally and functionally combined into a single integrated management unit. Integration may be horizontal or vertical, and above or below ground, either sequentially or simultaneously.

The economic benefits include the reduction of agricultural inputs, especially when using leguminous species which fix nitrogen to improve soil fertility. At the same time, this maintains or increases production and may diversify production in farming systems, for example, food, fodder, lumber, building materials and wood fuel.

The social benefits include improvements to the health and nutrition of the rural poor. The on-farm production of several products, often collected from off-farm sources, can reduce the time and effort needed to obtain them, often lessening the burden on women or generating money if the products can be sold.

The environmental benefits may include a range of environmental services such as improving soil fertility, minimising soil erosion, giving crops and livestock protection from the wind, restoring degraded lands, and water conservation. If properly designed and managed, agroforestry systems can also contribute to biodiversity conservation and climate change adaptation and mitigation. However, if not done properly, agroforestry can cause decreases in production because of competition among trees and crops.

Complete Activity 2.3 in your workbook.

Session 2.4: Access and the use of Climate Information Services for Agriculture

Session outcomes

After completing this session, you should be able to:

- Explain the relationship between Climate Smart Agriculture and CIS;
- Outline the contribution of climate information and extension to the pillars of Climate Smart Agriculture;
- Identify key meteorological service tools for Climate Smart Agriculture, give examples and assess their importance; and
- Recommend areas for improving the dissemination of climate information

Study unit overview

This unit addresses the issue of Climate Information Services (CIS) in light of the emerging body of knowledge and evidence on climate change, agriculture and food security. Climate information services encompass the entire process of procuring climate data for storage and processing it into specific end products for use by different clients within climate-sensitive sectors such as agriculture and health.

Climate information services contribute to Climate Smart Agriculture by ensuring the sustainable production of food and income generation, thus enhancing adaptation, increasing resilience to climate change, and developing opportunities to reduce greenhouse gases. An understanding of climate information services and the contribution of the various actors in the value chain is of importance for EAS actors and practicing extension agents. The key concepts in CIS, agro-meteorological tools and extension methods, supported by a set of interactive activities and case studies are presented in this unit.

Study unit introduction

This unit addresses the issue of climate information services, which is one of the requirements needed to achieve Climate Smart Agriculture objectives. Climate Smart Agriculture addresses climate change by systematically integrating climate information into the planning of sustainable agricultural systems. The major aim of this integration is to ensure sustainable livelihoods in the face of climate change (see https://CSAguide/csa /what-is-climate-smart-agriculture). Climate Smart Agriculture is knowledge-intensive and therefore requires access to information to enable stakeholders and farmers to make informed decisions. Under Climate Smart Agriculture, systems that are based on seasonal rainfall need to adapt and build resilience to climate change. It is within this context that this unit discusses the relevance of climate information systems.

Climate information services

Climate information services cover the whole process of obtaining climate data, storing it, and processing it into specific products that are required by different users in climate -sensitive sectors such as agriculture, disaster-risk reduction and health, among others. In short, it is the packaging and dissemination of climate information to specific users. According to the World Meteorological Organization, climate services encompass a range of activities that deal with generating and providing information based on past, present and future climate, and on its impacts on natural and human systems.

A climate information service is one of the five components of the Global Framework for Climate Services (GFCS) (Figure 6). The major goal of GFCS is to enable better management of the risks of climate variability and change at all levels through the development of science based climate information and prediction services and their incorporation into planning, policy and practice. As a component of the GFCS, Climate Services Information Systems (CSIS) has a role in producing and distributing climate data and information according to the needs of users and agreed standards. The CSIS is the principal mechanism through which information about climate (past, present and future) is routinely collected, stored and processed to generate products and services that inform decision-making processes across a wide range of climate-sensitive activities and enterprises.

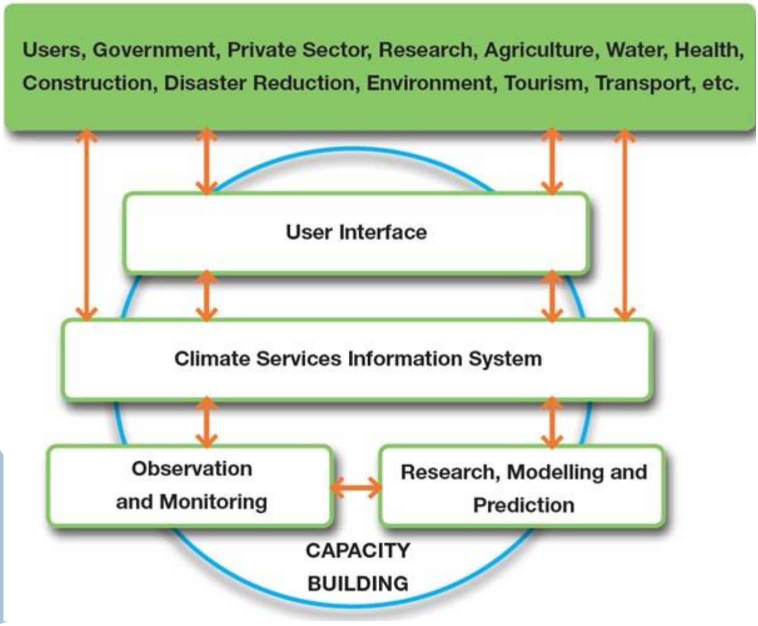


Figure 6: Global framework for climate services pillars and priority areas
Source: CTCN, 2017; Adapted from: www.gfcs-climate.org/

Contribution of climate information services

The following are the contribution that climate information makes to Climate Smart Agriculture :

- **Productivity.** Effective climate services are part of the enabling environment for the transition to Climate Smart

Agriculture. Adequate and timely weather information can help farmers make decisions on the timing of agricultural activities and the variety of crops to be planted, thus increasing productivity. Climate information provides a basis for flexible planning adapted to a range of climate possibilities. It supports decision-making on which options to invest in, and when and how much to invest. For example, a farmer may decide to grow a high-yielding maize variety, given a forecast of a good season for rainfall. The farmer may decide to diversify and add the value of the harvested maize to other projects such as poultry and piggery in order to increase income.

Farmers need the following type of data in order to make informed decisions:

- The expected start and end of rainfall patterns, as well as distribution. Simplified forecasting can help farmers understand better the concepts 'normal', 'below normal' and 'above normal'.
- Probability of extreme events, dry and wet spells. This information should be made available at the beginning of the season.
- Probability of having a certain quality of season, which can be calculated using historical data.
- Future weather patterns and their implications.
- Risks in producing different crops (for informed decision-making), planting dates and choice of crops and varieties.
- Basketful of livelihoods options.

- **Adaptation through risk management.** The effective use of climate information services contributes to resilience by enabling farmers to manage the negative impacts of weather-related risks in poor seasons better, while also taking greater advantage of average and better than average seasons. A climate information system is the key to understanding climate as a major influence on livelihoods, life, ecosystems and development. It allows effective adaptation, which involves developing a range of adaptation options with the flexibility to switch from one strategy to another or to combine strategies. It helps actors to adjust their plans as climate stressors and shocks unfold.

- **Mitigation:** Climate information services can contribute to Climate Smart Agriculture by providing information that supports the more efficient use of fertilisers so as to reduce emissions of greenhouse gases into the atmosphere.

Agro-meteorological tools for Climate Smart Agriculture

Understanding approaches and appreciating tools for communicating climate information and advisory services is important in the adoption of Climate Smart Agriculture practices.

Climate and weather.

The Rwanda Meteorological Agency (Meteo Rwanda) is responsible for the provision of a range of weather and climate information for farmers (real-time weather data and short-, medium- and long-range forecasts), that provide the basis for tactical and strategic adaptation at different levels of operational detail. When and if properly tailored to farmers' needs and expectations, these products are extremely valuable in the implementation of Climate Smart Agriculture. The products in most cases have to be used concurrently to ensure that users maximise the benefits. Climate forecasts are useful in giving an indication of what the climate may look like in the near future, whilst projections are for the long term, as discussed below.

Seasonal forecasts

The seasonal forecast, also referred to as the long-range (climate) forecast, is important as it assists strategic planning by users in climate-sensitive sectors such as agriculture, water and disaster risk reduction. Seasonal forecasts provide the expected rainfall performance for the season in terms of the total of accumulated amounts for sub-seasons.

Medium-range weather forecasts

These forecasts are useful in giving the weather conditions expected for the next seven to ten days. The forecast will assist in carrying out various agricultural activities such as planting, fertiliser application, weeding, spraying and mulching, i.e., tactical decisions. The forecast also helps farmers cope with increasing rainfall variability by adjusting decisions on the timing of planting at short notice.

Short-range weather forecasts

These forecasts are issued to cover one to three days. This assists in decisions which may be immediate such as chemical spraying, fertiliser application and frost protection. Delays in responses may limit the effectiveness of the operation, particularly if certain weather conditions are expected in the next few hours.

Complete Activity 2.4 in your workbook.

Complete the summative assessment in your workbook.

Study unit 3: Agriculture Extension and advisory services for climate smart agriculture

Study unit outcomes

After completing this study unit, you should be able to:

- Describe the role of Extension advisory service in adoption of climate smart agriculture practices

Study unit overview

This unit will look at the role of EAS in adopting climate smart agriculture practices at the farmer level. In order for you to communicate these practices to farmers you will be provided with an explanation of how to identify and implement climate smart agriculture practices through Extension. A number of case studies will be provided to further your understanding of the topics covered.

Study unit introduction

Effective use of climate smart agriculture in extension services can make a significant positive contribution to the agriculture system. It is the role of EAS to provide farmers with the capacity needed to adopt and apply relevant climate smart agriculture practices into their farming practices.

Session 3.1: Roles of EAS in building smallholder farmers' resilience to climate change

Session outcomes

After completing this session, you should be able to:

- Describe the role of EAS in disseminating CSA practices to farmers
- Understand how you can support farmers to be less vulnerable by improving their ability to adapt to climate change

Introduction

Though Climate Smart Agriculture has been gaining importance, its dissemination and uptake of climate-smart technologies, tools, and practices are still largely an ongoing and challenging process. The adaptation of climate-related knowledge, technologies, and practices based on regional requirements, promoting a coordinated learning by farmers, researchers, extension workers, and the wide dissemination of Climate Smart Agriculture practices, is possible through the extension to an extent.

The role of EAS in disseminating climate smart agriculture practices

Extension and advisory services can bridge the knowledge gap by providing clarity on Climate Smart Agriculture components and its relevant issues. They also play a vital role in helping farmers to cope with the diverse impacts of climate change by creating awareness by using appropriate tools to make them aware about different adaptation and mitigation strategies.

Training systems can be useful to share knowledge between farmers and to introduce farmers to new technology, approaches and concepts that can assist them in adopting new technologies and best practices. The novel extension approaches like the information and communication technology (ICT)-enabled extension services and climate information services help the farmers at grass root level.

Contribution of agricultural extension to Climate Smart Agriculture

Agricultural extension plays a key role in Climate Smart Agriculture mainly because adaptation to climate change requires changes in knowledge, attitudes, resilience, capacities, people's skills and extension systems. Agricultural extension contributes directly or indirectly to the three pillars of Climate Smart Agriculture. According to Singh and Grover (2013), agricultural extension roles include: technologies and management information; capacity development; facilitating brokering and implementing policies and programmes; coordination; infrastructure/institutions; training; use of technology demonstrations; yield crop forecasting; and feedback role. However, there are known challenges in respect of the dissemination and uptake of various Climate Smart Agriculture technologies. These include financial and operational resources; low ratios of extension officials to farmers; clientele socio cognitive factors, and institutional arrangements that are not responsive to climate change.

The challenges are amplified by the current extension services, which are staffed mostly by natural scientists, including agronomists and engineers. These scientists have limited resources to support farmers and have limited skills in communicating climate information or addressing social challenges. Although a strong interdisciplinary vision is required, it is not readily available in traditional extension systems. Moreover, there is a lack of adequate capacity at different levels with which to carry out the actions and changes needed to diversify in the interests of stakeholders. Other challenges include the lack of an enabling environment, including policies and the technical and financial conditions to increase productivity and resilience. The lack of capacity to adapt and to seek opportunities to mitigate emissions from greenhouse gases has also been reported. Lastly, the relevant information that is available is confined to the scientific literature, little being done in terms of operational activities to reduce greenhouse gases, for example.

Using TWIGIRE MUHINZI through FFS approach to adapt to climate change

From a sustainability point of view, it is recommended that the FFS approach be used as a means or a platform for disseminating Climate Change Adaptation (CCA) technologies among farmers. The FFS approach aims at reinforcing rural populations' CCA capacities, a concept which has been adopted for the integration of new resilient practices, such as the use of meteorological data in farmer decision processes, the use of resilient seed varieties, agricultural facilities and integrated pest management.

Climate Field Schools

The Climate Field Schools (CFS) based on the Farmers Field Schools' model were piloted by the project to disseminate knowledge about climate change, its causes, potential impact on livelihoods and local coping strategies. With curricula adapted to address local conditions such as specific climate change-related knowledge and skills, CFS can help farmers to adapt, develop better climate resilient integrated farming systems and improve their ability to cope with disasters and other environmental challenges. The CFS aims to enhance the capacity of extension workers and farmers to understand and apply climate information to reduce risks in agriculture. It is an innovative way to address problems on climate extremes, essentially through capacity building of farmers. Through CFS, the farmers and extension agents learned to identify what crops are suitable to grow at the onset of a predicted climate event. In addition, it helps the farmers in scheduling appropriate farm operations.

The objectives of the CFS program are to:

- Enable extension staff and farmers to understand climate related risks in agriculture and the crop management system;
- Show the importance of climate in plant growth and development, as well as its relationship with plant pests and diseases;
- Familiarize the participants on forecast implementation, climate parameters and instruments;
- Help farmers learn to integrate weather and climate information with disaster management and agricultural planning;
- Create awareness of participants on disaster risk reduction and climate change adaptation.

In general, the CFS is designed as a training program to be conducted over a period of 3 months. The farmers are taught how to read climate forecasts together with their indigenous knowledge on climatic phenomena in relation to agriculture. Other topics include land preparation, weather forecasting, use of fertilizer, pest management and soil analysis, etc. The CFS also teaches farmers about climate change and its impact on agriculture so that in future they can use seasonal outlooks and other forecast products for planning and decision-making.

Complete Activity 3.1 in your workbook.

Session 3.2: Introduction to Participatory Integrated Climate Smart Agriculture

Session outcomes

After completing this session, you should be able to:

- Understand the approach used in Participatory Integrated Climate Smart Agriculture to build farmers resilience to climate change

Introduction

Smallholder farmers are key to food security in sub-Saharan Africa where two thirds of the population depend on small-scale, rain-fed farming as their main source of food and income. Critical farming and household decisions depend upon the weather, for example, how much rain falls, the length and start date of the rainfall season and the timing of dry spells. Such aspects of the weather vary considerably from year to year.

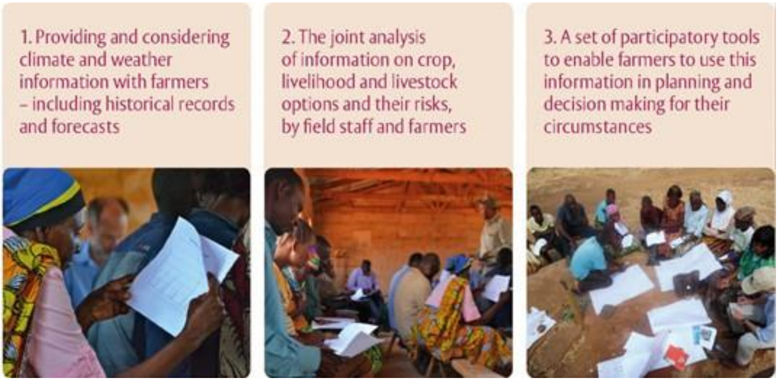
Definition of PICSA

The Participatory Integrated Climate Services for Agriculture (PICSA) approach aims to facilitate farmers to make informed decisions based on accurate, location specific, climate and weather information; locally relevant crop, livestock and livelihood options; and with the use of participatory tools to aid their decision making.

Considering farming and livelihood options in the context of climate is crucial for making good decisions. A farmer in Matumba village in central Tanzania expressed this notion perfectly when he said, “We should select crops that look like the climate”.

The PICSA approach has been designed with field staff in mind, and aims to support you to do your job better by providing you with improved resources and information.

Key components of PICSA



The 12 steps that are used when disseminating PIClimate Smart Agriculture processes

- Step A: What does the farmer currently do?
- Step B: Is the climate changing?
- Step C: What are the opportunities and risks?
- Step D: What are the options for the farmer?
- Step E: Options by context.
- Step F: Compare different options and plan.
- Step G: The farmer decides.
- Step H: Seasonal forecast.
- Step I: Identify and select possible responses to the forecast.
- Step J: Short-term forecasts and warnings.
- Step K: Identify and select possible responses to short-term forecasts and warnings.
- Step L: Learn from experience and improve process

Complete Activity 3.2 in your workbook.

Complete the summative assessment in your workbook.

Study unit 4: Gender and other adaptive options to Climate change

Study unit outcomes

After completing this study unit, you should be able to:

1. Explain the role of gender in mitigating effect of climate change
2. Explain adaptation in the context of climate change and variability and socio-economic change
3. Explain how you will engage the community in a conversation around climate change adaptation
4. Perform assessments and evaluations to identify vulnerabilities and climate change
5. Incorporate adaptation recommendations and actions into community plans

Study unit overview

This study unit looks at adaptive options to climate change by considering gender as a cross cutting option in terms of addressing issues and challenges related to climate change. You will be provided with skills needed to monitor and implement climate smart agriculture practices.

Study unit introduction

Climate change poses serious wide-raging risks to gender, economies, society and ecosystems in the Rwandan context. These risks include:

- Climate change is putting pressure on farmers' seed and food production systems, often resulting in different impacts on women and men.

- Increased food insecurity resulting from increased risk of storms, droughts, and floods.

Gender refers to the socially constructed characteristics of women and men, such as norms, roles, and relationships of and between groups of women and men. It varies from society to society and can be changed. Climate change is adversely impacting the lives and livelihoods of women and men, their families and communities across Rwanda.

Climate change tends to exacerbate existing gender inequalities; women in particular may thus face larger negative impacts.

By involving both women and men and drawing on their gender-based experiences in the formal and informal workforce, in communities and households, climate responses can be made more effective and sustainable.

Adaptation refers to how you respond to (or prepare for) change within an ecosystem, socioeconomic or political space, in order to reduce the negative impacts and take advantage of opportunities arising from abrupt change. Adaptation has been and will continue to be a strong component of human survival as the effects of natural variability and climate change manifest themselves.

Session 4.1: Gender mainstreaming in Climate smart agriculture

Session outcomes

After completing this session, you should be able to:

1. Explain gender mainstreaming
2. Understand steps that need to be taken to mainstream gender using principles of climate smart agriculture

Introduction

Gender mainstreaming

Mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality.

Impact of Climate change on gender

Climate change impacts men and women differently, given their different roles and responsibilities at the household and community levels. Women are more exposed and vulnerable to climate change because they are often poorer, receive less education, and are not involved in political and household decision-making processes that affect their lives. Cultural norms related to gender sometimes limit the ability of women to make quick decisions on whether to move to safer grounds in disaster situations until it is too late.

Rwanda considers Gender and Environment and climate change as cross cutting sectors. Gender mainstreaming takes its roots from the National Constitution of June 2003 which provides for higher levels of representation to previously marginalized groups such as women, youth and people living with disability.

Climate change

Rwanda as a whole is vulnerable to climate change. If realized as projected, climate change will exacerbate Rwanda's existing environmental, social and economic problems.

Gender equality in the three pillars of Climate smart agriculture

A gender-responsive approach will achieve more effective and equitable outcomes, reduce project risks, and reduce the gender gap in outcomes from climate change activities because it better reflects the lives and experiences of agricultural communities.

Pillar 1. Sustainably increase agricultural productivity and incomes

It is common for men and women within the same agricultural household to pursue separate but interrelated livelihoods and to incorporate different technology and production management options. Thus, it is important to look at how these differences, shaped by social norms and intra-household decision-making, may affect men's and women's participation in more sustainable agricultural practices and the consequent benefits. At the same time, an awareness of the importance of gender equality in improving productivity in the agricultural sector is needed.

Efforts to address gender in the context of Pillar 1 include:

- systematic gender analysis to identify where there may be differences in men's and women's productivity;
- resolution of the challenges women experience in accessing, using, and supervising farm labour;
- improvement in women's access to productive inputs and resources such as extension and technologies;
- improvement in women's use of agricultural inputs; and
- improving their tenure of natural resources, as women's lack of access to secure land tenure is a major constraint on adopting climate smart agriculture

Pillar 2. Adapt to and build resilience to climate change

The impacts of climate change and related adaptive strategies are not gender-neutral because vulnerability is often determined by socio-economic factors, livelihoods, people's capacity and access to knowledge, information, services and support – all of which may differ along lines of gender. In addition, men and women may have different coping strategies.

Pillar 3. Reduce and / or remove greenhouse gas emissions, where possible

According to the definition of climate-smart agriculture, reducing and removing greenhouse gases often comes as a co-benefit of activities enhancing productivity, resilience and/or efficiency and reducing waste and losses along the food chain. The ability to adopt climate smart agricultural practices that also reduce greenhouse gas emissions appears to be affected by gender inequalities. For example, in sub-Saharan Africa, insecure land tenure, workload, heavy tools, lack of capital and limited farm inputs posed major barriers to the adoption of conservation agriculture and agroforestry (often regarded as climate-smart) by women farmers.

When pursuing practices that contribute to climate change mitigation, it must be acknowledged that women and men are often in different starting positions to take them up. For example, agroforestry may be less accessible or offer fewer incentives to those with weaker tenure rights, and soil and water conservation may be difficult if hiring labour is not possible. On the other hand, some practices, like improved cooking stoves, biomass for energy and biogas, may be more attractive to women for their labour-saving features. Proposed mitigation actions therefore should harness the experiences, expertise, and realities of women and men alike.

Indicators of project outcomes designed to capture information on men and women to analyse the gender-related impacts:

Number of farmers who have access to and use (i) weather and climate information services; (ii) price information on a regular basis (disaggregated by sex).

Percentage change in crop yield per hectare and year as result of the Climate Smart Agriculture intervention (disaggregated by male or female-headed households and household members).

Number of farmers participating in functional associations as a result of the project (disaggregated by sex and by type of association, for example, market cooperative, producer association).

Farmers who consider themselves better off (for example, in terms of livelihood, income, nutrition, wellbeing, social status or empowerment) now than before the Climate Smart Agriculture intervention (disaggregated by sex). Note: Measurement of this indicator would require direct feedback from farmers via a survey.

✎ Complete Activity 4.1 in your workbook.

Session 4.2: Other adaptive options to climate change

Session outcomes

After completing this session, you should be able to:

1. Describe how adaptation strategies are applied in real world situations; and
2. Use adaptation strategies to both address current and future risks

Introduction

In this section you will look at a number of adaptation strategies that form a key component in risk mitigation. Note that adaptation strategies are risk mitigation approaches that focus on decreasing the vulnerability of communities to changes, both in terms of sudden climatic change and change related to the economic system. As such, adaptation strategies are key in areas with increased vulnerability to extreme events or poor communities that are unable to cope with market variance and the rising costs of living.

Adaptation strategies for extreme events Since extreme events often result in sudden and considerable loss of life and damage, the process of recovery can be extremely costly and can require long periods of time to take place. By having adaptation strategies in place the initial damage and loss of life and recovery periods can be reduced. Table 2 lists some extreme events and appropriate adaptation strategies.

Table 2: Common extreme events and their adoption strategies

Extreme event	Adaptation strategy
Adaptation to drought	• Public outreach/education such as supplying farmers with access to, and information about drought resistant crops; • Providing infrastructure to ensure there are additional water reserves stockpiled in case of droughts.
Flooding	Improving infrastructure by: • Adopting green approaches which reduce the effect of construction projects on the local plants and wildlife and prevents the loss of ground cover; • Limiting development in floodplains; • Moving existing buildings to areas above the flood level; • Building protective infrastructure such as walls near rivers, storm water drains and dams; and • Preserving/restoring wetlands, as they are important natural ground cover that reduce the impact of flood water.

Complete Activity 4.2 in your workbook.

Session 4.3: Monitoring the implementation of Climate Smart Agriculture practices

Session outcomes

After completing this session, you should be able to:

1. To know the importance of monitoring Climate smart agriculture practices
2. How to design and implement monitoring and evaluation for climate smart agriculture practices

Introduction

Monitoring and evaluation are core management tools for climate-smart agriculture. Monitoring and evaluation activities, which are integral parts of the planning and implementation of climate-smart agriculture interventions, set baselines, define indicators, measure progress and evaluate successes and setbacks. Monitoring and evaluation activities also identify the synergies among various climate-smart agriculture options.

Monitoring and evaluation need to be designed and conducted to measure progress towards climate-smart agriculture objectives. There are many general methodologies, data and tools to build upon. Monitoring and evaluation present several distinctive challenges for climate-smart agriculture. There is a set of core principles that are important to consider, such as obtaining management buy-in and ensuring that participating stakeholders and institutions have the capacities they need to contribute effectively.

Additionally, the monitoring and assessment of climate-smart interventions need to include gender-sensitive indicators that help track progress in closing the gender gap in agriculture. Achieved by assessing the differentiated effects on women and men from any intervention, the resulting information offers various advantages to: Highlight gender issues for consideration in climate-smart agricultural policy-making Build an evidence base on gender in climate-smart agriculture by collecting and analysing sex-disaggregated data Develop financial instruments that respond to the specific needs of women as well as men Introduce institutional changes to develop the capacity and build the commitment of decision-makers towards gender equality and women's empowerment Design climate-smart projects and investments that integrate gender issues throughout the cycle to ensure specific needs and priorities of both men and women are adequately addressed.

Defining monitoring and evaluation for climate-smart agriculture

The overall goal of assessments, and monitoring and evaluation activities is to effectively guide the transition of sound climate-smart agriculture policies into climate-smart agriculture programmes that are successfully implemented on the ground. Climate change is likely to have the most severe impacts on groups that are already coping with food insecurity and vulnerable to shocks. Interventions must focus on understanding and addressing the needs and aspirations of these groups and ensure that they are included in decision-making processes. Assessments, monitoring and evaluation must pay particular attention to these vulnerable groups and be accountable to them.

Traditionally, programme and project monitoring predominantly deals with tracking progress and intermediate results, and making adjustments during the project's implementation. Evaluation primarily deals with the assessment of results and impacts. Expectations for these results and impacts need to be set out clearly at the beginning of a project. They are of particular concern towards the end of projects and programmes. Also, monitoring and evaluation processes should not be isolated from learning processes. For the programme and project to remain flexible, all three processes are necessary.

Monitoring and evaluation are not completely separable, but they are two distinct activities. They need to be linked to understand causes and effects of different actions. Both are concerned, to different degrees, with tracking progress and change. Both are concerned with ensuring upwards and downwards accountability for results to a range of stakeholders. They both require participation by stakeholders to generate, analyse and verify information. Evaluative thinking and reflection is also important during implementation.

How to design and implement monitoring and evaluation for climate smart agriculture programmes and projects

Monitoring and evaluation of climate-smart agriculture programmes and projects use as a starting point the baseline projections regarding climatic conditions, even if these projections are preliminary. They are also based on the desired climate-smart agriculture objectives stated in the policy and project design assessments, which include an assessment of system-wide capacities. At the same time, given the uncertainties of climate change and the constant need to adapt to these uncertainties, as well as other factors of complexity, a more adaptable programme process may be needed. This will include developmental evaluation, where strategies and indicators may need to change on an ongoing basis through project implementation. This must be done in a highly participatory way to foster country-ownership and commitment for mutual accountability of results. Monitoring and evaluation are initiated at the project preparation stage when there is an interplay between assessments, monitoring and evaluation activities.

These activities are intimately linked through detailed and regular planning processes. In particular, impact evaluation frameworks should also guide the preparation of project and programme baselines. It should also be noted that there may be different levels at which data for climate impact assessments are gathered (e.g. national, regional, landscape and local), and for which interventions are designed. The predicted climate impacts at each level may differ somewhat, with those at the finer-grain levels being more specific and even unique. Objectives, indicators and baselines at the national or programme level may be quite general.

However, at a more local level (i.e: At the sector, cell or village levels in Rwanda context), they will need to be increasingly tailored to the context and the specific nature of the project intervention. A hierarchy of objectives and indicators might then be developed with monitoring and evaluation data from a range of different unique local projects being combined to prepare a report on indicators at the programme level. Shortly after appraisal of the project proposal and approval of the project, detailed indicators, baselines and targets are set, with clearly specified beneficiaries and well-defined interventions.

Throughout the implementation of the project, the progress of climate-smart agriculture interventions against indicators is monitored, as is the use of resources and delivery of outputs. At the mid-cycle and end of the project, the impacts of climate-smart agriculture interventions on socioeconomic, environmental and livelihood indicators are evaluated based on the baseline situation and the initial expectations in terms of results. As some of the benefits of climate-smart agriculture may not be realized within the timeframe of a short project, but only during a subsequent capitalization phase, it is ideal to continue project monitoring and evaluation and adaptive management beyond the project cycle, and institutionalize it in ongoing programmes.

Examples of indicators of common outputs, outcomes and impacts in monitoring and evaluation for climate-smart agriculture practices

1. Poverty and household impacts (where possible this data should be disaggregated by gender or by male- and female-headed households):
    - percentage of population that is food insecure;
    - percentage of population below the poverty line;
    - household income, income variability and diversification;
    - Gini coefficient;
    - marketing and commercialization chains that are adapted to changing conditions;
    - proportion of food and income that comes from climate-sensitive sources;
    - amount of time spent collecting firewood;
    - and amount of time spent collecting water.
2. Outcomes in terms of climate-smart agriculture-related changes in productivity:
    - agricultural productivity (e.g. tonnage of crop produced per hectare);
    - changes in land use in area; reduced greenhouse gas emissions;
    - changes in productive resilience to climate variability;
    - multiple productive benefits across a range of production systems, resulting from synergies and links in system;
    - changes in biophysical characteristics (e.g. content of soil organic matter); and diversification from climate-sensitive livelihood sources.
3. Outcomes in terms of adoption of climate-smart agriculture systems:
    - number of irrigation systems that raised drought prevention standards and area of farmland area covered by these systems;

- number of soil and water conservation works; area of farmland that adopted climate-smart agriculture technologies (e.g. reduced tillage, permanent crop cover, agroforestry);
- forest area in which climate-smart technologies are adopted;
- number of fisherfolk who adopted climate-smart fishery technologies, disaggregated by sex;
- increased access of women to land and/or productive resources.

4. Outputs and outcomes indicators related to capacity-development and service-related interventions:
   - number of people who benefited from capacity development, disaggregated by sex (output) women beneficiaries constitute half of participants in capacity-development activities (output);
   - number of officials trained on the inclusion of gender issues in climate-smart agriculture (output);
   - number of male- and female-headed households that have gained direct household benefits from more climate-resilient agriculture infrastructure (outcome);
   - changes in farm-gate and market price (outcome); and
   - proportion of officials applying gained knowledge on gender issues in climate-smart agriculture (outcome).

Complete Activity 4.3 in your workbook.

Resources

The following resources were used in writing this manual:

- FAO. 2019. Agricultural Extension Manual, by Khalid, S.M.N. & Sherzad, S. (eds). Apia.)
- Kevin.et al. (2016). CCAFS Rwanda Deep Dive Assessment of Climate-Smart Agriculture (Climate Smart Agriculture) in the USAID Feed the Future Portfolio in Rwanda)
- Simpson, Brent M.2016. Preparing smallholder farm families to adapt to climate change. Pocket guide1: Extension practice for agricultural adaptation. Catholic Relief Services: Baltimore, MD, USA
- FAO. 2019. Handbook on climate information for farming communities – What farmers need and what is available. Rome. 184 pp. Licence: CC BY-NC-SA 3.0 IGO
- Climate-Smart Agriculture Manual for Zimbabwe, Climate Technology Centre and Network, Denmark, 2017

global forum for rural advisory services
forum mondial pour le conseil rural
foro global para los servicios de asesoría rural

Republic of Rwanda
Ministry of Agriculture
& Animal Resources