



Ministry of Agriculture and Livestock Development
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Sustainable Agricultural Livelihood Restoration, Rehabilitation and Resilience in Kenya

Training Manual

2.1 MODULE 1

CLIMATE CHANGE AND VARIABILITY

Introduction

Climate change (CC) and climate variability (CV) are real and are an impediment to sustainable development globally. Climate change causes a range of positive and negative impacts in agriculture depending on the regions of the world. The negative impacts are expected to be more adverse in developing countries, particularly those in sub-Saharan Africa such as Kenya which has been experiencing increasing temperatures from the 1960s coupled with increased frequency and intensity of extreme weather events such as El Niño and La Niña. Effects of the negative impacts include declining agricultural productivity; land degradation; loss of crops, livestock and fish due to changing temperatures and precipitation regimes and increased frequency and intensity of extreme weather events. The current status of climate change shows that the rise in global temperatures since the industrial revolution has been 0.75 °C. The ten warmest years in the 134-year record have all occurred since 2000. Atmospheric concentrations of CO₂ have increased from 280 ppm in 1850 to 401.58 ppm.

The country's agriculture sector is predominantly rain-fed and therefore vulnerable to climate change. The sector is not only impacted upon by climate change but also contributes to the problem. It is a source of greenhouse gas (GHGs) emissions; responsible for one-third of Kenya's total emissions in 2010 and it is envisaged that this is likely to increase to 27 metric tons of carbon dioxide by 2030. Apart from the threat of climatic changes, the agriculture sector is affected by increasing population pressures and demand for natural resources. In their quest to boost incomes, enhance food security, increase overall productivity and market competitiveness, agricultural households face the challenge of maintaining an efficient natural resource base.

Agricultural production systems should provide adequate food and nutritional requirements; sufficient income for farmers to sustain a comfortable standard of living; and protect ecosystems both now and for future generations, including coping with changing weather patterns. This calls for climate smart agricultural practices that sustainably increase productivity; resilience or are adapted to changing climatic conditions; reduces/removes greenhouse gases; and enhances the achievement of national food security and development goals.

A climate system consists of various components and dynamics. It comprises; atmosphere, ocean, ice and snow cover, land surface and its features. Mutual interactions between these components are physical, chemical and biological processes. All these processes are explained by a complex set of equations that predict their future under modelling and downscaling.



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This module discusses the following aspects:

- Weather
- Climate
- Climate Change
- Climate Variability
- Greenhouse effect
- Adaptation
- Adaptive capacity
- Carbon sink
- Resilience
- Climate information services
- Impacts of climate change and climate variability
- Climate Smart Agriculture (CSA)
- Conservation Agriculture (CA)
- Gender in Climate Smart Agriculture (CSA) and Conservation Agriculture (CA)

Weather

Weather is the summary of temperature, rainfall, wind, humidity, sunshine, cloudiness or storms patterns in a specific place on a specific day or over a short period such as a season. They also include extreme events such as tornadoes, droughts and tropical cyclones. Thus, weather are what we see/hear/feel every day in a given location, which is the state of the atmospheric conditions at a particular place and time. Weather is dynamic and can change within a very short time, even within the same day.

Climate

Climate refers to average weather conditions (taken over a period not less than 30 years), including statistical description of its variations. Several factors contribute to the definition of climate, including long-term averages of temperature and precipitation, but also the type, frequency, duration, and intensity of weather events such as heat waves, cold spells, storms, floods and droughts. Climate is a complex natural process that involves the interaction of the air, the water, and the land surface. The earth's climate is in a state of continuous change, and has changed many times in response to various natural and human causes. The movement of air through the atmosphere and that of water through the ocean also affect temperature and rainfall.

Climate Change

Climate change (CC) refers to a broad range of alterations in climatic and weather conditions (Figure 2.1). It is characterised by changes in average conditions and in the frequency and severity of extreme conditions that have occurred over a long time, generally over 30-35 years. Climate change is the change in the long-term meteorological average itself, whatever the cause. The reality of CC is

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indisputable as it is seen or felt across the globe. It negatively impacts on core fabrics of human livelihood systems i.e. crops, livestock, water, soil and biodiversity.



Figure 2.1. Climate change: Focuses on trend and mean changes

Climate Variability

This refers to year-to-year fluctuations including seasonal variations in the climate parameters. The causes of climate variability (CV) are directly or indirectly by both natural processes and human activities. These processes can increase accumulation of greenhouse gases (GHGs) in the atmosphere. Climate Change and CV arise from the changes in the elements of the atmosphere. Several indicators of CC/CV are manifesting up to farm level. Temperatures have increased, rainfall decreased & depressed, increased pests and diseases affecting both livestock and crops that are the main livelihoods of the poor.

Greenhouse Gases

Greenhouse gases occur naturally in the atmosphere. These gases have longer wavelengths than visible light, which allows the gases to absorb and emit radiation. GHGs cause increased temperature on earth. Human activities that increase GHGs include; industrialization, deforestation, transport and energy production. The most common greenhouse gases are:

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous Oxide (N₂O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF₆)

Greenhouse Gases Effect

Greenhouse gases have chemical characteristics that allow these gases to capture, absorb and store heat energy for a long time (Figure 2.2). The greenhouse effect is therefore the process by which greenhouse gases absorb, reflected long wave radiation (background radiation), and raise atmospheric temperature



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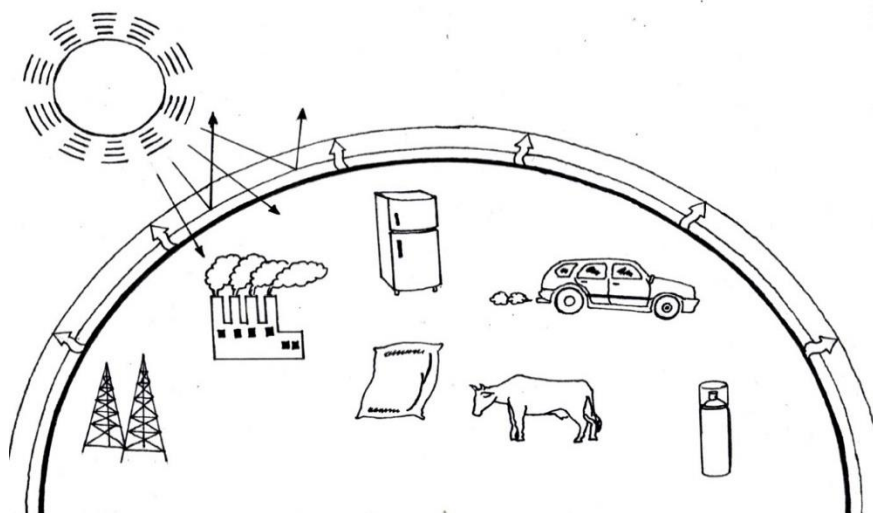


Figure 2.2. Greenhouse effect (Source Esilaba *et al.*, 2021)

Other Key Terminologies Relevant to Climate Change and Variability

Adaptive capacity - The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Carbon sink - Any process, activity, or mechanism that removes carbon dioxide from the atmosphere. Carbon sinks include the **oceans, plants, and other organisms** that remove carbon from the atmosphere via photosynthetic processes.

Carbon sequestration: is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change. there are two main types of carbon sequestration: biological and geological.

Mitigation - A human intervention to reduce the human impact on the climate system, including strategies to reduce greenhouse gas (GHGs) sources and emissions and to enhance GHGs sinks.

Resilience - The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.

Vulnerability - The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate and global change, including climate variability and extremes.