Formulation and Implementation of **Climate-Smart Agriculture Projects**

INTEGRATED, PARTICIPATORY, AND VILLAGE-BASED APPROACHES

Training Manual and Orientation Guide

February 2024

Citation

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Foreword
(RAAF ECOWAS)

> A first step towards adapting to current and future climate change is to reduce vulnerability and exposure to current climate variability.

M. Ousseini SALIFOU
Executive Director
Regional Agency for Agriculture and Food

In recent decades, the issue of climate change has emerged as a pressing global concern, significantly impacting the survival of humanity. The manifestations and effects of climate change vary depending on the climatic zone and the extent of the impact of economic activities. In West Africa, the effects of climate variability and change, as well as the extreme events associated with them, soil salinisation and the physical and chemical degradation of farmland, are disastrous for the agroforestry and fisheries sectors. In addition, these problems are exacerbated by production systems that are generally inadequate and that weaken natural ecosystems and the services derived from them. As a result, the majority of West African populations, mainly farmers, are increasingly poor and vulnerable, while at the same time, they are faced with water scarcity and food and nutrition insecurity.

These are the challenges that ECOWAS is tackling through the development of regional policies such as: i) ECOWAP, the West African Agricultural Policy, with its intervention frameworks such as the Intervention Framework for the Development of Climate-Smart Agriculture and the West African Alliance for Climate-Smart Agriculture; ii) ECOWEP, the Regional Environmental Policy, and iii) the Regional Climate Strategy, which aims to make a sustainable contribution to meeting the food needs of a population of nearly 424 million, to economic and social development and to poverty reduction, while ensuring the sustainable management of natural resources.

In paradox, the ECOWAS member-countries only contribute little to global warming, accounting for just 1.8% of global greenhouse gas (GHG) emissions. However, according to the most pessimistic scenarios, between now and 2060, West Africa will experience a temperature increase of +2.3°C, i.e. a rise of +0.6°C per decade. Rainfall, meanwhile, will be more erratic than ever, leading to an increase in the frequency and intensity of the extreme weather events already experienced in the region.

Given the seriousness of this situation, "Acting Together" through regional solidarity is becoming an absolute necessity to enable us to reduce our region's vulnerability and deal collectively with the risks induced by climate change, which is borderless. That is why ECOWAS, drawing on its past experience, is giving a central priority to capacity building for regional, national and local institutions.

A first step towards adapting to current and future climate change is to reduce vulnerability and exposure to current climate variability. Similarly, integrating adaptation into the planning and decision-making process can promote synergies with development and the reduction of disaster risks. Whatever the solutions envisaged, training and capacity-building for human resources must always be central to the process. High-quality human resources can ensure greater success in implementing the best strategies for adapting to and mitigating climate change. This is why the Training Manual and Orientation Guide "Formulation and Implementation of Climate-Smart Agriculture Projects. Integrated, participatory and village-based approaches" is a major tool for ECOWAS, particularly for the agricultural sector, which employs more than 60% of the working population and contributes up to 35% of the gross domestic product. This Manual is an important source of knowledge and information that will most certainly contribute to building the climate-smart agriculture (CSA) capacities of stakeholders at all levels, and thus ensure the effective implementation of CSA for the sustainable livelihood improvement of our communities.

M. Ousseini SALIFOU
Executive Director
Regional Agency for Agriculture and Food

Foreword
(ALLIANCE OF BIOVERSITY AND CIAT)

"Climate-smart agriculture (CSA) is an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change.

Dr Robert ZOUGMORE
Team Leader West & Central Africa region | Climate Action
Alliance of Bioversity International and CIAT

According to the IPCC Sixth Assessment report, the rate of surface temperature increase has been more rapid in Africa than the global average, with human-induced climate change being the dominant driver. Mean temperatures and hot extremes have emerged above natural variability, relative to 1850–1900, in all land regions in Africa. Extreme rainfall increased from 1981–2010, increasing flows in large Sahelian rivers and catchments, leading to flooding. The frequency of meteorological, agricultural, and hydrological droughts has increased since the 1950s. Observed increases in hot extremes are projected to continue throughout the 21st century with additional global warming. Although most African countries have contributed the least to human-induced climate change, yet have already experienced widespread losses and damages attributable to human-induced climate change. West Africa is no different and is already facing loss of lives and impacts on human health, reduced economic growth, water shortages, reduced food production, biodiversity loss, and adverse impacts on human settlements and infrastructure as a result of human-induced climate change. Climate change is reducing crop productivity in West Africa. It has slowed the growth of agricultural productivity in Africa by 34% since the 1960s, the highest impact of any region. West Africa's human settlements are particularly exposed to floods (from rain and river flows), droughts, and heat waves. Over 2.6 million and 3.4 million new weather-related displacements occurred in sub-Saharan Africa in 2018 and 2019, with West Africa (798,000) a hotspot.

Adaptation actions that focus on single sectors or single risks and prioritize short-term gains often lead to maladaptation for ecosystems and people, if the long-term impacts of the adaptation option are ignored. We need transformative adaptation to contribute to achieving climate resilience in West Africa. Climate-smart agriculture (CSA) is an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change. It systematically considers the synergies and trade-offs that exist between productivity, adaptation, and mitigation. CSA promotes coordinated actions by farmers, researchers, the private sector, civil society, and policymakers towards climate-resilient pathways through four main action areas: (1) building evidence; (2) increasing local institutional effectiveness; (3) fostering coherence between climate and agricultural policies; and (4) linking climate and agricultural financing. CSA therefore differs from 'business-as-usual' approaches by explicitly focusing on addressing climate change while emphasizing the capacity to implement flexible, context-specific solutions, supported by innovative policy and financing actions.

The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT) (henceforth, the Alliance) is committed to providing research-based solutions that address the challenges faced by the agriculture sector, especially in the context of climate change, biodiversity loss, and environmental degradation. Through innovative partnerships, the Alliance collaborates with key stakeholders to develop and apply timely high-quality science on climate adaptation and mitigation while producing decision-making tools that inform policies and guide implementation. As the lead CGIAR Center of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and of the Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA), the Alliance has been selected by ECOWAS/RAAF as a cognizant research organization to implement the capacity building component of the regional CSA project in West Africa. Leveraging the legacy of CCAFS and AICCRA validated innovations, the Alliance generates appropriate scaling mechanisms and partnerships to effectively deploy and bundle climate information services and CSA technologies to meet the climate and food security challenges faced in Africa. AICCRA supports African-led initiatives across different countries and regions to promote gender-sensitive investment and leverage opportunities to finance and deliver promising projects on a massive scale, collaborating with major public and private sector initiatives.

This training manual serves as a guide for the formulation and implementation of CSA projects. The main goal is to improve the knowledge and technical capacity of the national and sub-national actors on various aspects of CSA project design and implementation. Organized into 15 specific modules, the manual covers aspects of knowledge and information on CSA as well as practical approaches, methods, and tools to develop a CSA-mainstreamed project and to further implement activities on the ground. It also suggests breakout group activities to allow trainees to exercise in concrete terms on the various tools and methods. This is undoubtedly a knowledge resource that can contribute to strengthening the capacities of all people ambitioning to take action towards promoting climate-smart agriculture implementation at all levels in Africa.

Dr Robert ZOUGMORE
Team Leader West & Central Africa region | Climate Action
Alliance of Bioversity International and CIAT

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Structure and overview of the Manual (Syllabus)

Session	Modules	Content/description	Training animation methods and tools	Training materials (intermediate and final)	Duration
SESSION I: UNDERSTANDING THE PHENOMENON OF CLIMATE CHANGE (CC), ITS IMPACTS AND POTENTIAL SOLUTIONS **Targets:** Executives and Technicians **Objectives:** Explain to participants the phenomenon of CC, their causes, manifestations, impacts and strategies (efforts) for adaptation and mitigation **Expected results:** Understanding the functioning of the climate system (Atmospheric physics), their variability and change, as well as the global strategies/efforts to adapt to the adverse effects of CC.					2 hrs 00 mins
I	**Module 1:** Climate change: definitions and concepts	✔ Components of the atmosphere ✔ The atmosphere and its interaction with the other components ✔ Greenhouse effect, global warming, and global changes ✔ Definitions and differences between Weather and Climate ✔ Definitions and differences between climate variability and climate change (CC) ✔ Brief history of the CC phenomenon	✔ Theoretical course ✔ Practical demonstration ✔ Questions and answers	✔ PowerPoint presentation ✔ Short videos	30 mins
	Module 2: Causes and manifestations of CC	✔ Causes of CC: Main Vs. Secondary, Natural Vs. Anthropogenic ✔ Manifestations of CC: depending on each sub-sector:Plant and animal production, aquaculture and fishing, forest and environment, processing, and value chain, etc.	✔ Interactive course of listing and explanation of CC causes ✔ Group work/assignments: identification of CC manifestations according to the sub-sectors ✔ Recap in plenary ✔ Questions and answers	✔ PowerPoint presentation ✔ Short videos ✔ Guidelines for assignments	30 mins
	Module 3: Consequences and negative impacts of CC	✔ Consequences and impacts of CC: as perceived by actors/farmers according to each sub-sector: Plant and animal production, aquaculture and fishing, forest and environment, processing, and value chain, etc	✔ Group work/ assignments: enumeration of the consequences and impacts of CC as felt by the actors according to their sectors/ sub-sectors of activity	✔ Guidelines for assignments ✔ PowerPoint presentation	30 mins

Session	Modules	Content/description	Training animation methods and tools	Training materials (intermediate and final)	Duration
		✔ Recapitulation/Synthesis and comparison with the available literature	✔ Recap in plenary ✔ Presentation of the bibliographic summary (available literature) on the impacts and consequences of CC ✔ Questions and answers		
	Module 4: Measures/ approaches of adaptation and mitigation solutions to CC in agriculture	✔ Adaptation efforts and Global Vs. Local solutions (in general) in the face of CC ✔ Manifestations of CC: depending on each sub-sector: Plant and animal production, aquaculture and fishing, forest and environment, processing, and value chain, etc.	✔ Theoretical courseRole-playing exercises (RPE) on CC ✔ Interactive course listing solutions/ efforts by industry ✔ Recap in plenary ✔ Questions and answers	✔ PowerPoint presentation ✔ Components of the Ga me ✔ Short videos ✔ Guidelines for assignments	30 mins
SESSION II: ADDRESSING CLIMATE CHANGE: DIAGNOSIS AND ANALYSIS OF THE CURRENT STATUS AND FUTURE PERSPECTIVES **Targets:** Executives and Technicians **Objectives:** Familiarize participants with CC vulnerability assessment methods and tools Expected results.					5 hrs
II	**Module 1:** CC vulnerability assessment (current and future)	✔ Concepts and brief methodological approach for conducting a climate change vulnerability study ✔ Inventory of the different methods ✔ Practical case assignment for using a method: method/tool/analysis software	✔ Theoretical course ✔ Practical demonstration ✔ Group assignment: enumeration of local solutions by participants ✔ Questions and answers	✔ PowerPoint presentation ✔ Guidelines for assignments ✔ Guidelines on key answer for the assignments	2 hrs
	Module 2: Case Study and Practical assignment	✔ Presentation of vulnerability case study (example of Benin: It preferable to provide example as pertained to the country where the training is conducted) ✔ Practical assignment: Hands-on a vulnerability assessment tool	✔ Theoretical course based on case study ✔ Practical assignment ✔ Recap in plenary ✔ Questions and answers	✔ PowerPoint presentation ✔ Guidelines for assignments	3 hrs

Session	Modules	Content/description	Training animation methods and tools	Training materials (intermediate and final)	Duration
SESSION III: CLIMATE-SMART AGRICULTURE (CSA) **Targets:** Executives and Technicians **Objectives:** Familiarize participants with the concept of CSA by distinguishing it from other existing/known CC adaptation concepts and know how to identify and assess potentially CSA practices **Expected results:** Know what CSA is and be able to make the difference between CSA and other concepts of adaptation to CC and know how to identify and evaluate potentially CSA practices.					6 hrs
III	**Module 1:** definition, basic principles, and main characteristics	✔ Recall of the impacts of CC on each component of the agricultural sector (orally) ✔ Recall and brief description of responses and adaptation strategies by sub-sector (orally) ✔ Concepts of constraints, barriers, and limits of adaptation ✔ The current challenges of adaptation to CC ✔ Presentation and explanation of the CSA concept ✔ Origin and history of the CSA ✔ Basic principles and the three pillars of CSA: Productivity – Adaptation – Mitigation ✔ Similarities/dissimilarities between CSA and other concepts (agroecology, agroforestry, integrated agriculture, sustainable agriculture, conservation agriculture, etc.) ✔ Benefits of CSA	✔ Theoretical course ✔ Interactive reminder course of solutions/efforts by sector of activity ✔ Role-playing exercises (RPE) on CSA ✔ Questions and answers	✔ PowerPoint presentation ✔ Short videos ✔ Guidelines for assignments	2 hrs
	Unit 2: Methodological approaches for identifying and evaluating CSA strategies and practices	✔ Inventory of existing methodological evaluation approaches/tools ✔ Brief description of these evaluation methods/ approaches/tools ✔ Explanation of an approach/tool ✔ Practical assignment: calculation of smartness: CIAT and CCAFS tool ✔ Individual assignment: CIAT tool and CCAFS	✔ Theoretical course ✔ Practical assignments ✔ Questions and answers	✔ PowerPoint presentation ✔ Components of the Game ✔ Practical demonstration ✔ Short videos ✔ Guidelines for assignments	6 hrs

Session	Modules	Content/description	Training animation methods and tools	Training materials (intermediate and final)	Duration
	Module 3: Examples and success stories of CSA strategies	✔ Inventory of potential CSA practices in crop production ✔ Identification and description of 3-5 good practices used in crop production (the practices are country-dependent) ✔ Explain the elements of smartness of these practices ✔ Sharing experiences and skills between participants	✔ Group assignment: listing of CSA practices by participants and sharing of experience ✔ Practical demonstration ✔ Recap ✔ Questions and answers	✔ Guidelines for assignments ✔ Summary PowerPoint ✔ Short videos	2 hrs
SESSION IV: INTEGRATION OF CSA PRACTICES AND CONCEPT IN PROJECTS AND PROGRAMS AND DESIGNING OF NEW CSA PROJECTS/PROGRAMS **Targets:** Executives and Technicians (more in-depth development for executives) **Objectives:** Explain methods and techniques for designing, developing and obtaining funding for bankable CSA projects/Programs **Expected results:** Know how in the designing of CSA projects/programs and be able to defend them to mobilize funding					4 hrs 00 mins
IV	**Module 1:** General principles and methods for developing projects/programs	✔ Principles and general techniques of development (generation of the project idea)/designing and drafting of projects/programs ✔ Monitoring and evaluation of projects/programs	✔ Theoretical course ✔ Information synthesis techniques ✔ Questions and answers	✔ Summary PowerPoint ✔ Summary support	45 mins
	Module 2: Integrating CSA into projects/ programs	✔ Elements and criteria to be considered for incorporating CSA in projects/programs ✔ Steps for incorporating CSA principles in Projects/ Programs ✔ Presentation techniques / defense of the CSA project / programs to potential donors to obtain funding ✔ Practical assignment	✔ Group work for project/program idea identification	✔ Summary PowerPoint ✔ Resume support	1 hr 15 mins
	Module 3: Implementation of CSA projects/ programs	✔ General techniques and methods for implementing and scaling up projects/programs ✔ Techniques and methods for implementing CSA projects/programs ✔ Monitoring-evaluation aspects	✔ Theoretical course ✔ Information synthesis techniques ✔ Questions and answers	✔ Summary PowerPoint ✔ Summary support	2 hrs

Session	Modules	Content/description	Training animation methods and tools	Training materials (intermediate and final)	Duration
SESSION V: INTEGRATED AND PARTICIPATORY APPROACH **Targets:** Managers and technicians (more in-depth development for technicians) **Objectives:** To become familiar with integrated and participatory approaches, with an application to the Climate-Smart Village (CSV) concept. Understand the challenges of CSA and the CSV approach. Know the stages and implementation of the CSV approach. Case study of selected CSV implementations. **Expected results:** At the end of this workshop, you will have a clear idea of the CSV approach and its main features. You will also know the challenges of CSA and the CSV approach and the steps and implementation of the CSV approach. Finally, you will practice and master the CSV implementation process.					
V	**Module 1 :** Concepts, approaches and vision of climate-smart villages (CSVs)	✔ Concept of climate-smart villages ✔ Conceptual approach and main characteristics of CSVs ✔ Components and vision of CSVs	✔ Theoretical course ✔ Interactive reminder course of solutions/efforts by sector of activity sector ✔ Practical demonstration ✔ Questions & answers	✔ Syllabus, Training Manual ✔ PowerPoint présentation	3 hrs 30 min
	Module 2: Stages and implementation of the CSV approach	✔ Stages and implementation of the CSV approach	✔ Theoretical course ✔ Interactive reminder course of solutions/efforts by sector of activity ✔ Practical demonstration ✔ Questions and answers	✔ Syllabus, Training Manual ✔ PowerPoint présentation	4hrs
	Module 3: Experiences and lessons learned	✔ Success stories ✔ Lessons learned and recommendations	✔ Group work on the implementation of a climate-smart village (CSV)	✔ Short videos, charts and photos	2hrs

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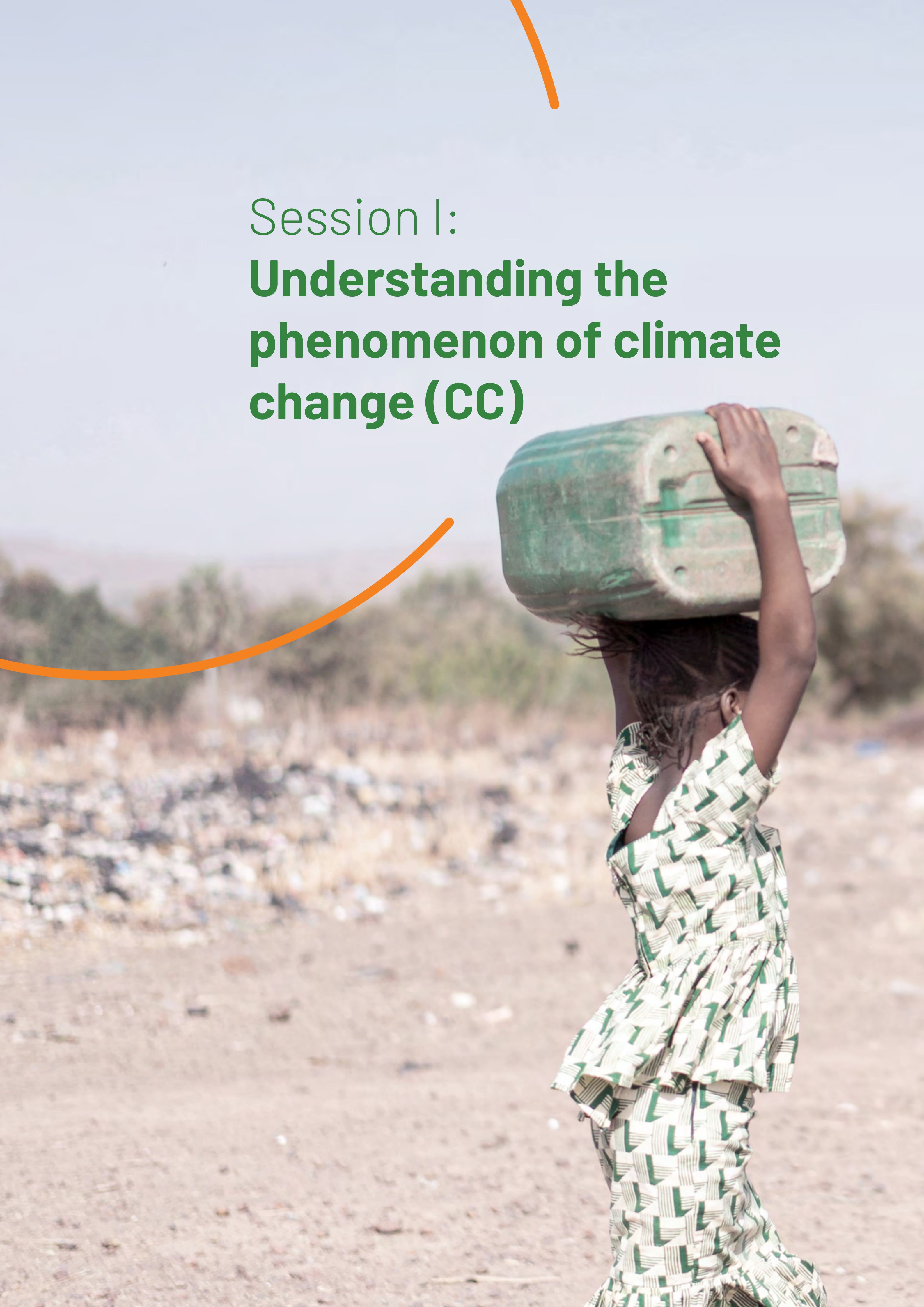
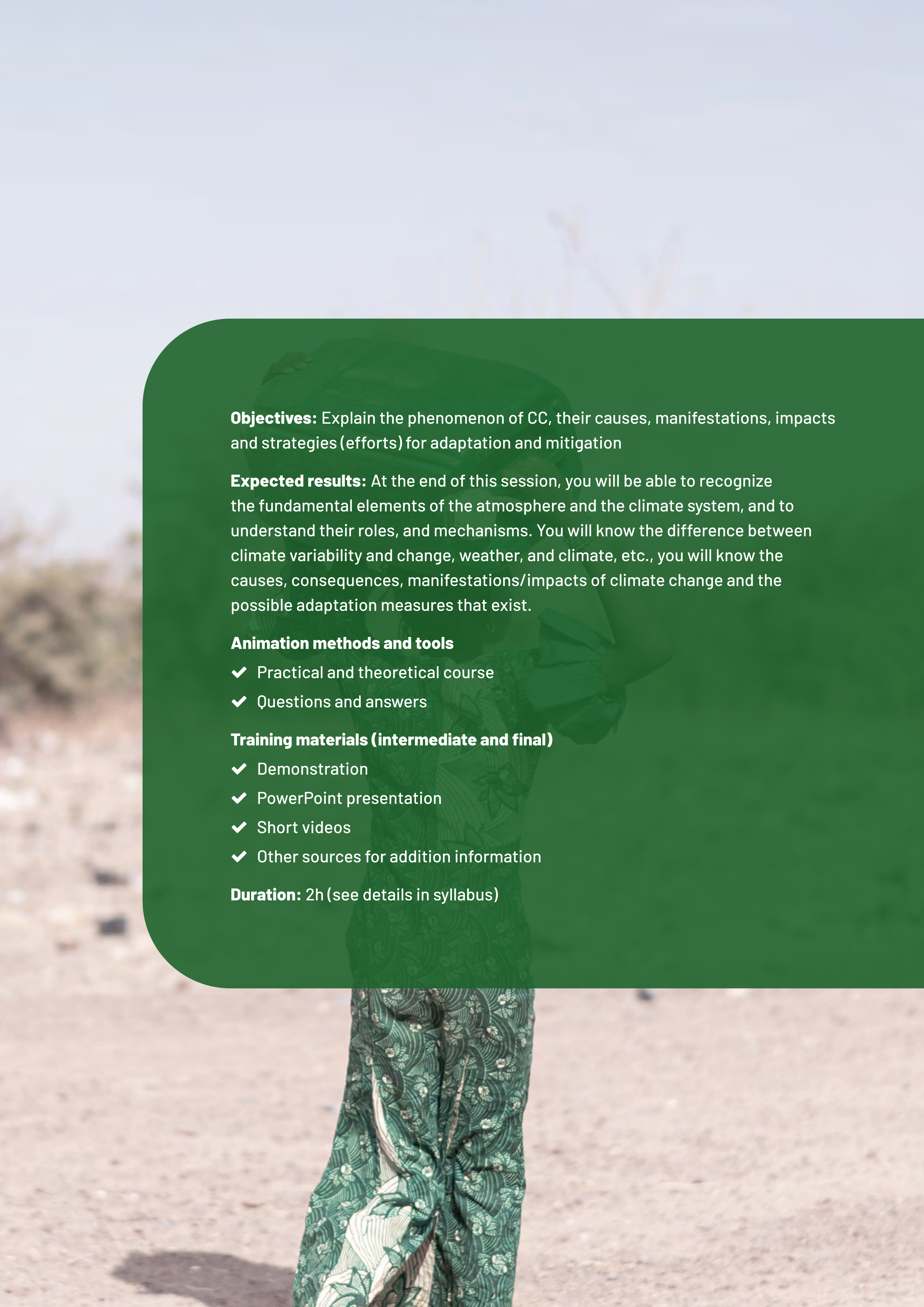
Session I:

Understanding the phenomenon of climate change (CC)





Objectives: Explain the phenomenon of CC, their causes, manifestations, impacts and strategies (efforts) for adaptation and mitigation

Expected results: At the end of this session, you will be able to recognize the fundamental elements of the atmosphere and the climate system, and to understand their roles, and mechanisms. You will know the difference between climate variability and change, weather, and climate, etc., you will know the causes, consequences, manifestations/impacts of climate change and the possible adaptation measures that exist.

Animation methods and tools

- ✔ Practical and theoretical course
- ✔ Questions and answers

Training materials (intermediate and final)

- ✔ Demonstration
- ✔ PowerPoint presentation
- ✔ Short videos
- ✔ Other sources for addition information

Duration: 2h (see details in syllabus)

Content

1. Module 1 : Climate change: basic knowledge of the climate system

1.1. System, components and functioning of the climate system

The climate system is composed of five (05) essential layers: the **atmosphere** which is the gaseous layer, the **hydrosphere** which constitutes the layer of water (liquid or solid) of the Earth, the **lithosphere** which is the external layer of the earth's crust, the cryosphere, which includes all the ice sheets and the **biosphere**, which is all the living organisms that develop on Earth.

These different layers receive energy from the sun and interact with it and each other. The atmosphere plays **a central role in** regulating the energy sent by the sun to the earth (**Figure 1.1**). The atmosphere is a gaseous envelope that surrounds the earth. It is fundamental to the existence of living organisms and life on earth. It also plays a major role in the water cycle and therefore the regulation of life on earth. The dry air in the atmosphere is composed of 78% nitrogen, 21% oxygen, 0.93% argon, 0.041% carbon dioxide, and traces of other gases. It has a thickness of 800 km and is composed of sub-layers namely:

- **the troposphere** is the part of the atmosphere closest to the earth in which the main meteorological phenomena take place. It rises between 8 km at the poles and 10 km above the Equator. Temperature decreases with increasing altitude by 0.60°C every 100 m, on average;
- **the stratosphere** is the second main layer of the atmosphere. It is above the troposphere. It occupies the region of the atmosphere from about 12 to 30 kilometers. The ozone layer is a layer of ozone particles dispersed between 19- and 30-kilometers altitude in the stratosphere. The ozone layer is essential for life on Earth as it absorbs ultraviolet (UV) radiation emitted by the sun.
- **the mesosphere** is the layer between 30 to 50-80 km above sea level. The thermal gradient becomes negative again. At an altitude of 80 km, it becomes about –65°C. The mesopause is its upper limit.
- **the ionosphere or thermosphere** is located between 50 and 400 km. The temperature increases with the altitude within this layer up to 200-300 km where it reaches approximately 1500°- 2000°C; then it remains constant up to the upper limit.
- **the exosphere** located approximately between 400 to 2000 km; it is characterized by the dissipation of atmospheric gases. Dissipation is favored by the high kinetic energy of gases.

The greenhouse effect

What will happen if 100% of the solar radiation should directly reach the Earth? The different areas of the earth are not located at the same distance from the sun because of the spherical shape of the earth. Thus, certain zones (closer to the sun) receive more solar radiation (equator) than others (the poles for example). This partly forms the Earth's climates. Regardless of its position from the sun, no area on earth receives 100% of solar radiation. This is, fortunately, made possible by the atmosphere. The atmosphere absorbs about 20% of solar radiation and at the same time reflects 30% of it. The remaining 50% of solar radiation that reaches the earth's surface causes the earth system to warm up, which then emits infrared radiation (warmed bodies emits radiation) (**Figure 1.1**). Infrared (IR) radiation is electromagnetic radiation with a wavelength greater than that of the visible spectrum but shorter than that of microwaves. Its particularity is to warm the body without changing the air temperature. These rays can penetrate biological tissues and cause damages. Clouds and greenhouse gases (GHG) act as an insulating layer and partly absorb and send these IRs to the earth's surface: this **is the greenhouse effect (Figure 1.1)**. The heat is thus trapped between the compartments of the Earth, as usually observed in a greenhouse.

The greenhouse effect is the natural phenomenon by which the earth's atmosphere (atmospheric layer closer to the earth), through some of its constituents, captures on the earth's surface the heat radiation emitted by the earth under the effect of solar radiation. Without the greenhouse effect, the average temperature on the surface of the globe would be −18°C instead of 15°C, making life difficult on earth. The constituents of the atmosphere which participate in the phenomenon of the greenhouse effect are essentially water vapor, carbon dioxide, ozone, methane, and nitrous oxide.

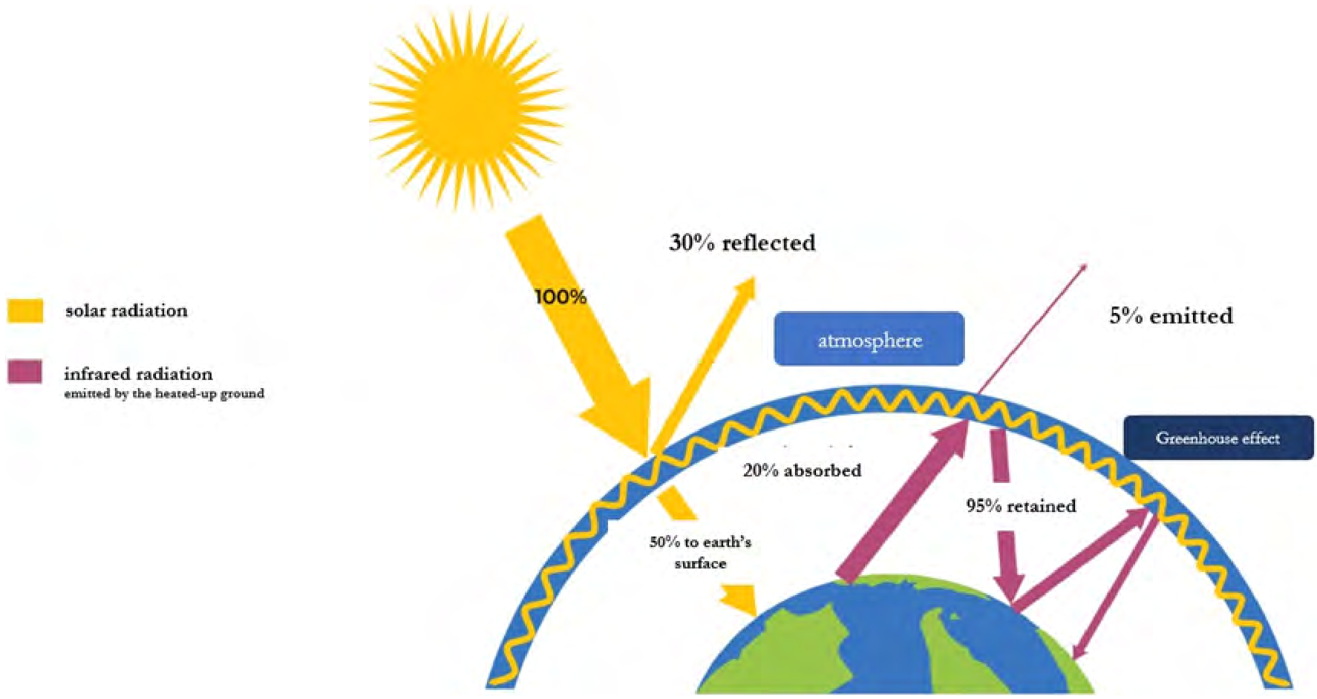


Figure 1-1: Atmospheric phenomena contributing to the greenhouse effect
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The greenhouse effect is a phenomenon where:

- some of the incident solar energy (about 30%) is reflected by the atmosphere from the earth's surface back into space;
- the remaining portion (about 70%) reaches and warms-up the earth's surface;
- the earth in turn emits part of the absorbed energy in form of heat into the space;
- the radiated heat by the earth is largely absorbed and re-radiated by greenhouse gases;
- the lower layers of the atmosphere and the earth's surface warm up as well.

Greenhouse gases:

- are essential to life (otherwise the earth would be too cold);
- are naturally present in the atmosphere;
- prevent part of the solar energy captured by the earth from escaping into space;
- do not respect borders and spread through the air.

1.2. Advent and brief history of the phenomenon of climate change

1.2.1. Difference Between Weather and Climate

Weather: This is the scientific study of atmospheric phenomena (cloud formation, precipitation, wind, etc.) on a relatively short time scale. The information provided by this study on the state of weather and atmosphere is also known as weather.

Climate: is a set of meteorological parameters recorded over a given period that characterizes a region. It is also the average atmospheric behavior over relatively long periods of time (30 years at least).

The weather provides information for the purposes of air navigation, agricultural practices, and natural resource management within a short period of time (a few days) while climate provides information over a long period (10 years, 20 years even 30 years).

It was recorded that the Primary geological era was characterized by several variations, while the Secondary, the Tertiary and the Quaternary eras were characterized by hot period, followed by a progressive cooling process to reach very low temperatures, and the glaciations, respectively. This clearly shows that the climate is not then constant over time. It is characterized by an alternation of cold and warm periods.

1.2.2. Differences between variability and climate change

Climate variability refers to the natural fluctuations of the climate, including average states and extreme events. The climate is naturally and constantly changing.

Climate change refers to significant and measurable modifications over a long term (mainly due to human activities) of the standard variations (patterns of climate variability and average values).

Variability is the natural fluctuation of climate while climate change is the fluctuation associated with anthropogenic action.

The Intergovernmental Panel on Climate Change (IPCC), defines climate change as "any change in climate over time, whether due to natural variability or human activities". Climate change is reflected in several phenomena that make up its components: modification of temperatures on the earth's surface, rise in sea levels, melting of snow and ice, disruption of precipitation patterns and then multiplication and intensification of extreme events (e.g. floods, droughts)

1.2.3. Evolution of assessments of the phenomenon of climate change

In 1975, American researchers published an article which showed that CO_2 was not the only greenhouse gas generated by human activities. The expression "global warming" was first used in 1975. The first public mention of the impact of human activity on climate change was made on June 23, 1988. The American scientist James E. Hansen, a NASA climatologist, drew the authorities' attention to the fact that the Earth's atmosphere was warming up, as observed in greenhouses, whose internal temperature was rising due to warming: hence the term "greenhouse effect". This scientific effervescence led to the creation, in 1988, of the IPCC (Intergovernmental Panel on Climate Change) which published its first assessment report in 1990. From this starting point to date (2022), IPCC has published its 6^{th} report (**Figure 1.2)**.

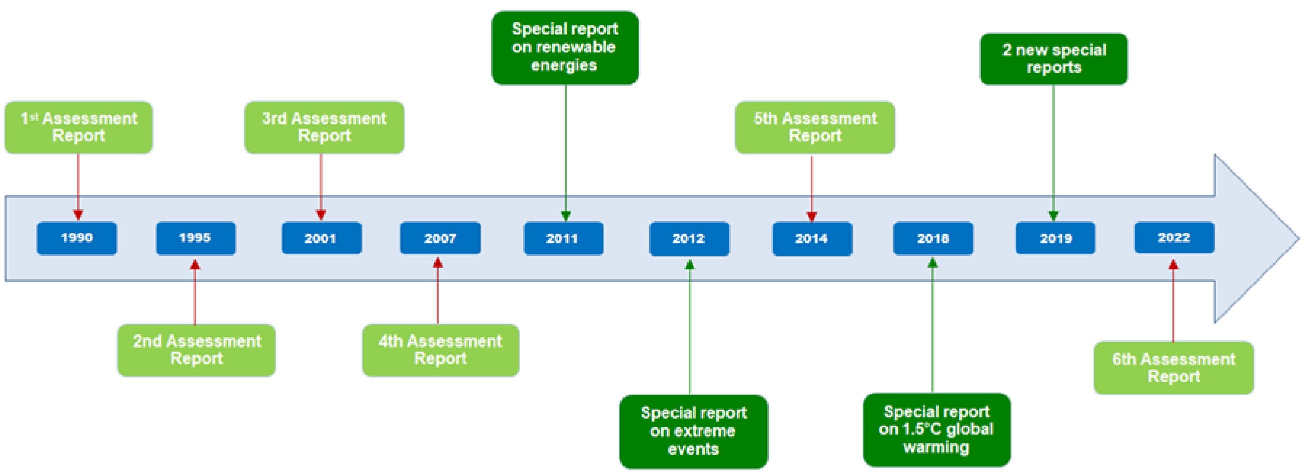

Figure 1-2: Key dates in the evolution of the climate change phenomenon
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2. Module 2 : Causes and manifestations of climate change

2.1. Causes of climate change

It has been scientifically established that climate change is the consequence of the enhancement of the phenomenon of greenhouse effect due to the release into the atmosphere of greenhouse gases (carbon dioxide) by certain human activities.

Increase of greenhouse gas concentrations induces an increase warming of the earth's surface and atmosphere. The sixth IPCC report revealed that the best estimate of global warming was 3°C with a margin ranging from 2.5°C to 4°C (strong confidence), compared to 1.5°C to 4.5°C in the AR5 report. Atmospheric concentrations of greenhouse gases, such as carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), have significantly increased since 1750. Today, they exceed by far their pre-industrial levels. According to Environment and Climate Change Canada (2022), between 2005 and 2019, global GHG emissions increased by 23.6%, from 38,669 to 48,117 megatonnes of carbon dioxide equivalent (Mt CO2eq).

Carbon dioxide is the most important anthropogenic greenhouse gas, with an atmospheric concentration of around 379 ppm in 2005. Unfortunately, this concentration continues to rise faster thanit has ever been since the introduction of systematic measurements in 1960. This is mainly due to the use of fossil fuels and, to some extent, land-use changes. For example, CO2 emissions from fossil fuel combustion rose from 6.4 Gt per year in the 1990s to 7.2 Gt per year between 2000 and 2005 (IPCC, 2022). Atmospheric concentrations of methane and nitrous oxide have also risen significantly since pre-industrial times, resulting largely from human activities such as agriculture and the use of fossil fuels (IPCC, 2022).

The term "radiative forcing" is used to describe the effects of different factors of change on climate. A positive radiative forcing corresponds to a warming of the earth's surface, while a negative forcing indicates a cooling. It is very likely (probability greater than 90%) that human activities have had a warming effect on planet Earth since 1750, with a radiative forcing (an increase in energy) of around 1.6 Watt per square meter over the whole Earth's surface (AR6 IPCC, 2022).

Different sectors of activity contribute to the GHG emissions. The energy sector is the first producer of GHG (73.2%) with the industry sub-sector being the most important, followed by agriculture, forestry, and other land use sectors (18.4%) (**Figure 2.1**).

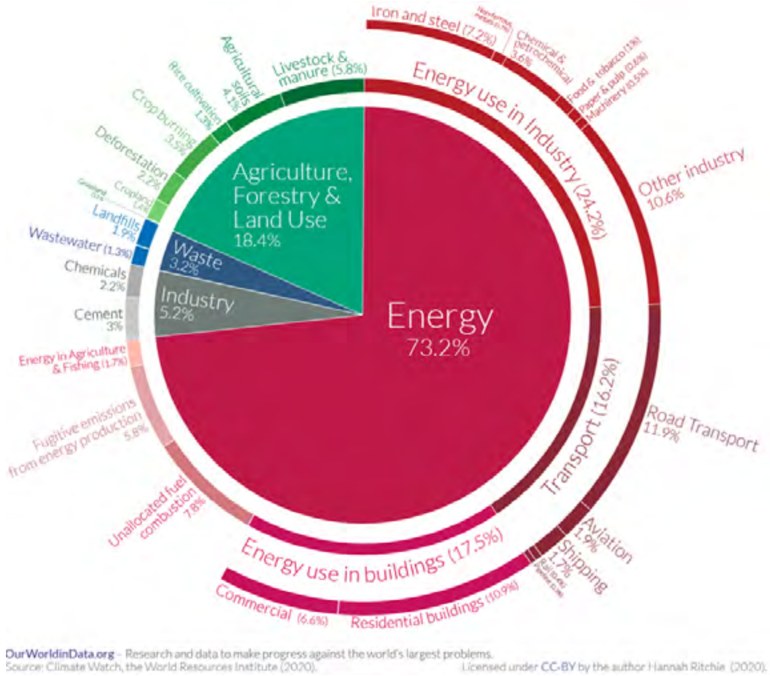

Figure 2.1: GHG emissions by sector.
Source: OWID (Our World in Data), https://ourworldindata.org/emissions-by-sector .

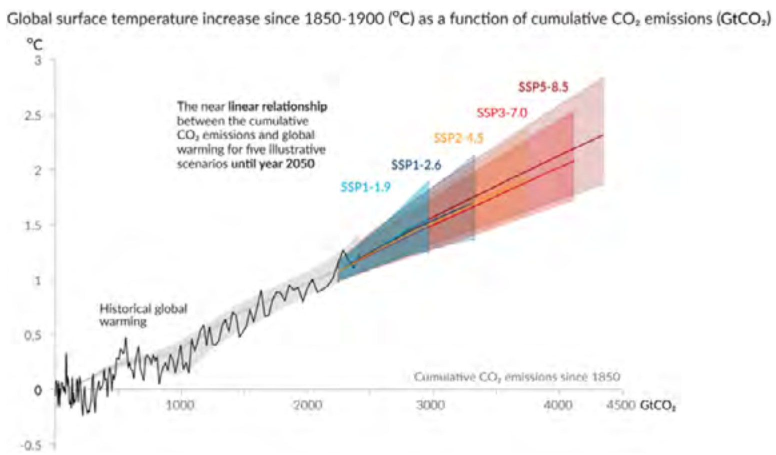

Figure 2-2: Illustration of the increase in GHG concentrations and the link with rising temperatures
Source: 6th IPCC Report (2021)

2.2. Manifestations of climate change

There are different manifestations of climate change depending on the climatic parameters and regions. The temperature of surface waters is increasing in all major ocean basins. During the past 100 years, there was first a period of warming (1910-1945), followed by a period of cooling. But since the 1970s, surface water temperatures have been increasing. For example, since 1971, the ocean surface (up to 75m deep) has warmed by more than 0.1°C per decade. It is often acknowledged that this warming can sometimes reach up to 3,000 m of depth.

3. Module 3 : Consequences and impacts of climate change

Over the past few decades, there has been consistent increase in natural disasters, in terms of frequency, and their intensity. West Africa is not exempt from these negative impacts, which in this region often take the form of floods, droughts and pockets of drought, disruption of rainy seasons, heat waves, soil erosion, severe coastal erosion, desertification, and degradation of forest resources. A total of 19 areas are most affected in West Africa (UNDP, 2011). These hotspots are located in the central Sahel (Niger, Burkina Faso), northern and coastal Ghana, northern Togo, Benin, and Nigeria (UNDP, 2011). These disasters have many implications. Since 2000, for example, around 50 million people have died because of drought, particularly along the Mauritania-Mali-Nigeria axis.

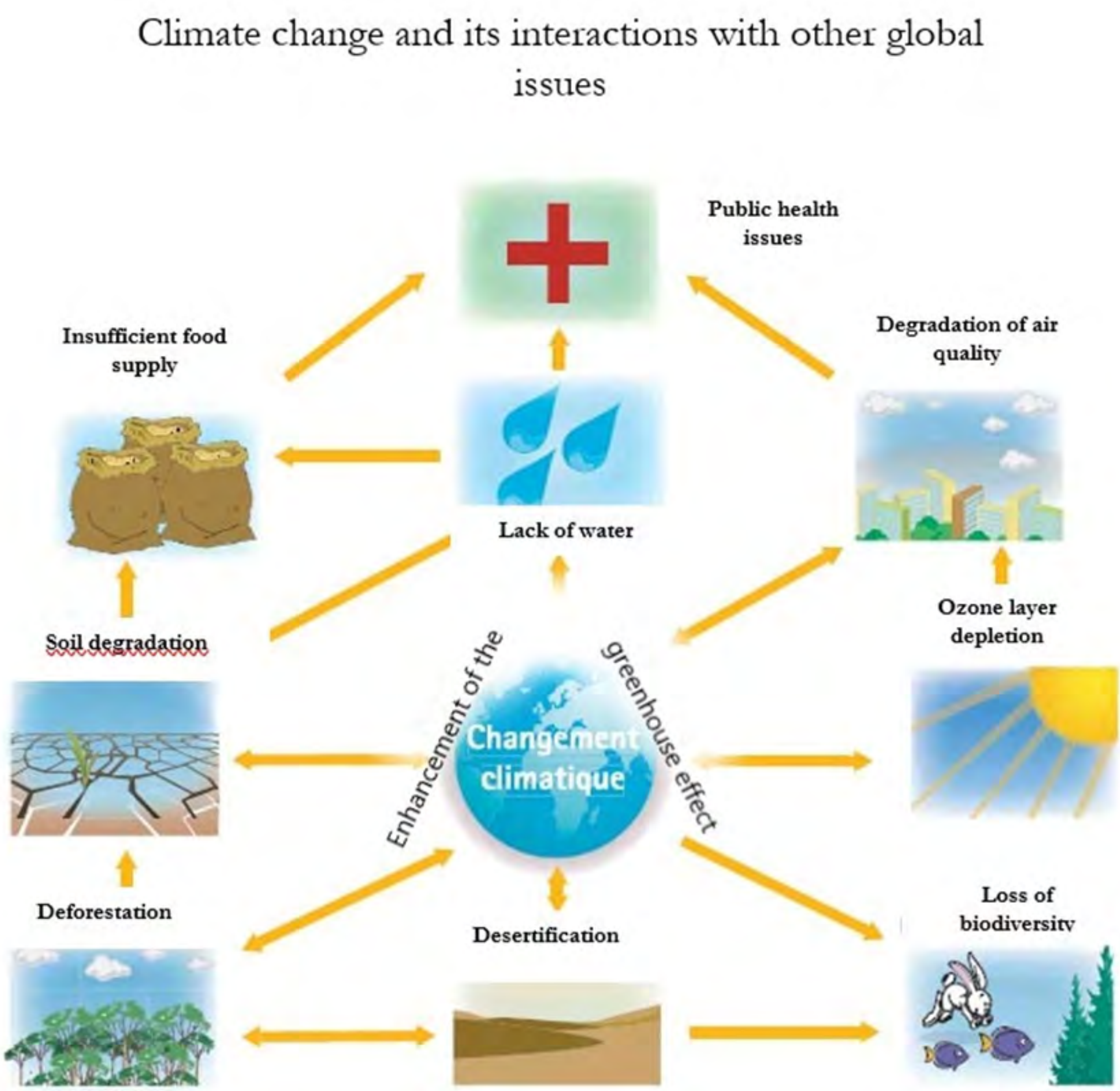

Figure 3-1: Impacts of climate change in different fields.
Source: https://didaquest.org/wiki/Changement_climatique_Conséquences

In general, the manifestations and impacts of CC are diverse and vary depending on the sub-sectors (Figure 3.2). These manifestations include floods, drought, dry spells, rising temperatures and storm winds (Figure 3.2). These impacts affect the biological and physiological functioning of animals, influence the intrinsic natural equilibrium of animals and plant species, as well as their relationships with the ecosystems. The major impacts are summarized in Figure 3.2 by sub-sector (crop production, animal and fish production, ecosystems, and natural resources, as well as on the productivity and health of the farmer).

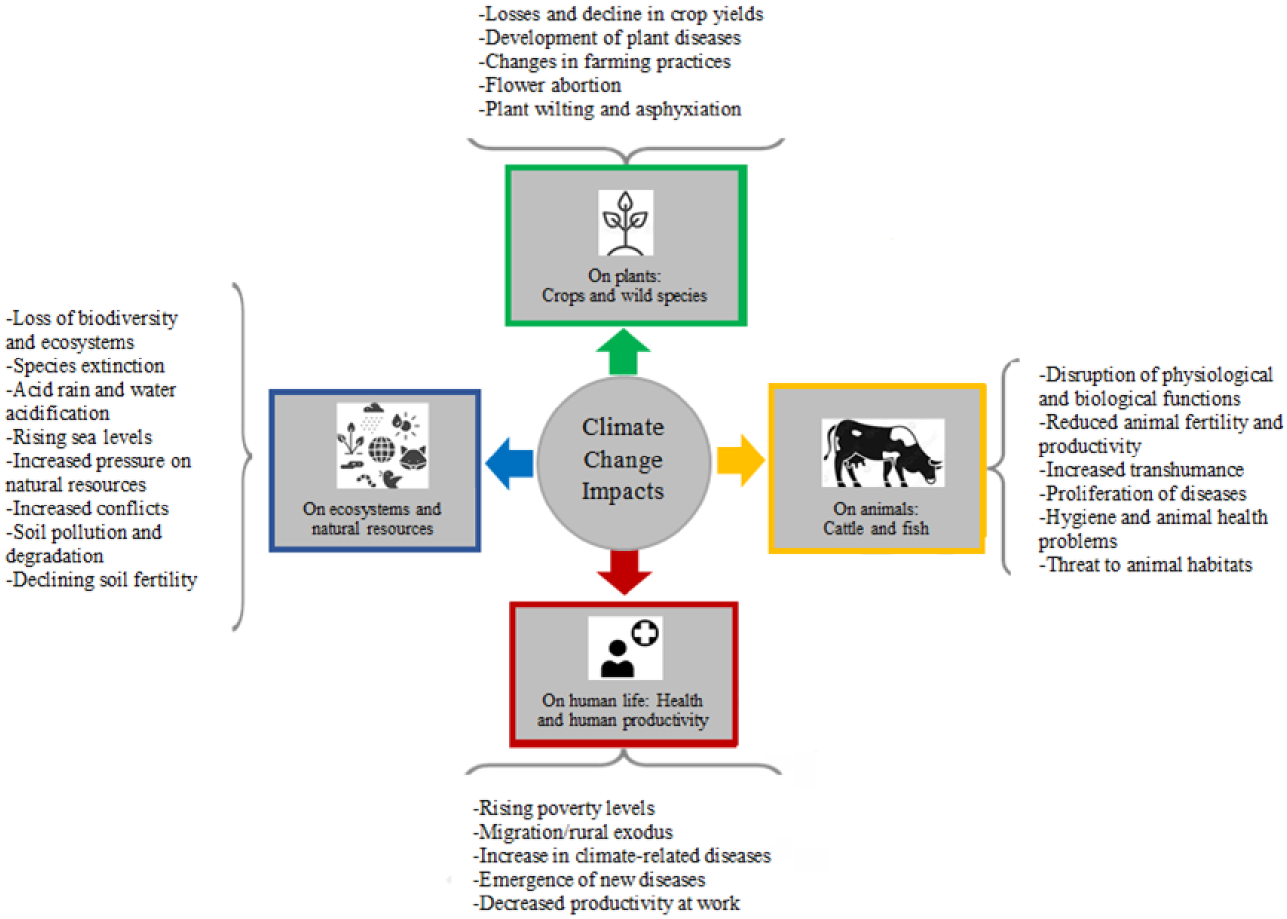

Figure 3-2: Summary of CC impacts on each agriculture sub-sector

3.1. Plants: annual crops, fruit tree

The rise in temperature and heat waves (sometimes accompanied by storm winds) lead to flower abortion and consequently a reduction in yields. High temperatures also negatively affect plant physiology, inducing a high photosynthetic activity, and transpiration, followed by sometimes irreversible wilting. Rainfall variability leads to two (02) major and antagonistic extreme climatic events: (i) dry spells or dry periods, which lead to water deficit and plant wilting, resulting in a decline in yield due to the poor crop growth and development as well as destruction of certain plants in orchards, and other tree plantations; (ii) seasonal or periodic floods due to flooding or downwelling, or heavy rains over a short period. These floods affect large cropped areas and thus result in crop losses. Excess water also causes soil saturation/hydromorphy and suffocates plants, and influences soil oxidation-reduction (redox) potential with the major consequence of iron toxicity in soils.

3.2. Animals: livestock, aquaculture, fish farming

An increase in temperature leads to dehydration of animals and consequently a disturbance of their physiological and biological functioning, a drop in fertility and productivity, especially for females. Rainfall variability leads to an increase in the rate of transhumance, promotes the proliferation of diseases and weakens the chain of hygiene and animal health, while high winds threaten the monitoring of animals. Climatic change in general threaten the habitats of sedentary livestock and affect the movement of transhumant livestock, which creates recurrent conflicts between farmers and breeders.

3.3. Ecosystems, the environment, and natural resources

Climate change leads to the loss of biodiversity and ecosystems, the extinction of certain species which are sometimes endemic species. The increase in CO_2 in the atmosphere increases the occurrence of acid rain and undissolved CO_2 in rivers and oceans increases acidification. Alongside these negative effects, there is eutrophication of water bodies due to the excessive supply of nutrients caused by runoff water and erosion, as well as anthropogenic activities (industrial pollution, agriculture, etc.). One of the major impacts of CC on marine ecosystems is the rising of sea level. The scarcity of resources to meet the demand for ecosystem services leads to an increase in anthropogenic pressures on natural resources (deforestation, wildfire, poaching, etc.). This results in an increase in inter-community conflicts around these resources. Soil pollution and degradation caused by CC results in declining soil fertility and productivity.

3.4. Health

Heat waves could have serious consequences on public health. Changes in rainfall influence the existence and spread of malaria vectors and increase susceptibility to water-borne diseases, such as cholera. Small changes in temperature and rainfall can increase the population of malaria-carrying mosquitoes. Rising floods are also likely to encourage spread of malaria carriers in previously arid areas. These challenges will be further exacerbated by the inability of many communities to cope with the increased frequency of these diseases, which will lead to higher health costs. In general, CC leads to a decrease in farmers' productivity.

4. Module 4 : Measures/solutions for adaptation and mitigation to climate change

The fight against climate change is organized around adaptation to and mitigation of climate change. Taking adaptation measures into account in development policies is essential to reduce the harmful effects of climate change.

4.1. Adaptation and mitigation

Adaptation and mitigation are two groups of complementary strategies/measures to reduce and control the risks associated with climate change.

Adaptation is the adjustment of natural and human systems in response to present or future climatic stimuli or their effects to reduce adverse effects or take advantage of the opportunities (IPCC, 2001). Adaptation to climate change involves adjusting practices, procedures, or structures to the current and projected changes in climate. Adaptation can occur in response to or in anticipation of climate change. Adaptation is necessary to complement climate change mitigation measures **and aims to minimize the negative impacts of climate** change and take advantage of new opportunities that may arise **Figure 4.1**).

Mitigation aims at reducing greenhouse gas (GHG) emissions, either directly by minimizing their production at source, or indirectly by trapping GHGs already present in the atmosphere (**Figure 4.1**). Mitigation consists of promoting actions, practices and technologies aim to directly reduce CO_2 and all the GHGs emissions or eliminate pollution and anthropogenic pressures on resources in order to guarantee future generations a healthy and stable environment.

Past emissions are expected to cause unavoidable warming (about 0.6°C by the end of the century), even if total greenhouse gas concentrations in the atmosphere remain at the level it was in 2000. For some of the effects of global warming, adaptation is therefore the only possible outcome.

Adaptation options are numerous and range from technical solutions, such as coastal protection systems, to behavioral changes, such as changing our consumption habits, to policy and management solutions. While the limits of adaptation are not yet known, it is not expected that adaptation alone will be sufficient to cope with all the expected effects of global warming, which are becoming ever more important.

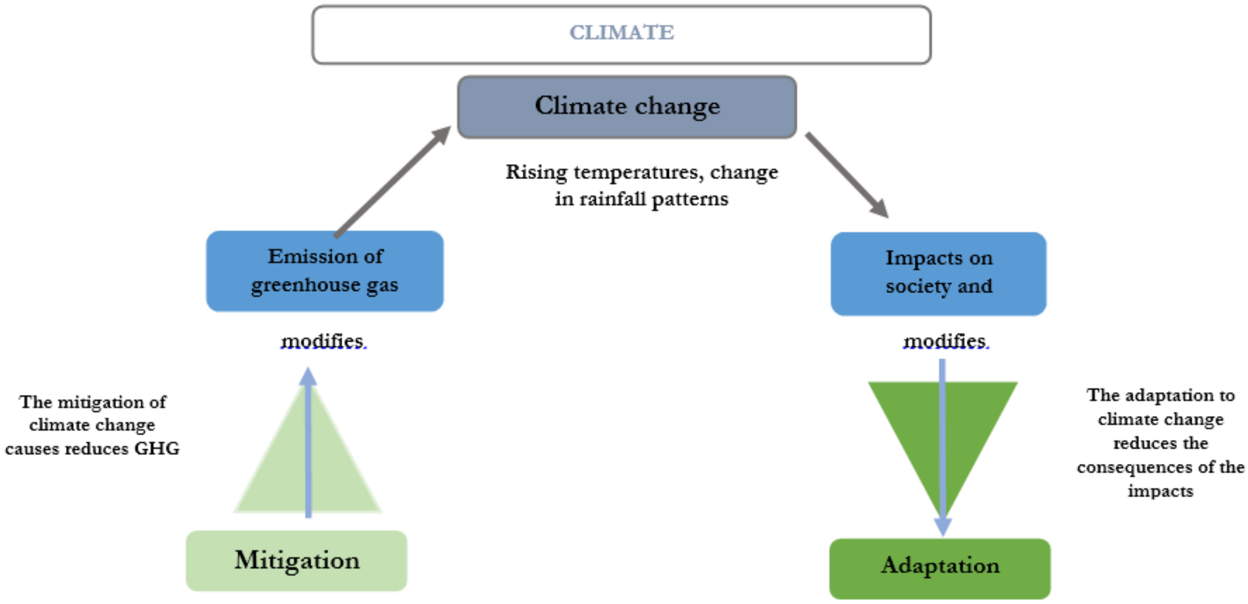

Figure 4-1: Concept of adaptation and mitigation to climate change French Agency for Biodiversity
© Chantal Fitoussi /Agence française pour la biodiversité (‹'from : Les enjeux environnementaux au cœur du développement territorial")

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Session II:

Climate change Vulnerability assessment

Objectives: Familiarize participants with the concept, methods, and tools of climate change vulnerability assessment

Expected results: At the end of this session, you will be able to define and explain the concept of vulnerability to climate change. You will be introduced to the different stages of a vulnerability assessment. You will be able to develop and conduct a climate change vulnerability study using simple yet precise methods and tools.

Animation methods and tools

- Theoretical course
- Practical demonstration
- Practical individual and group assignments
- Questions and answers

Training materials (intermediate and final)

- Training manual
- PowerPoint presentations/supports
- Instructions on the assignments
- Other sources for more information

Duration: 5h (see details in syllabus)

Content

5. Module1 : Climate change vulnerability assessment (current and future)

5.1. Concepts and methodological approach for conducting a climate change vulnerability study

5.1.1. The concept of vulnerability

Vulnerability

It is defined as the extent to which a system copes or not with the adverse effects of climate change (including climate variability and extremes). Vulnerability depends on the character, magnitude and rate of climate change, the variations to which the system is exposed, its sensitivity and its adaptive capacity (IPCC, 2007). According to WHO (2002), vulnerability is the extent to which a population, individual or organization is unable to anticipate, adapt, resist, and recover from the impacts of disasters.

It is a comprehensive measure of human well-being that integrates environmental, social, economic, and political exposure to a range of harmful disturbances (Bohle et al. 1994). Vulnerability is not a measurable characteristic of a system, as temperature, precipitation, or agricultural production can be. It is a concept that depicts a complex interaction among several factors that will determine the sensitivity of a system to the effects of climate change.

Assessment of the impact of climate change

Assessments are typically conducted to inform decision-makers and the public on the consequences of climate change and options for dealing with them. There are diverse approaches to assess the impact of climate change (i.e. an estimate of the effect of a changing climate, assuming that there is no adaptation) depending on the users and contexts. Introducing participants to some of these approaches and methods will help them understand the principles applied in the field and make smart choices for their studies.

Vulnerability assessment

Overall, the purpose of a vulnerability assessment is to inform decision-making. However, Hinkel (2011) identified six broad categories of objectives into which vulnerability assessments can fit. Vulnerability study can help:

- Identify mitigation targets;
- Identify the most vulnerable people, regions, or sectors;
- Raise awareness on hotspots of climate change;
- Allocate adaptation funds to the most vulnerable regions, sectors, or groups of people;
- Monitor performance of adaptation policy and interventions;
- Conduct scientific research to better target adaptation or mitigation measures.

Depending on the time scale of analysis, we have current vulnerability and future vulnerability: The way people are vulnerable to existing climate patterns may not be the same way they will be vulnerable to future climate patterns. Understanding what makes people vulnerable to existing climate variability is the first level of system analysis. However, the current situation may differ in the future due to the nature of shocks and threats the system will face.

5.1.2. Components of climate change vulnerability assessment

Based on the cause-and-effect relationships behind climate change and its impact on people, economic sectors, and socio-ecological systems, four key components can help determine the extent to which a system is likely to be impacted by climate change: exposure, sensitivity, potential impact, and adaptive capacity (**Figure 5.1**).

Climate hazards are events likely to occur and which may cause damage to populations/communities, activities, ecosystems (climatic extremes: droughts, floods, heat waves, etc.) or long-term changes (increase in temperatures, rise in sea level rise, change in rainfall patterns, etc.).

Exposure is the nature and extent to which a system is in contact to significant climatic variations and/or hazards (McCarthy et al., 2001). Exposure is the only one that is directly related to climatic parameters, *i.e.* the character, magnitude and rate of climate change and variability. Typical exposure factors include temperature, precipitation, evapotranspiration, climatic water balance as well as extreme events, such as heavy rains and droughts. Variations in these parameters can place significant additional stress on these systems.

Sensitivity is the extent to which a system can be affected or modified in a negative or beneficial way, by stimuli related to the climate. The effect may be direct (for example, a change in crop yield in response to temperature variability) or indirect (for example, damage caused by an increase in the frequency of coastal flooding due to the rise in sea level)(McCarthy et al., 2001). It also refers to human activities that influence the physical composition of a system, such as farming methods, water management, resource exploitation and population pressure.

Potential impact is determined by the combination of exposure and sensitivity. The effects of climate change can form a kind of **impacts chain** of direct impacts that extends from the biophysical sphere to the social sphere (*e.g.* erosion as a direct impact and lower yields and loss of income as indirect impacts).

Adaptability is the ability of a system to adapt to climate change – including climate variability and extreme events – to moderate potential damage, take advantage of opportunities, or cope with consequences (McCarthy et al., 2001).

Vulnerability is therefore the potential impacts (Exposure + Sensitivity) minus the adaptive capacities (**Figure 5.1**). Vulnerability to climatic hazards is the extent to which a system can be adversely affected by the effects of these hazards. Vulnerability is a function of the nature and the magnitude of the climatic hazards to which a system is exposed; its sensitivity to that hazard, and its ability to adapt (Adger et al., 2004, and Downing et al., 2002 and 2004, IPCC). Hence, vulnerability depends on multiple factors (exposure, sensitivity, and adaptability) and therefore partly linked to the political choices and strategies developed in the territory. Resilience is the opposite of vulnerability. The more resilient a system is, the lower its vulnerability.

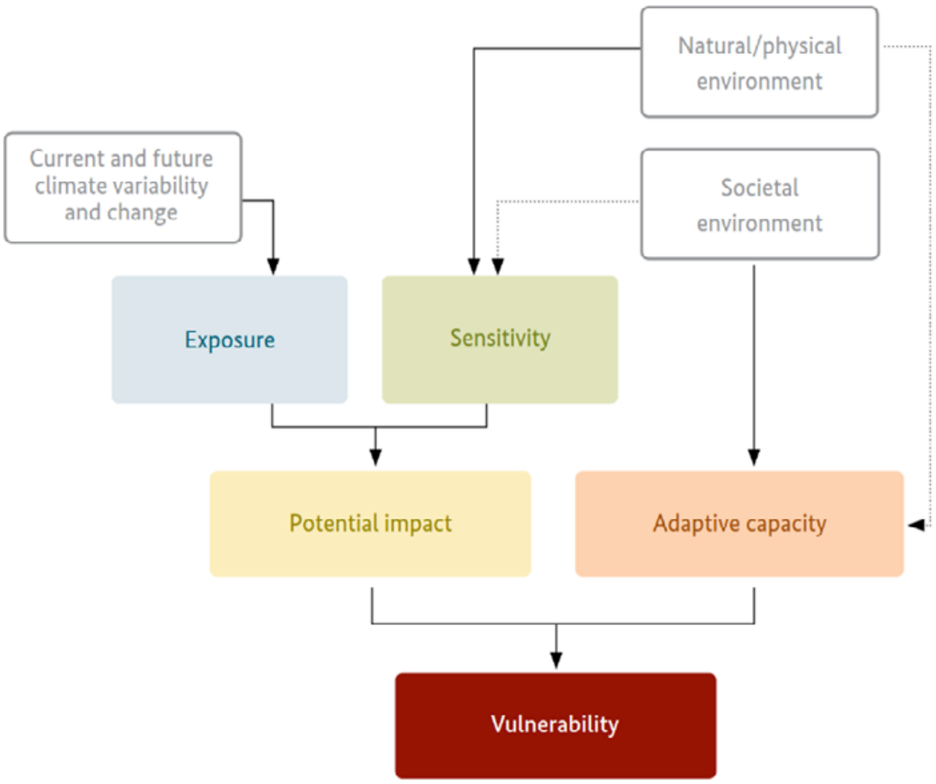


Figure 5-1: Components of vulnerability
Source: Kerstin et al. (2014)

5.1.3. Approaches for assessing climate change vulnerability

The purpose of a vulnerability study is to inform decision-making. It is worth recalling here the six broad categories of objectives into which vulnerability assessments can be categorized (Hinkel, 2011):

- Identify mitigation targets;
- Identify the most vulnerable people, regions, or sectors;
- Raise awareness on hotspots of climate change;
- Allocate adaptation funds to the most vulnerable regions, sectors, or groups of people;
- Monitor performance of adaptation policy and interventions;
- Conduct scientific research to better target adaptation or mitigation measures.

Thus, depending on the objective, we often distinguish between **two general approaches** to the study of vulnerability: **the top-down approach** and **the bottom-up approach** (Dessai & Hulme, 2004). This distinction appears in the scientific literature and is also referred to as an **"endpoint"** versus **"starting point"** vulnerability approach (Kelly & Adger, 2000), **"biophysical"** versus **"social"** vulnerability assessment (Brooks, 2003), or vulnerability assessment **based on "outcome"** versus **"context vulnerability"** (O'Brien, et al., 2007)

Top-down approaches

Top-down approaches are used in most existing vulnerability studies. They begin with an analysis of the context of climate change and its impacts (van Aalst, et al., 2008). Top-down approaches focus more on the biophysical aspects of climate change that can be easily quantified. Higher-order socio-economic impacts are considered only if quantitative models are available to relate them to biophysical effects. They use simulation models to project future impacts, *i.e.* use scenarios of the future socio-economic development of the world to feed global or regional circulation models (GCM and RCM). In turn, GCMs and RCMs are used to project future climate, *e.g.* daily or annual precipitation, mean annual temperature, etc. Climate impact simulations provide **the starting point** for top-down vulnerability assessments (**Figure 5.2**). These simulations typically assume a direct cause and effect relationship between climatic stresses and their impacts on biophysical systems, *e.g.* the effect of a decrease in total rainfall on crop growth. Top-down vulnerability assessments explicitly consider existing coping capacities and strategies that can reduce the negative impacts of climate change in biophysical models. They can also integrate, if possible, bioeconomic aspects in the modelling. For example**, the approach based on global climate modelling rely on** data and results from work carried out internationally on modeling the future climate and its impacts. The approach used these data with regional climate models (downscaling) to assess the future impacts of climate change at the local level, focusing on biophysical effects. The results of this stage enable the involvement of various actors in order to develop participatory socio-economic development scenarios for the region and to show them the future biophysical impacts of climate change resulting from the models. Thus, stakeholders will be able to provide feedback on the data generated by the models, based on their lived experience and their vision of the future (Schröter et al., 2005). Finally, by combining these results, they will be able to identify adaptation options.

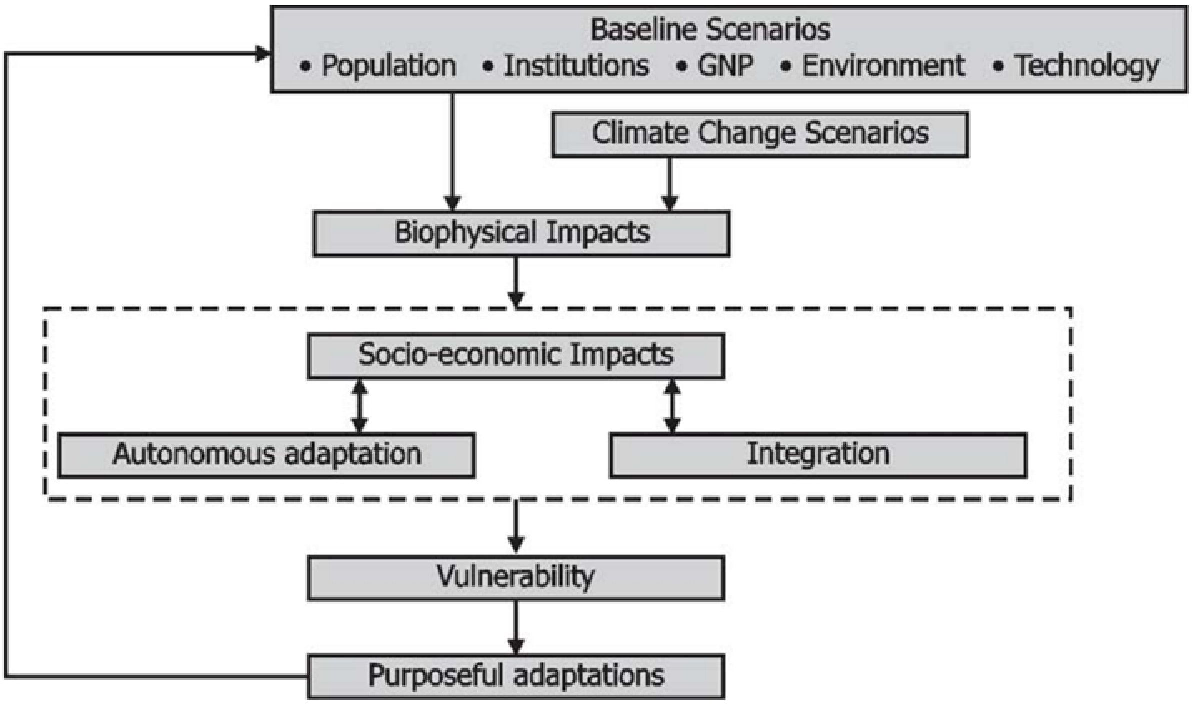


Figure 5-2: Basic conceptual framework of the top-down approach
Source: UNFCC, 2006

Bottom-up approaches

Conversely to top-down approaches, **bottom-up approaches**, start with an analysis of who is affected by climate change (van Aalst, et al., 2008), *i.e.* what makes people vulnerable to a given climate hazard or shock. They first address the underlying development context of why people are susceptible and exposed, and then explicitly consider the fact that not all social groups have the same levels of vulnerabilities to negative impacts of climate change. Bottom-up approaches are participatory in nature and are primarily driven from the local level, such as households or rural communities. They focus much more on assessing current vulnerability rather than future vulnerability. Most vulnerability assessments that follow bottom-up approaches are in developing countries, where current vulnerability is generally perceived as a greater threat than long-term climate change. The results of bottom-up evaluations often reflect different perceptions stemming from the various experiences of the actors. As such, an ability to summarize the results and identify priorities for action is required (Hinkel, et al., 2010).

In addition to using the results of participatory assignments, bottom-up approaches can also incorporate quantifiable data such as local meteorological data, downscaled climate simulations (small scale or local scale) and data collected through household socio-economic surveys. Bottom-up approaches are closely linked to other frameworks dealing with resource management, disaster management and sustainable development. This provides opportunities to integrate climate change considerations into decision-making and management contexts. In summary, bottom-up approaches are **participatory approaches** that rely on the involvement of local communities using mainly a qualitative methodology and primarily focusing on the study of past and current vulnerability **(Figure 5.3)**.

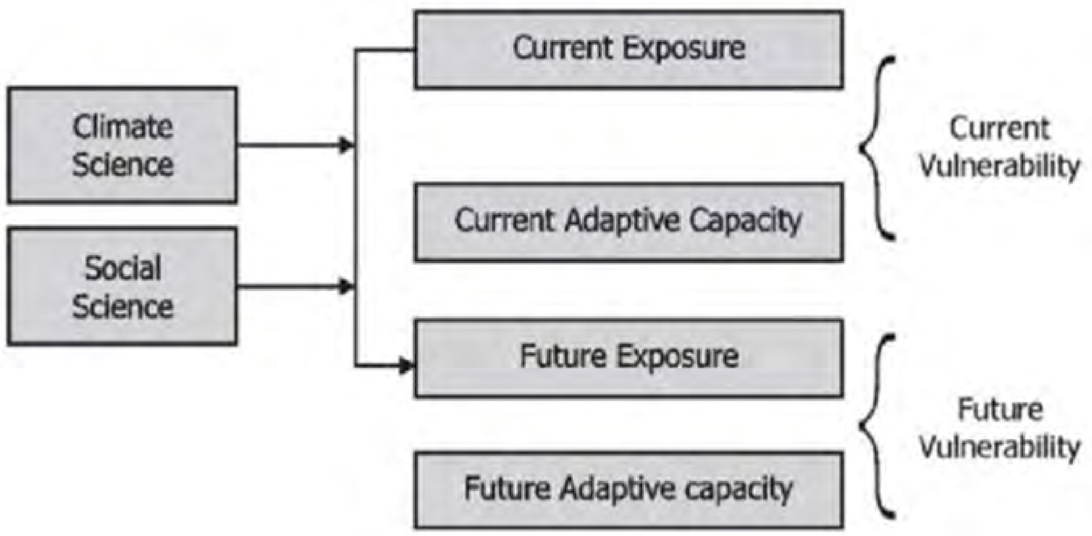
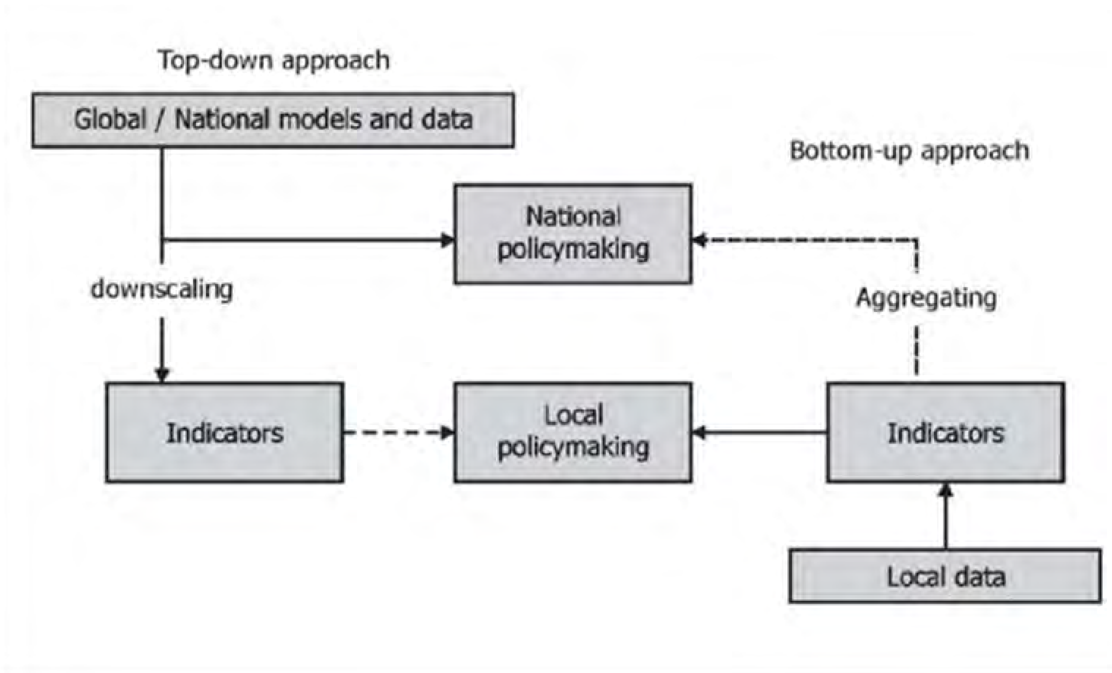


Figure 5-3: Basic conceptual framework of the bottom-up approach.
Source: UNFCC, 2006

Integrated approaches

Integrated approaches consist of carrying out sectoral vulnerability studies by combining bottom-up and top-down approaches in interaction with each other to create an avenue to explore synergies between sectors and different scales **(Figure 5.4)**.

Most vulnerability assessment studies that have tried to integrate top-down and bottom-up approaches started first with a scenario-based approach in which, by defining a set of future climate and non-climate variables, identifying critical areas that would be most vulnerable in the future using top-down methods and tools. Then, they carried out assessments at the local scale (within the communities), *i.e.* they used bottom-up approaches to carry out more detailed studies in the most vulnerable areas identified in the first phase, and thus, to validate the results obtained using top-down methods and tools



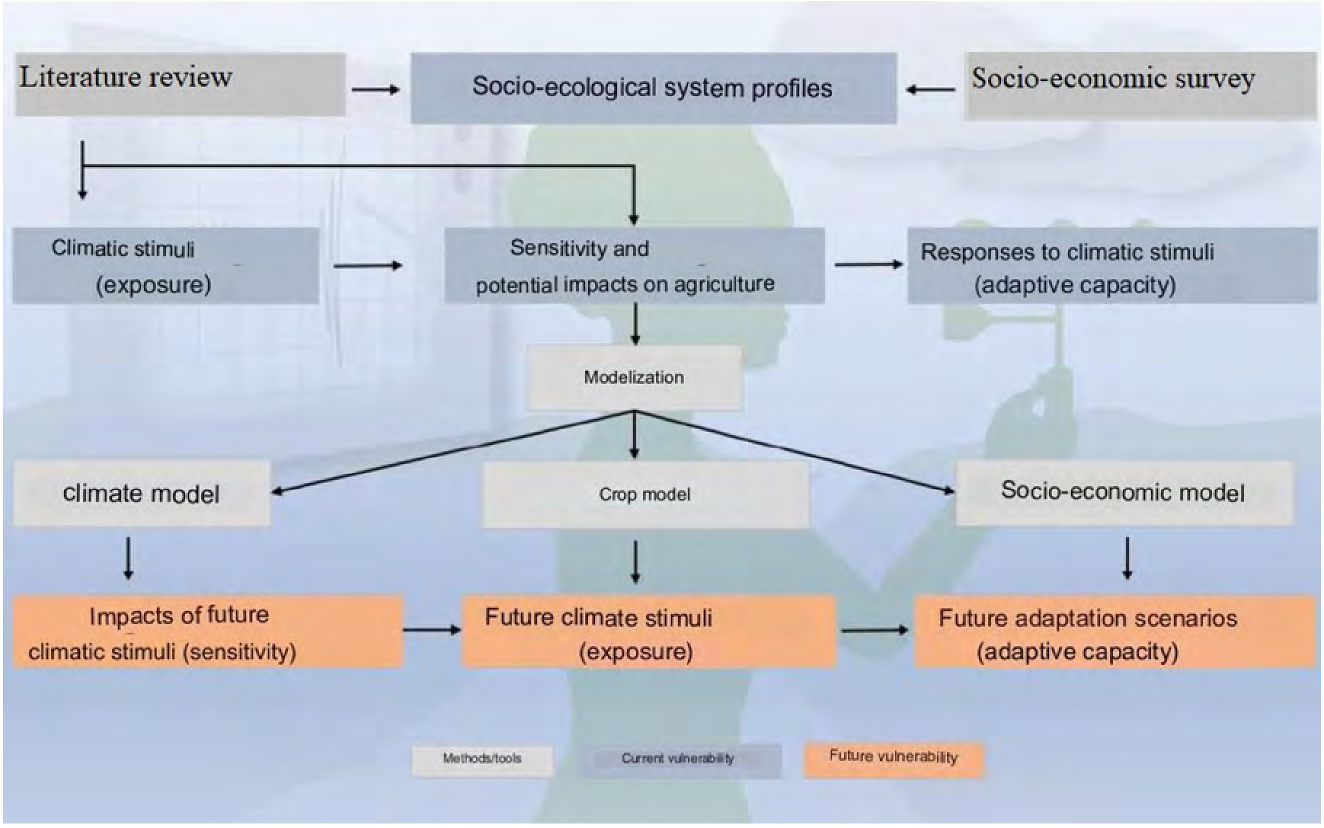


Figure 5-4: Basic conceptual framework of the integrated approach (bottom-up and top-down)
Sources: (a) UNFCC, 2006 and (b) Faye et al., 2019.

According to the UNFCCC (2006) vulnerability assessment approaches can also be categorized based on: **(i)** the subject matter on which the study is conducted (relative or specific to the subject matter), **(ii)** the spatial scale (communities, village, district, region, department, country), and **(iii)** according to time (chronological order). Starting from a spatio-temporal scale, the approach focuses more on **(i)** resilience issues, followed by those related to **(ii)** vulnerability and ends with **(iii)** scenario-driven analysis (**Figure 5.5**).

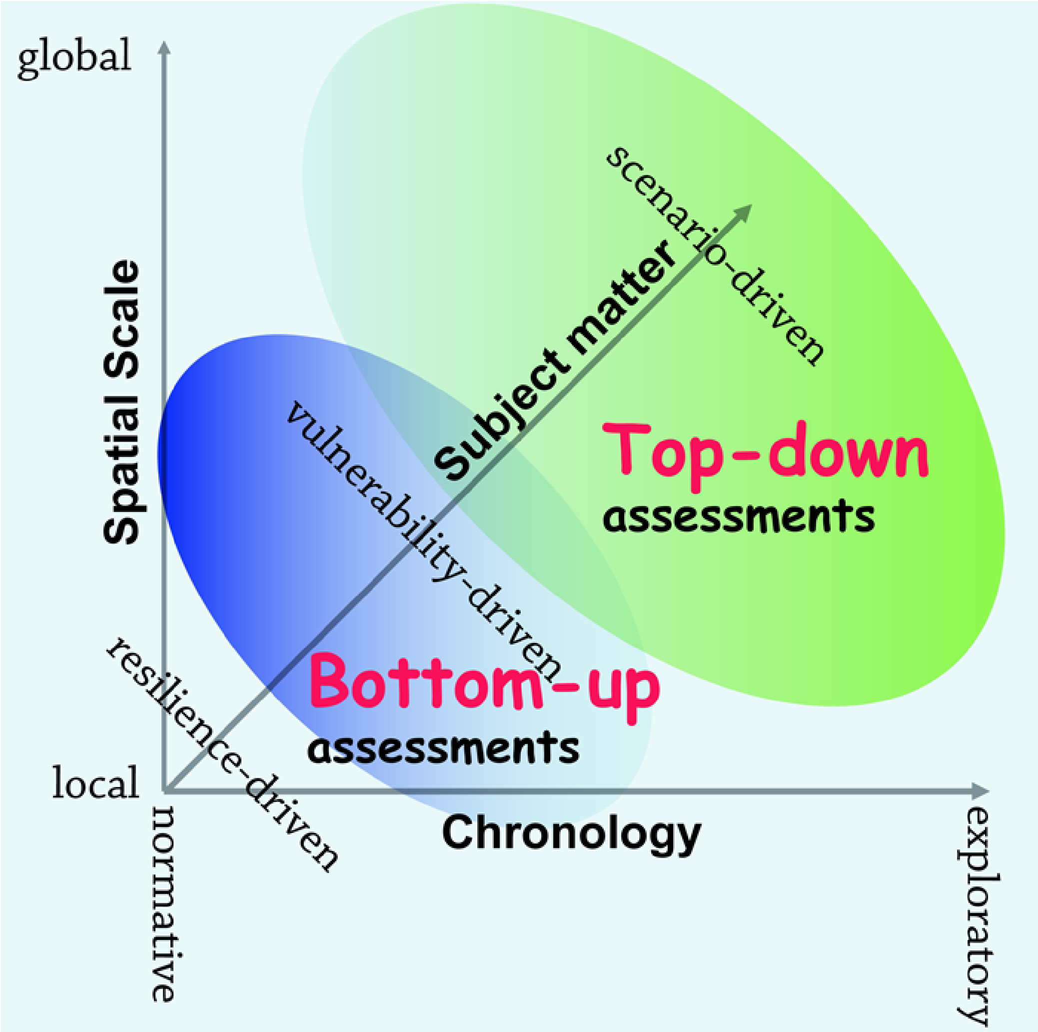


Figure 5.5: Categories of approaches to assess vulnerability to climate change
Source: UNFCCC, 2006

5.1.4. Different stages for conducting a vulnerability assessment study

The vulnerability assessment is implemented in eight main phases (GIZ, 2015), namely:

- Preparation phase;
- Development of impact chains phase;
- Identification and selection of indicators phase;
- Data collection and processing phase;
- Data standardization phase;
- Weighting and aggregation of indicators phase;
- Vulnerability component aggregation phase; and
- Presentation of the results of the vulnerability assessment phase.

Figure 5.6 presents the different characteristics of the first three stages; the rest being grouped under the nomenclature of data analysis.

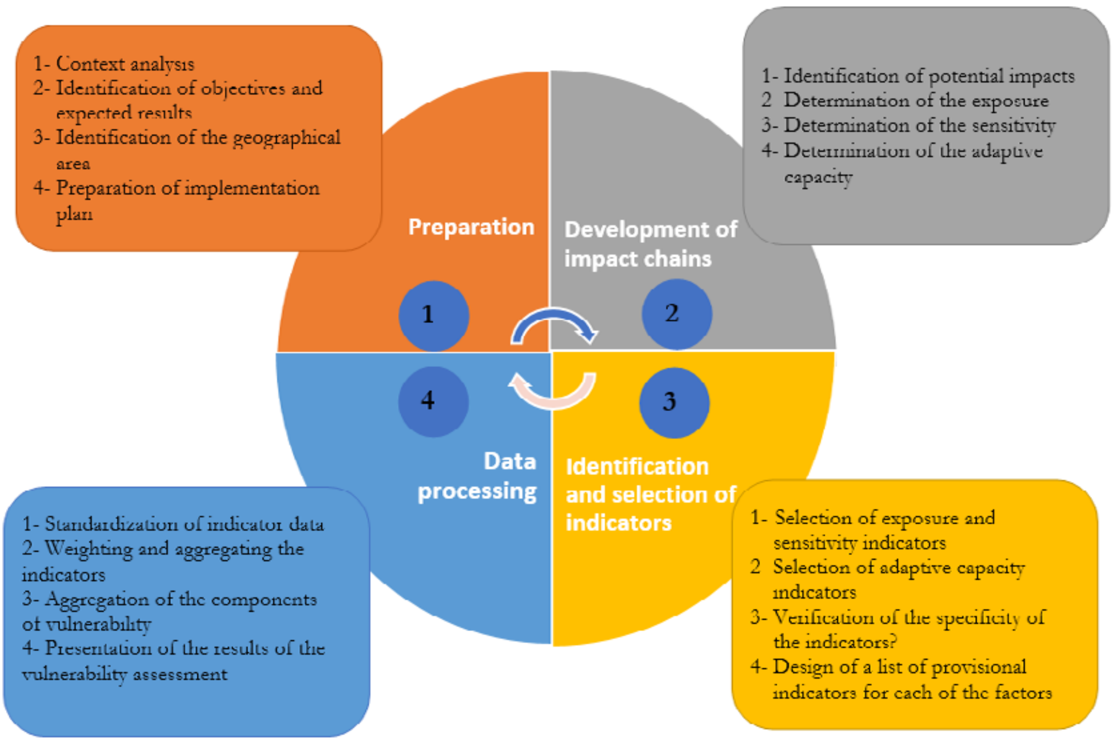


Figure 5-6: Different phases of a vulnerability assessment study.
Source: Adapted from (GIZ, 2015)

Based on the methodology proposed by GIZ (2015), a summary of the different phases is provided below:

Stage 1: Study preparation

This involves identifying and understanding the context in which the vulnerability assessment will be conducted, defining the objective, and expected results, defining the geographical scope of the study, and then preparing the implementation plan.

Stage 2: Development of impact chains

This is one of the most important phases of the vulnerability assessment. The development of impact chains requires the use of expert knowledge as well as an excellent understanding of the system to be analyzed. To achieve this, it will be necessary to follow the five steps presented in Figure 5.7 with more detail in Figure 5.8:

- **Step 1: Identify potential impacts:** this first step must start with a **literature review** on all the potential impacts that exist in the study area. It is worth noting that an impact can be an effect/consequence of direct or indirect climate change, in the short, medium, or long term as perceived and/or experienced by the communities. It is then necessary to reorganize these impacts by thematic groups (sectors, sub-sectors, components of the environment such impacts linked to soil erosion and degradation, impacts linked to water scarcity, impacts linked to food insecurity). Depending on the selected analysis approach, you can carry out a **survey** to collect data on the impacts of climate change as experienced by the communities daily. The list of these impacts can be compared with the one resulting from the literature review. Subsequently, you will have to carry out a consistency check in order to identify the potential impacts on which you will conduct the vulnerability assessment

- **Step 2: Determine exposure** to climatic hazards: a climatic hazard (threat) refers to either a climatic event likely to occur and which can cause damage to populations/communities, activities, ecosystems (climatic extremes: droughts, floods, waves heat, etc.) or long-term changes (increase in temperature, rise in sea level, change in rainfall patterns, etc.). People and their activities, natural ecosystems, animals, etc. can be exposed to any climatic hazard or risk. Exposure can be characterized by (i) a typology of what is exposed (agriculture, livestock, water resources, population, industry, infrastructure, etc.); (ii) an analysis of the level of exposure (volume of what is exposed, e.g., population density, percentage of infrastructure, percentage of resources, etc.). These two levels of analysis determine the scope of the adaptation policy to be implemented. The difference between exposure and impact is often blurred. However, it is recommended to first identify the intermediate impacts for each given main impact. Thus, you can establish the link between this main impact and the climatic parameter triggering the latter. The frequency of occurrence as well as the intensity of these main impacts can provide information on the level/degree of exposure. The frequency of activities and/or use of system resources are also indicators of exposure.

- **Step 3: Determine sensitivity:** sensitivity is the extent to which a given community or ecosystem is affected by climate hazards. For example, a community practicing rain-fed agriculture is much more sensitive to changing rainfall patterns than one where mining is the dominant livelihood. Similarly, a fragile, arid, or semi-arid ecosystem will be more sensitive than a tropical ecosystem to a decrease in rainfall, due to the subsequent impact on water flow. Here, it is important to identify the characteristics of the system or the internal and external factors that make the system/individual sensitive to the impacts identified. To achieve this, the natural or physical characteristics of the system under study, such as existing infrastructure (*e.g.* irrigation or water storage systems) or facilities (*e.g.* agricultural credit, agricultural advice, insurance, etc.) to which the individual has access can guide the analysis. Farmers who have an irrigation system, for example, will be less sensitive to the problem of water deficit or dry spells even if their degree of exposure to this impact is high. It is critical not to confuse the factors of sensitivity and the adaptive capacity. The ability or resources needed to implement adaptation measures are part of adaptive capacities. But once the measures are already implemented and functional, they are considered as sensitivity factors.

- **Step 4: Determine adaptive capacity:** the capacity of a system to adapt to climate change (including climate extremes) refers to its capacity to reduce potential negative effects and impacts, to exploit opportunities (impact positive) or deal with the consequences. It depends on social, political, economic, cultural, institutional, environmental factors, etc., and it involves different territorial, community, and temporal scales. To simplify the analysis at this stage, adaptive capacities can be determined by category. (i) Knowledge: is there any knowledge or expertise that can support adaptation? (ii) Technology: what technical options (practices) are available and affordable that can improve adaptive capacity? (iii) Institutions: how can the institutional environment contribute to adaptive capacity? (iv) Economy: what economic and financial resources are available to build adaptive capacity and implement adaptation measures?

- **Step 5: Lead a collective reflection on adaptation measures:** Whatever the method used (literature review, individual survey, group consultation, etc.) to identify the factors of exposure, sensitivity, and adaptation, it is advisable (but not essential) to lead a collective reflection with grassroots communities on the ways in which sensitivity factors could be alleviated and adaptive capacities strengthened.

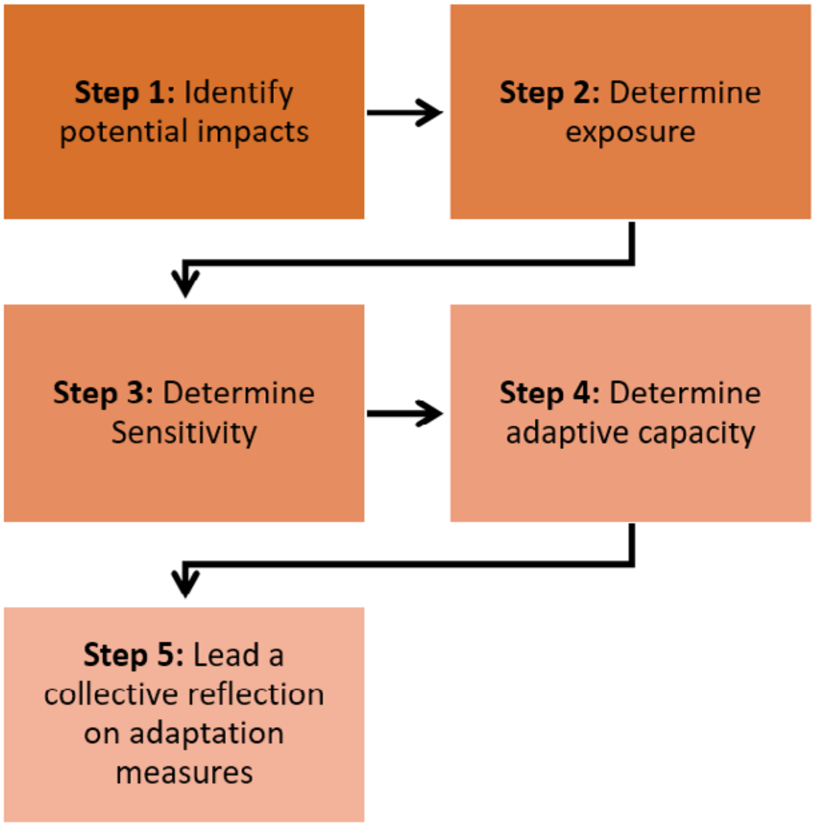


Figure 5-7: Stages of the value chain development phase
(Designed based on information from GIZ, 2015)

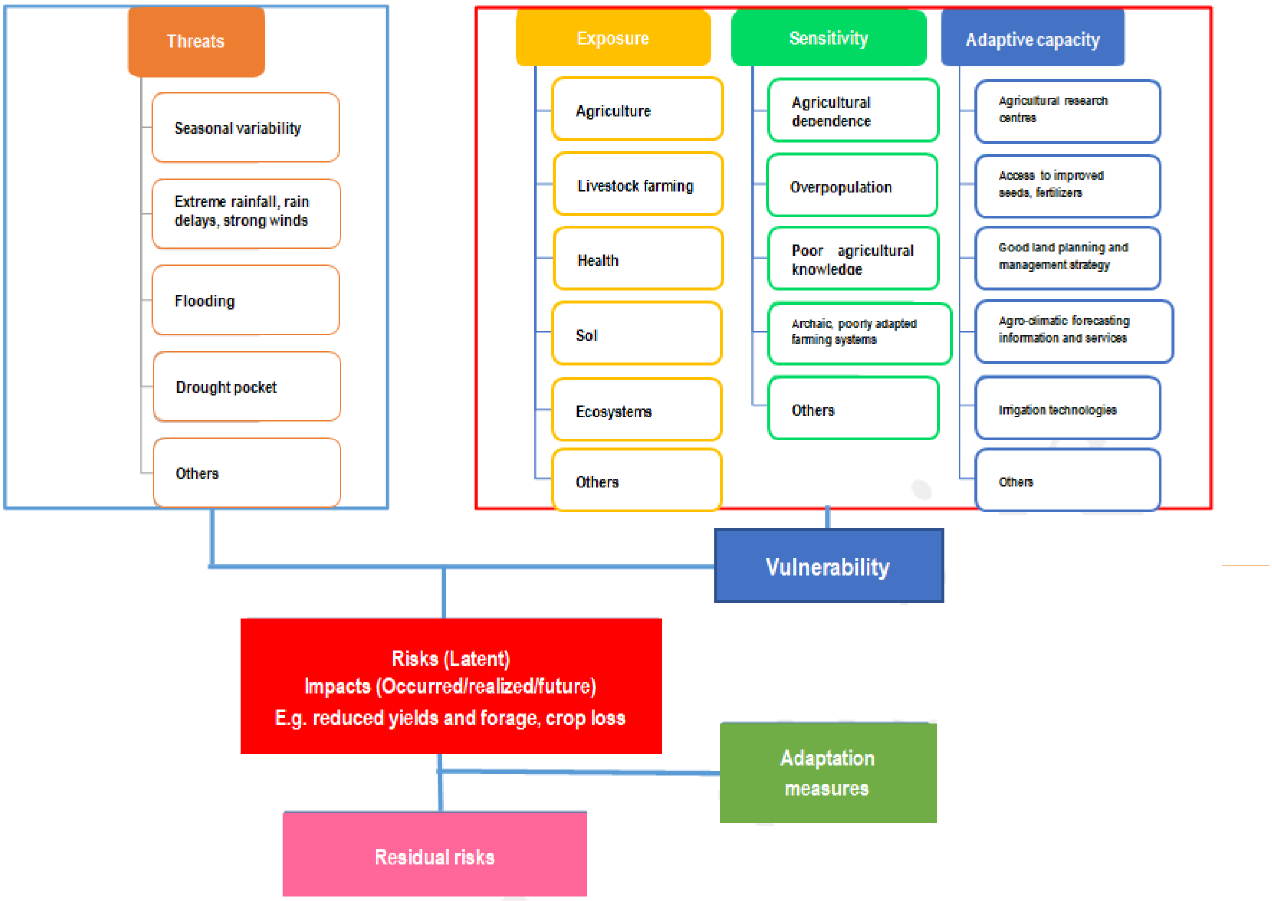


Figure 5 8: Explicit conceptual diagram of the impact chain
Source: adapted from GIZ, 2015

Stage 3: Identification and selection of indicators

Generate a list of indicators that can be used to **quantify** the relevant and previously identified factors likely to intensify or attenuate the effects of climate change. Such quantification could only be done by measurable indicators. It is important to identify and select at least one indicator for each of the factors retained per component (exposure, sensitivity, and adaptation). An indicator is "a function from observable variables, called indicating variables, to a theoretical variable (Hinkel, 2011). The techniques for identifying criteria and indicators will be discussed in detail in the session dealing with Climate Smart Agriculture Intelligence (CSA). Meanwhile, a good indicator has the following characteristics:

- **valid and relevant** *i.e.* it represents the factor to be evaluated;
- **reliable and credible** and allows data acquisition even in the future scenario analysis;
- has a **precise meaning**, easily understood by all stakeholders;
- the **direction of its evolution is clear**, *i.e.* an increase in its value is clearly

positive or negative with respect to the factor to be evaluated and comes from an easily accessible data source;

appropriate, *i.e.* its temporal and spatial resolution is consistent with the constituent elements of the vulnerability assessment.

Stage 4: Data collection and analysis

Once the indicators have been identified, we can move on to collecting data. The data can be obtained either from the literature, by direct measurement, secondary data (on climate, yields, etc.) by survey and poll, by "expert statements", by modelling, etc. After collecting the data, it is important to check their quality before processing them. In data processing, we have some sub-steps that will also be covered in detail in the session on Climate-Smart Agriculture:

- **Standardization of indicator data:** because the data collected does not have the same units of measurement and scope, it is desirable to standardize them to the same unit, often in percentages or unitless. For this purpose, a rating scale must be established. A rating scale often defines classes of ratings (positive or/and negative) according to the direction of variation of the variable/indicator.
- **Weighting and aggregation of indicators:** the indicators often do not have the same influences on the system under study. This reality is considered here by assigning weight to each indicator according to its importance. The indicators are then aggregated by sub-component or component. Some studies choose to present the results of their analysis with and without weighted indicators to allow a better understanding of the system.

5.2. Inventory of methods and tools for conducting vulnerability assessment

Several practical methods and tools are used to assess vulnerability to climate change (Table 5.1).

Table 5-1: Common methods used for vulnerability studies and their levels of application

Approaches	Application level	Tools and methods
Bottom-up approaches	Project planning	✔ **CRiSTAL** – Community-based Risk Screening Tool ✔ Adaptation and Livelihoods
	Community-based	✔ **CARE** Climate Vulnerability and Capacity Analysis Handbook (CARE, 2009) ✔ Framework for Community-based Climate Vulnerability and Capacity Assessment in Mountain Areas (ICIMOD, 2011) ✔ Participatory Capacity and Vulnerability Assessment – Finding the Link Between Disasters and Development (Oxfam, 2002)
Top-down approaches	Sectorial (ecological impacts)	✔ Scanning the Conservation Horizon – A Guide to ✔ Climate Change Vulnerability Assessment (Glick, et al., 2011)
	Sectorial (hydrology and water resources, infrastructure, and transportation)	✔ Preparing for Climate Change – A Guidebook for Local, ✔ Regional, and State Governments (Snover, et al., 2007)
	National level and developing countries	✔ Impacts, Vulnerabilities and Adaptation in Developing ✔ Countries (UNFCCC, 2007)
	Sectorial (coastal resources, water resources, agriculture, and human health)	✔ Handbook on Vulnerability and Adaptation Assessment (UNFCCC, 2008a)
Integrated approaches	Level linked to that chosen for the bottom-up and top-down approach	✔ Combination of bottom-up and top-down tools

6. Global vulnerability Status

Vulnerability to climate change is high in tropical areas, particularly in sub-Saharan Africa, where preparedness levels are rather low.

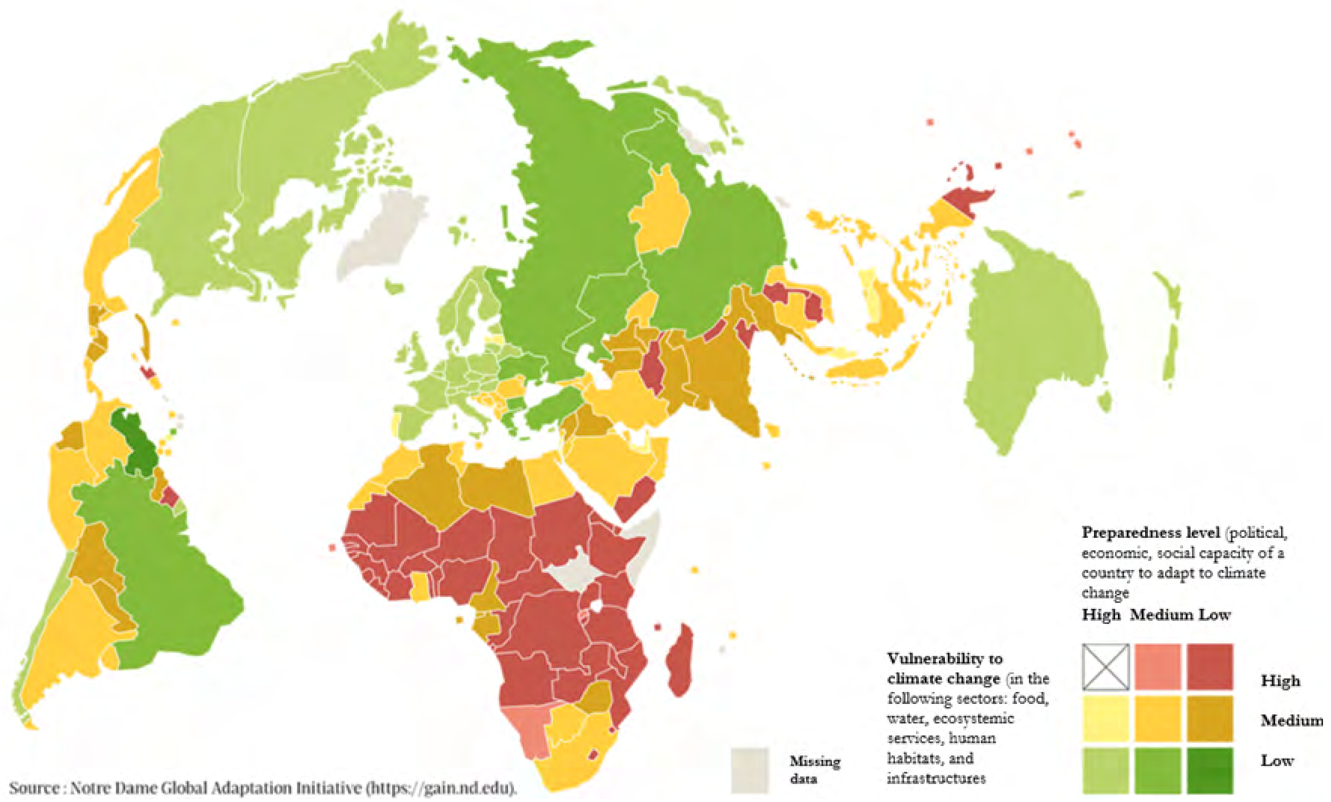


Figure 6-1: World vulnerability to climate change

7. Module 2 : Case Study and Practical Assignment

7.1. Presentation of the results of a case study of vulnerability assessment

Illustrate the approach in group work by analyzing the vulnerability of a sector or sub-sector in the area of intervention of the CSA project.

Refer to the outline of the results obtained from the analysis of the vulnerability of the country (agriculture sector) if applicable.

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Session III:
Climate-Smart Agriculture (CSA)

Learning objectives: Become familiar with the CSA concept and know how to distinguish it from other concepts, and the challenges related to its implementation. Be acquainted with the methods and tools for identifying and evaluating climate-smart agriculture strategies/practices/technologies. Case study of some CSA strategies/practices.

Expected results: At the end of this session, you will have a clear idea of the concept of CSA, know its basic elements, and be able to distinguish the CSA approach from other concepts used in agriculture and climate change by relying on certain distinctive elements of uniqueness and similarity. You will know the principles and characteristics of CSA. This session introduces you to the concepts of constraints, barriers/obstacles, and limits of adaptation to climate change and the new elements brought by CSA against CC. The session also addresses the the required steps for the effective implementation of the CSA concept. You will be able to design your own methodology to identify, assess (compute climate smartness score) and prioritize potential CSA practices/ strategies. You will be introduced to some existing and practical tools and some CSA strategies/practices will also be assessed.

Animation methods and tools

- ✔ Theoretical course
- ✔ Refreshing discussion on the solutions/efforts by sector of activity
- ✔ Practical assignment
- ✔ Questions and answers

Training materials (intermediate and final)

- ✔ Syllabus, Training Manual
- ✔ PowerPoint presentation
- ✔ Short videos, graphics, and photos
- ✔ Guidelines for assignments
- ✔ Other sources for more information

Duration: 6 hours (see details in syllabus)

Content

8. Module 1 : Concept of Climate-Smart Agriculture : Definition, basic principles, and main characteristics

8.1. Presentation of the CSA concept: definition, origin/history

Climate-smart agriculture (CSA) aims to address and deal with issues relating to food security, sustainable development, adaptation to climate change and its mitigation in a more integrated manner. CSA aims to strengthen the capacity of agricultural systems, to contribute to food security, by integrating adaptation needs and mitigation potential in the designing and implementation of agricultural development strategies. The CSA approach helps to coordinate, guide and direct actions aiming at transforming agricultural systems to achieve food security more efficiently and sustainably in the context of climate change (Lipper et al., 2014).

CSA was developed and first presented by the Food and Agriculture Organization of the United Nations (FAO) in a background document prepared for the Hague Conference on Agriculture, Food Security, and climate change in 2010. The CSA concept is guided by the idea of making agriculture "climate-smart", with particular emphasis on food security for current and future generations, as well as adaptation to climate change. Since then, the concept has been widely embraced by governments, regional and international organizations, civil society, and the private sector. There are now several national, regional, and international organizations working on CSA with some global and regional (Africa) Alliances on Climate-Smart Agriculture (ACSA) already formed providing platforms for knowledge sharing, learning and collaboration between all parties interested in the concept.

8.2. Basic principles and main characteristics of CSA

The CSA concept has **three key principles or pillars**:

i **Agricultural productivity and food security:** to sustainably increase agricultural productivity, in order to support the equitable increase of agricultural incomes, the improvement of food security, and to promote development. This first pillar of CSA also considers the capacities of the system/strategy of interest to reduce or not generate pre and/or post-harvest losses and facilitate access to the market for agricultural products to obtain substantial income.

ii **Adaptation to climate change:** adapt and strengthen the resilience of agricultural systems to achieve food security despite the adverse effects of climate change at different levels. This pillar covers adaptation actions/strategies and practices at the farmer level as well as at the national and regional level. This increases resilience to climate shocks.

iii **Mitigation:** reduce greenhouse gas (GHG) emissions from agriculture (including crops, livestock, fishing, agro-food processing, and the entire value chain of agricultural products). It considers the capacities of the system/strategy under consideration to emit little or not at all GHGs and/or its capacity to sequester these GHGs. These mitigation capacities can be upstream (during manufacturing, development of the product/technology/practices/project, etc.) and/or downstream (during or after use).

These three (03) principles, also called pillars of CSA, are closely linked, and allow countries/organizations/projects/producers to identify and select the most advantaged options and to make informed decisions. The implementation of the CSA measures or strategies is determined by the context and the specific capacities of each country/organization/project/producer facilitated by access to more precise information, harmonized policies, coordinated institutional arrangements and flexible incentive and financial mechanisms. The CSA approach aims to be dynamic over time and space, so there is no universal model for its application. However, CSA has key characteristics that are essential for its implementation.

The **key characteristics of the CSA** are:

i **Maintaining ecosystem services:** ecosystems, beyond their roles in maintaining ecological balance, provide producers and populations with essential natural resources such as air, water, energy, food, and others goods and services. The implementation of CSA strives not to compromise these achievements but rather to consolidate/strengthen them, to benefit from them and to conserve ecosystems for future generations.

ii **Intervention at different levels:** CSA goes beyond the simple implementation or application of agricultural practices and technologies. It also encompasses their design, their evaluation, and their readjustments to new challenges. It also addresses issues related to improving value chains, policies, organizations, and institutions.

iii **Contextualization:** CSA remains context-specific, *i.e.* what seems "smart" in a given place/locality may not be so elsewhere. The same goes for the "time" scale, the challenges of CC being dynamic, CSA must also adapt to them over time.

vi **The involvement of women and marginalized groups:** the implementation of CSA starting from the diagnosis of the existing situation, takes stock of the levels of vulnerability according to the localities (at the finest spatial scale possible) and socio-cultural groups. It, therefore, addresses "smart" solution approaches by favoring the most vulnerable and weakened populations and socio-economic groups.

Agriculture is based on the principle of inputs producing outputs. The different levels of inputs as well as the other mechanisms that surround them are climate, water, nutrients, energy, knowledge and information, processing and products conservation, and the market. These factors are closely linked to CSA. Thus, we distinguish seven levels of CSA options **(Figure 8.1)**:

i **Weather-smart:** the proper management of the climate and weather information such as: rainfall, temperatures, radiation, relative humidity, etc. (early warning systems) allows good forecasting of potential hazards during the cropping season and for animal production in order to limit or better manage the displacement/movement of livestock (transhumance). Real-time data and information (on smart phone or by SMS for example) on the overflow of water courses and bodies allows fishermen to take measures in advance and fish farmers and aquaculturists to be aware of potential hazards.

ii **Water-smart:** efficient and integrated management of water resources to reduce losses. Water conservation, collection, and efficient use of rainwater on the plot and in reservoirs for animal watering, use of improved irrigation techniques (computer-programmed irrigation, irrigation calendar, supplementary irrigation, etc.).

iii **Soil and nutrient-smart:** good management of macro and micro nutrients essential for crops, efficient management of livestock feed (supply of food supplements, formulation of improved feed, etc.), improvement of enteric and fermentation processes in animals to reduce GHG emissions, application of organic fertilizers and integrated soil fertility management (ISFM) *e.g.* fertilizing plants, legumes, crop rotation and association, microdose, biochar , compost, etc. for the improvement of soil productivity but above all the reduction or elimination of GHGs.

vi **Energy-smart:** the use of clean/green energies, and efficient management of energy sources that generate little or no GHGs for agricultural production, animals, processing, preservation, and transportation of the products.

v **Knowledge and information-smart:** production and access to quality information (for production and for the market) and data (for monitoring, studies, and diagnosis of the existing situation) via telephones, community radios, or other improved means, access, and improvement of knowledge (learning by videos to producers).

vi **Value chains development-smart:** this level of smartness encompasses the improvement of transport, preservation and processing of agricultural products which make it possible to improve the productivity of the systems, a better adaptation but above all a controlled and moderate emission of GHGs.

vii **Market and services-smart:** at this level of smartness, sales, market access, promotion, marketing, labeling and product certification techniques should be introduced, facilitated, and improved. As an example, we have the promotion of digital sales (online), the dematerialization of labeling processes, the optimization of taxes and the setting up of incentive measures. The construction and good management of modern and smart markets

8.3. Opportunities, challenges and limitations of CSA and its comparison to other concepts

What is new in the CSA concept is the explicit consideration of climate risks that occur more often (high frequency) and with greater intensity than in the past (CCAFS and UNFAO, 2014). To overcome these risks, responses to the harmful effects of CC must also be dynamic and effective in time and space. For this, CSA requires greater investment in: (i) climate risk management; (ii) understanding and planning for adaptation transitions that may be required; (iii) taking advantage of opportunities to reduce or eliminate greenhouse gas emissions wherever possible (CCAFS and UNFAO, 2014).

The CSA concept integrates the three dimensions of sustainable development: economic, social, and environmental (FAO, 2010). Therefore, it goes beyond the goals of green revolution, conservation agriculture, agroecology, etc. (**Figure 8.2**), and differs from agricultural intensification and sustainable agriculture by integrating the fight against climate change, as well as the mitigation and/or elimination of greenhouse gases (GHG) (Kpadonou et al., 2019). Ultimately, CSA equals to sustainable agriculture plus resilience to climate change minus GHG emissions: **CSA = Sustainable Agriculture + Resilience – Emissions.**

CSA also influences options and decisions at the global, regional, and national level (**Figure 8.2),** and addresses issues of agricultural policy development and implementation at various levels (Zougmoré et al., 2015). *For further reading, https://fr.csa.guide/csa/how-is-it-different*

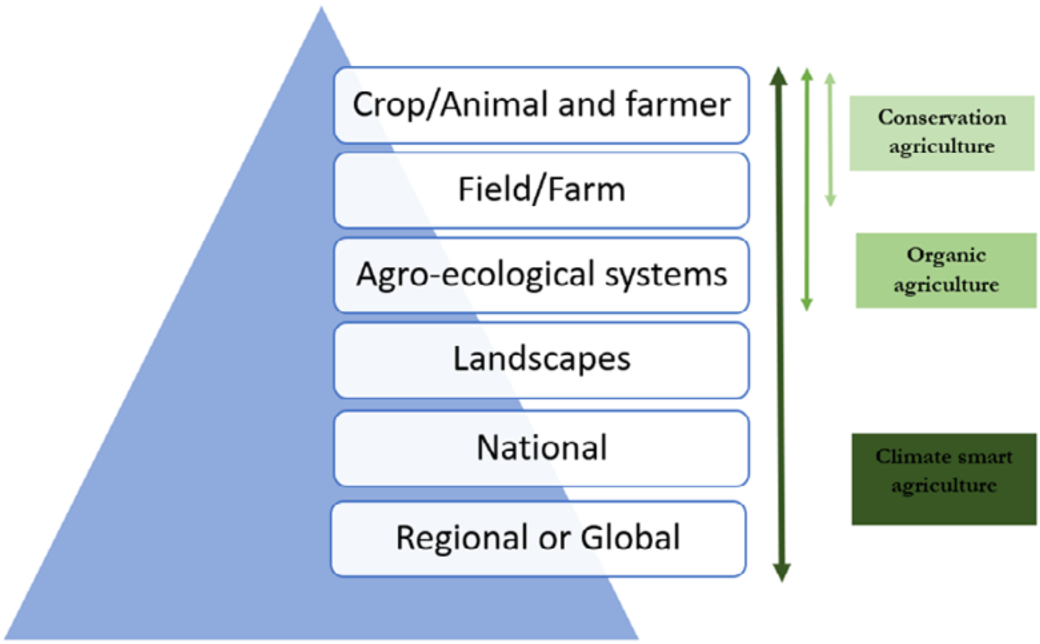

Figure 8-2: Level of influence of CSA in the agricultural production system.
Source: Kpadonou et al., 2019

By more effectively addressing current climate change issues and preparing for future ones, the triple advantage (productivity, adaptation, mitigation) of CSA confers to the concept a privileged position in national, regional, and international funding mechanisms. It appears to be the long-awaited response to effectively deal with the phenomenon of climate change. However, it has some **limitations** that hinder its wide adoption and scaling. In fact, most of the adaptation limits presented in the previous module constitute potential challenges to the adoption of CSA. Added to this are factors such as the type of cropping system, the area cultivated, access to irrigation facilities, access to agricultural extension and advisory services, the distance between fields and markets and the access to climate information services, which are the determinants of CSA adoption (Kifle et al., 2022).

To address challenges related to the adoption and scale-up of CSA, the following four actions should be taken (CCAFS and UNFAO, 2014):

i **Action 1:** Increase and promote evidence and success stories (the most convincing) to get the buy-in of others, design and make available evaluation tools in order to identify good strategies for agricultural growth to ensure food security, which incorporate the potential adaptation and mitigation needed;

ii **Action 2:** Develop strategic frameworks and consensus to support the implementation and scaling up of CSA;

iii **Action 3:** Strengthening national and local institutions to enable farmers to manage climate risks and adopt agricultural practices, technologies, strategies, and systems that adapted to their context;

vi **Action 4:** Improve financing options to support implementation and link climate and agriculture finance.

9. Module 2 : Methodological approaches for identifying and evaluating CSA strategies and practices

9.1. Design of a methodology and tool for evaluating CSA strategies, technologies, and practices

- **Why assess:** not all adaptation measures in general and specifically those that are potentially climate smart are systematically applicable anywhere. Due to certain constraints in terms of funding, capacity or national priorities, and socio-cultural reasons, one strategy or measure may be possible and more effective than another in a locality during a period. An initial evaluation of all the strategies is therefore crucial to make informed decisions and to avoid problems of maladaptation.
- **No one-size-fits-all tool:** priority strategies can be selected through different methods and tools depending on needs, context, available data, and capacity. The use of reputable/robust tools and methods improves the credibility of the choices, increases their effectiveness, acceptability, and the viability of the investment.
- **Common data analysis methods and tools** include Multi-criteria Analysis (MCA), Cost-benefit Analysis (CBA), Cost-Effectiveness Analysis (CEA) and the Cost Comparison (CC) method (**Figure 10-1**). The choice of one of these methods depends on the objective of the study and the analysis criteria (**Figure 10-1)**.

However, it would be desirable to set up a specific methodology to integrate all the el-

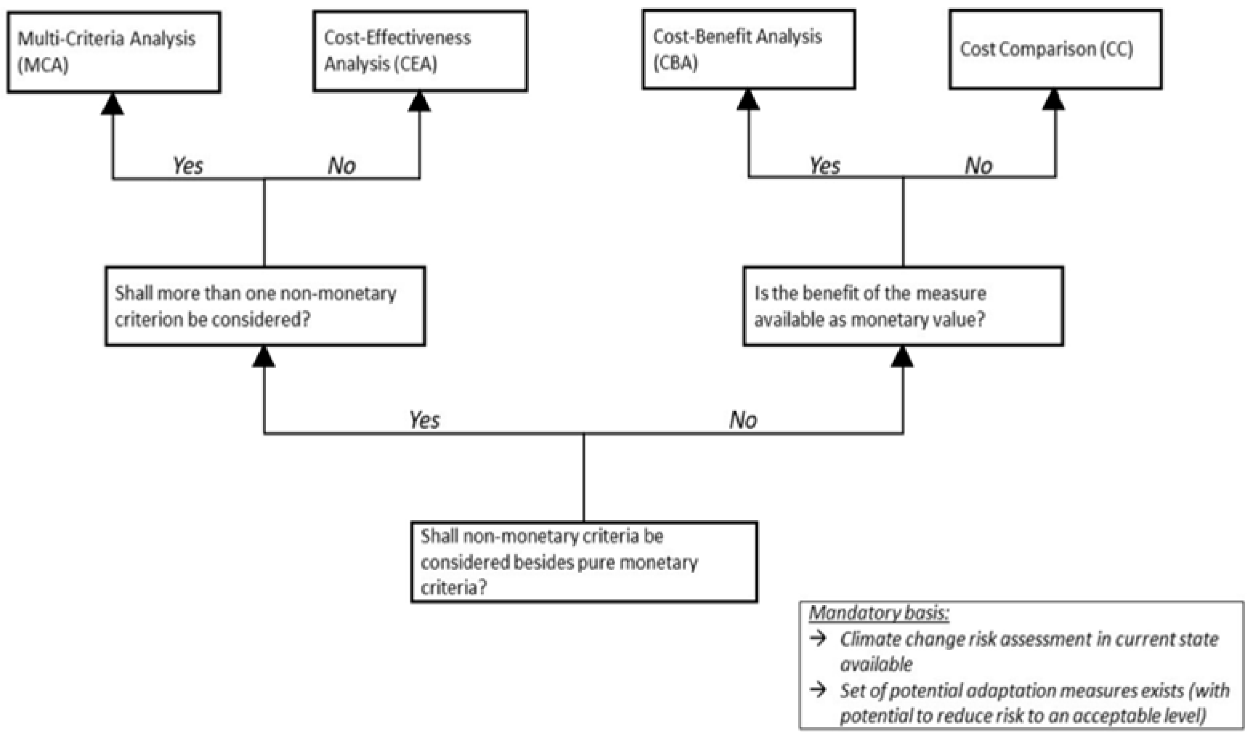

Figure 9-1: Decision tree for selecting a common method for socio-economic analysis of climate change adaptation strategies
Source: Adapted from van Alphen et al. 2021

ements and levels of analysis desired. A methodology **for evaluating** potential CSA strategies/practices must consist of **two main phases** (**Figure 10.2**):

(i) **A phase of identification of strategies, and**

(ii) **A proper evaluation phase.**

Each of its phases is composed of different steps as described in **Figure 9.2**.

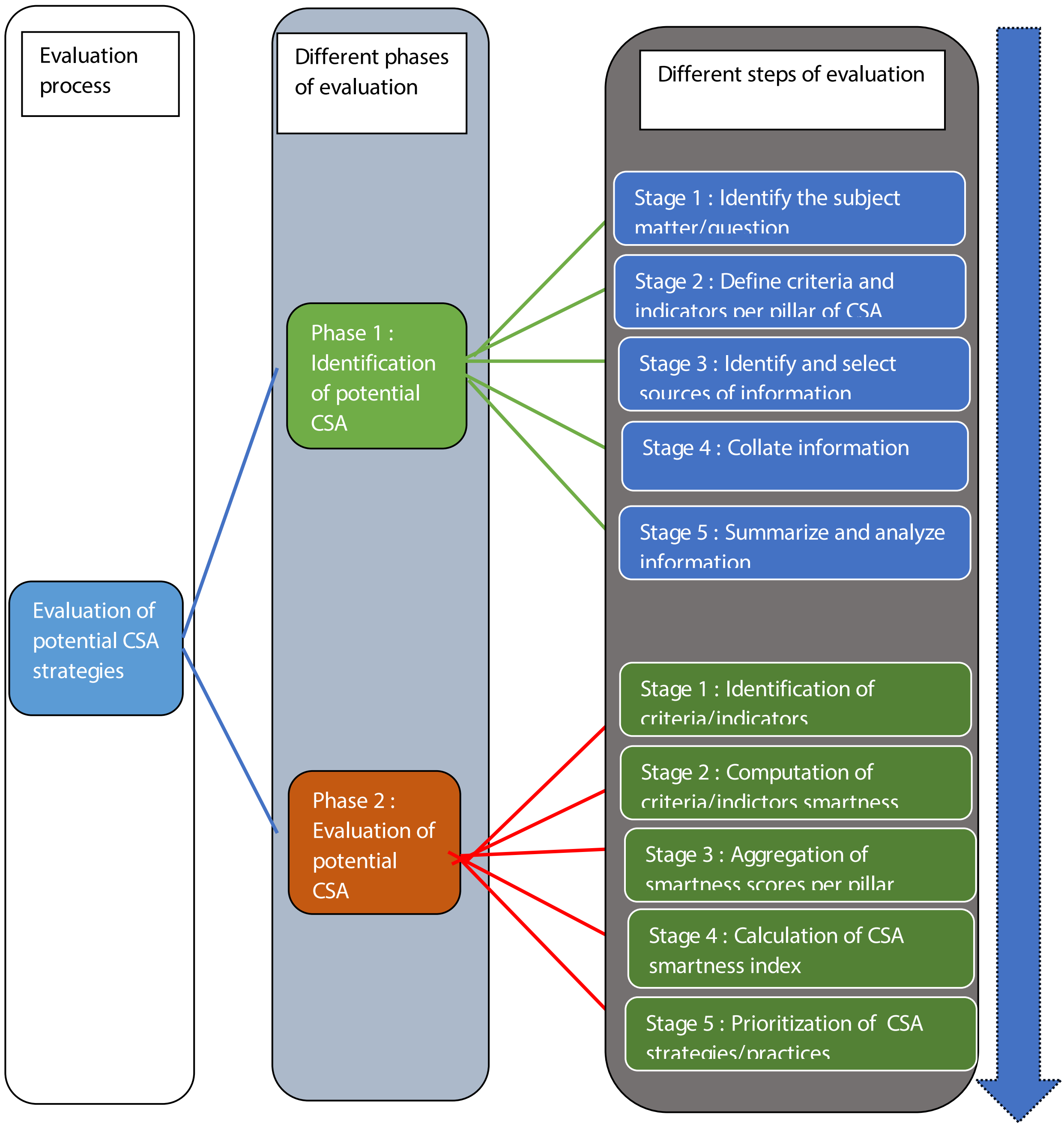

Figure 9 2: Standard methodology for CSA practices assessment process

9.1.1. Phase 1 : Identification of potential CSA strategies/practices

There are different ways to access information on a subject. In general, a methodological approach to research on CSA also follows the classic research plan on any subject, but with some specificities. There are **five basic steps** to follow for the identification of potential CSA strategies/technologies/practices (**Figure 9.3).**

Figure 9-3: Different steps for identifying potential CSA strategies/practices

- **Step 1: Clearly identify and define the subject matter/research question:** it is important to clearly state the problem or the question to which you want to answer in a very precise way. Here, the focus is to identify CSA strategies/technologies and practices in each agricultural sub-sector (to be specified). If possible, also specify the level of smartness (weather, water, soil/land, market, etc.) where the strategies will be identified.

- **Step 2: define the selection criteria and indicators:** this involves establishing a list of CSA criteria to be considered in order to identify and select a potential CSA practice. These criteria or indicators should be developed per CSA pillar. The key to the success of an CSA analysis depends on the relevance of the selected indicators. The quality of the results then relies on the choice of indicators.

  - **How to choose an indicator/criterion?**
    There are various indicators that could be used in an CSA analysis. However, it is necessary to only select the most relevant indicators. The quality of the indicators here is more important than their quantity (number). FAO (2010) has proposed **four essential attributes** to consider when choosing a good indicator. The indicator should be:
    Relevant: it must be able to bring out an important element about something that you would like to know on the system you are analyzing. What does this indicator concretely reveal about the research question?
    Precise: addresses a very clear and specific element/aspect, which may allow others to understand and believe you (*e.g*: yields).
    Sensitive: the indicator must be sensitive to any change in the system under consideration.
    Easy to understand: any external person who does not even have complete knowledge of the subject should understand the indicator by simply reading it.
    Measurable: it must be able to be quantified it. Therefore, it must be based on data that is easily accessible and available or that can be easily collected and interpreted.
    In fact, in the process of selecting criteria/indicators, one must always bear in mind the characteristics used to define a good objective: **SMART** = Specific-Measurable-Achievable-Realistic-Time-bound. A good indicator should also have these **five attributes:**
    Specific: the indicator conveys or reflects one and only one simple piece of information that can be easily understood and communicated.
    Measurable: the information sought should be easily measurable, and changes thereto are also verifiable.
    Achievable and Realistic: the indicator and its unit of measurement should be achievable/feasible/achievable; and sensitive to any changes the system experiences.
    Temporal: the indicator should be recorded within a timeframe.

- **Indicative elements to consider when choosing CSA criteria/indicators**
  For further reading: The World Bank, 2016. climate-smart agriculture Indicators, available here.

(i) Criteria or indicators of productivity: this is the capacity of the strategy/technology/technique/practice to:

Improve **yields and agricultural productivity** in general. To do so, you must ask yourself the question of whether the practice allows you to increase yields or achieve good productivity? Productivity is agricultural production (leaf, grain, fruit, etc.) per unit of input (land, capital, water, labor, or other input);

Improve **food security:** does the practice allow for an increase in the **availability, accessibility, use and stability** (over **time**) of food/food?

Reduce or not generate **pre- and post-harvest losses**. During the production and/or processing, does the practice induce too much losses or not? does the practice improve products quality without enough or no losses during the harvest? Are harvested products less susceptible to post-harvest losses?

Improve **incomes as well as the living conditions** of the producers. Does the practice make it possible to have substantial and stable incomes which guarantee a better living standard for producers?

(ii) Criteria or indicators of adaptation to climate change: the strategy/technology/technique/practice will be assessed against the seven levels of CSA options:

a. **Weather-smart:** does the practice generally improve adaptation to CC? Phrase differently, does the practice make it possible to resist extreme climatic events (floods, pockets of drought, violent winds, etc.)?
b. **Water-smart:** does the practice improve availability and access to water? does the practice improve water use efficiency? Does the practice improve or disturb water quality and water sources?
c. **Soil and nutrient smart:** does the practice improve the quality and quantity of animal feed? does the practice bring more nutrients to the plants? does the practice improve soil moisture? or does the practice increase the water retention capacities of the soil? does the practice contribute to soil degradation? etc.
d. **Energy-smart:** does the practice use clean and renewable energy sources? does the practice efficiently use energy? etc.
e. **Knowledge and information management-smart:** does the practice allow producers and actors to have access to important and quality information in real time? Is this information useful to producers in the management of climate risks and shocks? Does the practice value local knowledge? Did the practice make use of ICT? etc.
f. **Value chains development-smart:** does the practice use improved processing technologies and preserving agricultural products? Does the

practice easily adapt to product labeling processes? What added value does this practice bring to agricultural products?

g. **Marketing and services-smart:** does the practice make it easy to sell the products? does it have its own commercial circuit? are the products resulting from the practice labeled? etc.

(iii) Mitigation criteria or indicators: the questions here are related to greenhouse gases, their emission and/or sequestration.

a. **Emissions:** does the practice reduce GHG emissions? Does the use of the practice generate GHG emissions?

b. **Sequestration:** Does the practice contribute to carbon sequestration?

The expected answers here are qualitative (*YES* or *NO*), suggesting that they are dichotomous qualitative variables which can only take two modalities (*YES* or *NO*). To ease data collection and summary, we provide a fact sheet in which the questions can be organized (see example in **Table 9.1**)

Table 9-1: Example of data collection sheet for identification of potential CSA strategies

CSA pillars	Components of the pillar	Identification criteria or indicators in CSA	Answers	
			YES	NO
Productivity and food security	Productivity	Criterion/indicator 1		
	Food Security	Criterion/indicator 2		
Adaptation	Climate	Criterion/indicator 3		
	Water	Criterion/indicator 4		
	Soil	Criterion/indicator 5		
	Ecosystems	Criterion/indicator 6		
Mitigation	Emissions	Criterion/indicator 7		
	Sequestration	Criterion/indicator 8		

- **Step 3: Identify and select information sources**. We distinguish two large groups of information sources: **written and non-written sources**. **Written sources** can be **official documents** (scientific: scientific publications, articles, book chapters, etc. or regulatory/legal: texts, regulations, and laws), **unofficial** (printed press reviews, rolling documents, blogs, social media, etc.) and information from **statistical sources** (current statistics, censuses, etc.). Information from **non-written sources** can be material objects and traces, iconography, oral sources: stories, testimonies, recorded images, and sounds (**Figure 9.4**)

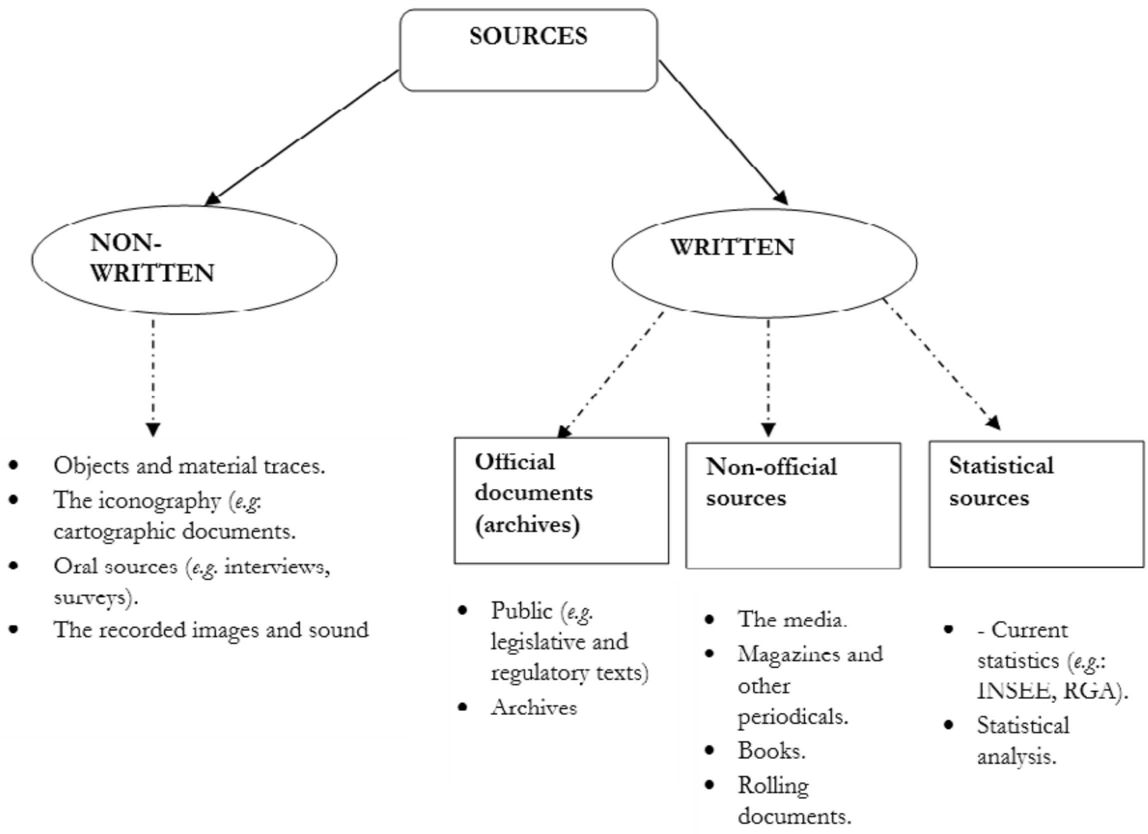

Figure 9.4: The different sources of information
Source: Albarello et al. (1995)

- **Step 4: Collecting information.** Collecting information from **written sources** can be done through searches from various standard search engines (Google, Bing, Yahoo, Ask.com, AOL.com, Baidu, Wolframalpha, DuckDuckGo, Web Archives, Yandex.ru.) or scientific (Google scholar, Scinapse, Semantic scholar, Web of science, Science direct, etc.). The sources of non-official and statistical documents can be consulted directly either on the web pages of newspapers, press organs, organizations and statistical institutes producing this information, or by visiting the premises of the latter to consult documents and reports. As part of a CSA analysis, organizations and institutes working in key areas and on climate change should be identified upstream, then their websites and/or social media pages should be consulted. Also, the reports (hard version) can be consulted from the physical library of these organizations. Within the framework of a **scientific literature research**, there are even more specificities which could not be addressed in detail in this manual. However, a scientific literature research must follow a very clear methodology. There are qualitative literature reviews (systematic or not), where the information sought is more qualitative (without quantification objective) and quantitative literature reviews (metadata analysis). Regardless of the method, it is necessary to read the identified documents (starting with the titles, summaries, abstracts, etc.) and to extract relevant information considering the research question. For example, it will be necessary to identify the elements of comparative analysis between potentially climate smart measures/strategies and conventional strategies in the light of the three pillars of CSA.
  For **non-written sources**, a field visit is necessary to meet and discuss with the actors and/or key informants. It can be done through surveys and group interviews (focus group), as well as through participant observation. The visualization and analysis of photos and videos are equally important. This type of information can also be collected by conducting face-to-face or online surveys with experts, resource persons, technicians, and experts in the field.

- **Step 5: Summarize and analyze the information.** The information obtained during step 2 is analyzed and summarized. This information will allow for **tracking and listing of** potential CSA strategies/technologies and practices using the criteria and indicators defined in phase 2.

9.1.2. Phase 2: Evaluation of potential CSA strategies/practices

There are **five different steps to assess/prioritize potentially** CSA strategies/practices (**Figure 9.5)**.

Figure 9 5: Different steps for identifying potential CSA strategies/practices

(iv) Step 1: Identification of criteria/indicators: This was described in stage 1 in the previous section. It consists of identifying and listing potential CSA strategies/practices based on well-defined criteria. The criteria/indicators here must necessarily be quantifiable.

Table 9.2 provides examples of criteria/indicators proposed by the World Bank that can be used to assess practices/**technology**

Table 9-2: Criteria/indicators that can be used to assess practices/technology

Source: adapted from World Bank (2016)

CSA pillars	Pillar sub-elements	Indicators
Productivity (P)	**Cropping systems**	1-The technology allows an increase in yields of (%)
		2-The technology does not contribute to land degradation or allows the recovery of eroded/degraded land by (%)
		3-The technology increases soil fertility by (%).
		4-The technology improves/increases the biodiversity (soil and ecosystems) of cultivated areas compared to ordinary practice.
	Water resources	5-The technology increases the irrigated areas by (ha) or increases the share of irrigated land by (%)
		6-The technology allows a water saving of (mm/%)
	Energy	7-Technology reduces the amount of energy used for agriculture compared to overall household needs/use (%)
	Pest management	8-The technology promotes an increase in area using integrated pest management techniques (%)
	Animal husbandry	9-The technology allows a diversification of high species compared to the current situation or an ordinary practice (number of species or %)
		10-The technology allows a good management of the resources of the breeding systems compared to the current system
		11-Technology improves the production of animal feed
		12-Technology allows diversification of livestock products

CSA pillars	Pillar sub-elements	Indicators
Resilience	**Robustness**	13-Technology improves human capital skills (technical skills)
		14-Technology improves the stability of agricultural production that farmers need for their own food security and improved income.
		15-The technology promotes the diversification of farmers' incomes and their access to basic needs
		16-Technology promotes agricultural diversification
		17-Technology promotes indigenous/local knowledge
		18-Producers have appropriate access to the intellectual property rights and/or license exploitation they need for the deployment or uses of CSA technologies
	Organizational	19-Technology facilitates cooperation and networking between producers
		20-Technology promotes good local and regional production and supply chains
		21-The intervention allows for feedback (reporting obligation) from the support staff (extension agents/agricultural advisers).
		22-CSA services reduce inequalities between local communities
		23-Technology can reduce gender inequalities
	Cropping systems	24-Technology increases the resilience of cropping systems
	Livestock farming systems	25-Technology increases livestock resilience
Mitigation	**Emission intensity**	26-Technology allows for the achievement of the emission reduction objectives
	Carbon sequestration	27-Technology enables carbon sequestration

(v) **Step 2: Calculation or estimation of smartness scores by criterion:** Once the potential CSA strategies/technologies and practices have been identified, they must be evaluated. The evaluation of CSA practices consists in calculating or estimating their level of smartness, that means their contribution to each evaluation criterion/indicator. This is not a simple YES or NO answer but it requires the extraction of the figures or their estimation in terms of percentage of contribution to the various evaluation criteria. This can be done either by:

Quantitative literature review: the aim is to systematically collect all the publications addressing different aspects of the strategy/practice in a locality. Extract from this literature the factual elements related to the contribution of the strategy/practice to each criterion.

Evaluation based on experts' knowledge: consists in carrying out a more refined and detailed survey of practitioners in the field. The experts here can be technicians, resource persons, scientists, supervisors, etc. The expert gives a rating (on a predefined scale) which he reads beforehand. His understanding of the annotation system is therefore essential for the objectivity and quality of the evaluation. Each CSA criterion should also be explained to him beforehand. To obtain harmonized responses, it is often advisable to organize expert workshops during which the methodological approach of the evaluation is explained.

Evaluation by the actors or end users: this involves having the practices evaluated by the users who are the farmers. It can be done through individual interviews or consultations with groups of actors. The criteria and weighting system are also explained and often well detailed in the local language. Explanations can also be provided to group of farmers during a workshop before the individual interviews.

Evaluation by estimation-modelling: this involves estimating by oneself the contribution of the practices according to the criteria by using estimation or modeling tools (technical and scientific).

Regardless of the method used, the contributions of the practices to each criterion/indicator can be direct quantities (yields in kg/ha, soil moisture in mm, quantities of runoff water, quantities of water drained/infiltrated, quantities of nitrate lost, etc.) or percentages. It is desirable to convert the quantities obtained into percentages (Percentage of improvement) by comparing, for example, the yield obtained under potential CSA practice (R_{P_PCSA}) with that of conventional practice (R_{PO}) using **equation 1**.

$$\%AR = \left(\frac{R_{P\_PCSA} - R_O}{R_O}\right) * 100$$

Equation 1

With %AR equals to percentage of Yield Improvement of practice X.

- **Step 3: Smartness aggregation by CSA pillar:** this involves going from contributions by criterion to contributions by CSA pillar, i.e. aggregating the percentages of contributions by CSA level. In other words, to what extent or percentage does the practice/strategy lead to good productivity and ensure food security? Up to what percentage does the practice allow producers to adapt to climate change? and how much carbon could the practice sequester? and/or how much GHG can the practice emit? To achieve this, the percentages obtained by criterion are grouped by CSA pillar either by considering all the criteria having the same weight (aggregation based on equal weight), or by prioritizing the criteria according to their importance for the strategy/practice (weighted aggregation).

  a. **Aggregation with equal weight:** It is assumed that all the evaluation criteria used are equally important for the CSA pillar or for the practice to be evaluated. In this case, the percentages obtained by criterion are used directly to make the aggregation by pillar using **equation 2**.

$$\%P_y = \left(\frac{\sum \%C_i}{NC}\right)$$

Equation 2

With %C i denotes the percentage obtained by criterion i , NC denotes the total number of evaluation criteria used for the CSA pillar y , and %Py is the contribution percentage of the CSA pillar y.

b. **Weighted aggregation:** It is assumed that all the evaluation criteria used do not have the same importance for the CSA pillar to be evaluated. For example, the total yield for a given practice as an evaluation criterion for the productivity and food security pillar may be favored over the pre- or post-harvest loss criterion. In this case, the weighted percentages for each criterion are first calculated using a clear weighting system. Weighted contribution percentages (PCP) are relative contribution percentages which can be calculated by multiplying the contribution percentages (%C i) of a given criterion by a weighting coefficient (Cp) which can for example be 3 for very important criteria , 2 for important criteria and 1 for not too important. From these relative contribution percentages, the contribution percentage of the CSA pillar is estimated using equation 3.

$$\bar{\%P_y} = \left(\frac{\sum Cp_i.\%C_i}{\sum C_p}\right)$$

Equation 3

With Cp being the weighting coefficient, %C i is the contribution percentage of criterion i, and %Py is the contribution percentage of the CSA pillar y = weighted contribution percentages (WCP) .

- **Step 4: Calculation of the CSA smartness index:** the final smartness index of the practice is obtained by calculating the average of the contributions by CSA pillar, using **equation 4**

$$\bar{Indice_{CSA}} = \left(\frac{\sum \%P_y}{3}\right)$$

Equation 4

Three (3) being the total number of CSA pillars.

- **Step 5: Prioritization of strategies/practices:** the CSA smartness indices per strategy/practice are ranked in ascending order. This makes it easy to identify, for example, the top 3-5 or best strategies/practices that are smarter than others. An average percentage can also be defined, for example all strategies/practices that have obtained an CSA index of more than 50% are considered eligible for CSA.
  Moreover, there are a certain number of ready-to use data analysis tools that are available to those who cannot design their own tool/database.

9.2. Inventory of existing tools for the evaluation of CSA strategies/practices/technologies and practical assignments

There are different tools to assess potential CSA strategies and practices. We have for example the CIAT/CCAFS CSA Prioritization Framework, the CCAFS CSA Prioritization Toolkit, mitigation optimization tools (*e.g.* the FAO Carbon Balance Sheet and the CCAFS Mitigation Optimization Tool), as well as the CCAFS Compendium of CSA Practices.

- **CIAT/CCAFS CSA Prioritization Framework**
  It was designed to channel investments into CSA, with the aim of helping decision-makers identify the most promising investment portfolios for CSA. This framework is composed of four phases (**Figure 9.6):** (i) initial assessment of CSA options; (ii) identification of the best CSA options (workshop); (iii) calculation of the costs and benefits of the best CSA options; and (iv) portfolio development and barrier assessment (workshop).

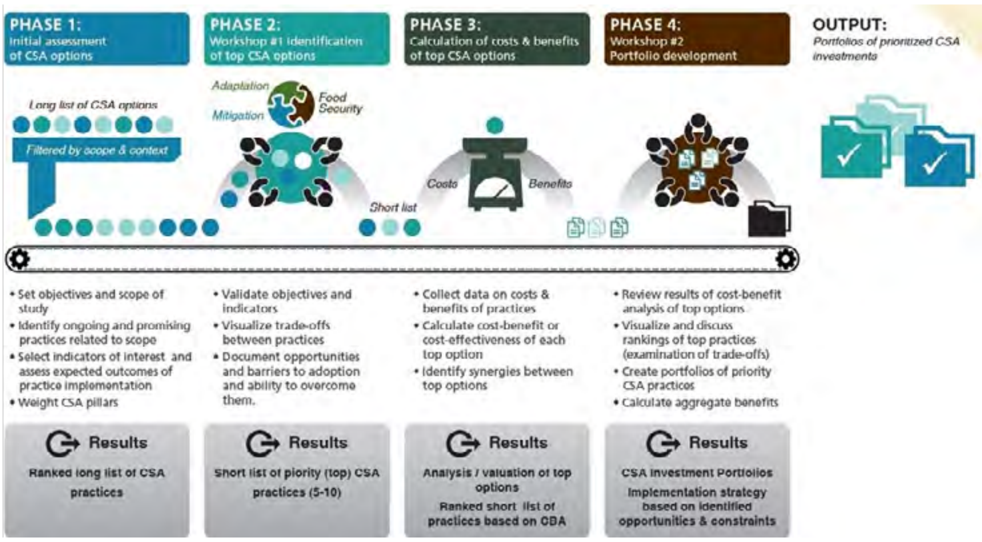

Figure 9-6: Conceptual framework for prioritizing investments in CSA.
Source : Andrieu et al., 2017.

The CSA programming and indicator tool: the BETA:

This tool was designed by CCAFS and will be used for practical assignment in this session. It is a simple Excel-based tool which requires little data. The tool is made up of three steps:

Step 1: Defining the scope and identifying desired outcomes: The user is prompted to answer specific questions related to the three pillars of CSA. A traffic light system enables the user to specify the desired result (red: not at all, amber/yellow: indirectly and green: directly);

Step 2: Selection of the scale of action planned (household/farm, regional, national) and the type of indicator based on the current stage of the intervention;

Step 3a: Results summary. It leads to the establishment of a set of relevant indicators, which can be used both to develop implementation plans and to monitor and evaluate activities.

Step 3b: Visualization. This step includes evaluating the intervention through the CSA principles and the degree of intentionality.
The user manual can be downloaded here.The tool can be downloaded here.

The CCAFS ERA (Evidence for Resilient Agriculture) analysis platform

The ERA, previously called the "Climate Smart Agriculture (CSA) Compendium", is an online performance analysis platform for CSA practices and technologies. It was built based on the principle of metadata analysis in the agricultural field (Ouédraogo, 2019). It covers 150,000 scientific articles from developing countries including 49,000 articles in Africa with more than 75,000 data points describing the impacts of more than 100 agricultural technologies on more than 50 indicators of productivity, resilience, and mitigation (Ouédraogo, 2019). The latest version of ERA launched in October 2019, calculates the response rate of situational change in percentage (%) as the log ratio of the mean treatment effect (improved practice or CSA) to the mean effect of the control practice (non-CSA practice). The platform can be accessed here.

The CSA Prioritization and Rapid Assessment Tool (RA-CSA)

The RA-CSA allows for a rapid assessment of the barriers/challenges and opportunities related to the adoption of CSA across landscapes in an environment. The data used is collected at the household level and is linked to actors' perceptions of climate variability, resources and the availability and allocation of labor, and economic aspects. The approach combines participatory workshops, interviews with experts, interviews with farmers, transects and participatory field observations with farmers. More information about the tool can be found here.

The Consensus-driven decision support framework "TARGETCSA": Support framework for consensual decision-making.

The "TargetCSA" aims to facilitate the targeting of CSA at the national level by involving all stakeholders in the search for consensus and the integration of complete and reliable information. This framework incorporates quantitative and spatially explicit information such as vulnerability indicators (*e.g.* soil organic matter, literacy rate and market access) and CSA indicators (*e.g.* improved soil fertility, water harvesting and agroforestry) as well as qualitative advice on these targeting criteria. More information about the tool can be found here.

- **Climate-Smart Agriculture Prioritization Toolkit (CSAP)**
  This toolkit allows the user to identify the best possible decisions. It allows for a trade-off analysis of alternative CSA development pathways, and thus supports decisions on which species to grow, which CSA agricultural technologies and practices to invest in, where to target to make investments, and when to make those investments. More information about the tool can be found here

- **Mitigation optimization tools**
  They are not necessarily used for full CSA analyses. Most of them allow for the estimation of GHG emissions according to agricultural activities. We have for example:

  - **The CCAFS Mitigation Options Tool (CCAFS-MOT)** is used to estimate GHGs and rank the most effective mitigation options for 34 different crops. It requires little data and is functional in Excel.
    The tool's user manual can be accessed here.
    The tool is accessible here .

  - **The Ex-Ante Carbon Balance Analysis Tool (EX-ACT)** is an evaluation system developed by FAO that provides ex ante estimates of the impact of agricultural and forestry development projects, programs, and policies on the carbon balance.

9.3. Evaluation of evaluation methods: Case study

Challinor et al. (2022) evaluated some valuation methods and summarized their findings in Table 9.3. The article is accessible here

Table 9-3: Evaluation of some CSA strategy evaluation methods/tools
Source: Challinor et al. (2022)

Method/reference	Food security			Adaptation			Mitigation	
	Productivity	Sustainability	Food security pathways analysis	Short term	Long term	Adoptability of technologies	Short term	Trend
Soil-based Climate-Smartness Index (SCSI) (Arenas-Calle et al., 2021)	Green	Yellow	Red	Yellow	Red	Red	Yellow	Green
Climate Smartness Index (CSI) (Arenas-Calle et al., 2019)	Green	Red	Red	Green	Yellow	Red	Green	Red
CSA technology Index (World Bank, 2016)	Green	Red	Red	Green	Yellow	Red	Green	Red
CSA Results Index (World Bank, 2016)	Green	Red	Red	Yellow	Yellow	Yellow	Green	Red
Multi-criteria ranking system for climate-smart agriculture technologies (Wassmann et al., 2019)	Green	Green	Yellow	Yellow	Green	Red	Yellow	Green
Climate-Smart Agriculture country profile (World Bank, CIAT, 2015)	Green	Red	Red	Green	Red	Green	Green	Red
Evidence For Resilient Agriculture (ERA) platform (Nowak and Rosenstock, 2020)	Green	Red	Red	Green	Red	Red	Green	Red
integrated Future Estimator for Emissions and Diets (iFEED) (Jennings et al., 2022)	Green	Yellow	Yellow	Green	Green	Yellow	Red	Green

Green circles indicate the sub-component is addressed in detail; yellow circles indicate subcomponents are partially addressed and red circles indicate is not addressed or only to a very limited extent.
The eight categories used are those of vW2020 (i.e., van Wijk et al., 2020).

9.4 Practical assignment

Instructions: Hands-on the simplified CIAT or CCAFS tool

10. Module 3 : Examples and success stories of CSA strategies

10.1. Identification and description of some good practices used by sub-sector and by country

There are a variety of practices/technologies developed to adapt to climate variability and climate change. They can be grouped by sectors including crop, animal and fish production, forestry, value chains and energy.

10.1.1 Crop production

The practices/technologies developed in the crop production sub-sector focus on (i) climate risk prevention and management, often through Climate Information Services; (ii) management of cropping systems and the agricultural calendar; (iii) management of production plant material (improved and/or climate-resilient crop varieties); (iv) water and soil conservation practices. These practices can be grouped into different categories (Table 10.1):

- **Soil management:** use of manure to improve agricultural production, crop mulching (harvest residues, straw, or polyethylene film);
- **Crop management:** use of improved varieties (early maturing varieties, tolerant to drought, resistant/tolerant to diseases), the System of Rice Intensification (SRI);
- **Water management:** refers to efficient irrigation techniques such as localized irrigation systems (drip irrigation, micro diffusers, etc.), capillary systems, etc.
- **Pest management:** use of plant extracts and biological agents in pest management.

10.1.2 Animal production

The practices/technologies developed in the animal production sub-sector are essentially oriented towards improving animal husbandry systems, reproduction techniques and animal feed by adding value to the by-products of plant production while preserving the environment. These practices include the introduction of improved breeds, crossing with local breeds for good disease resistance, the constitution of food reserves for the dry season (hay, silage, etc.), the cultivation of locally adapted fodder varieties and seasonal livestock mobility (Table 10.1).

10.1.3 Fisheries

Fisheries production practices/technologies aim to improve the performance and profitability of farming systems through proper management of fish species, environmental hygiene, and water quality management. Examples of this group of practices include the use of floating cages and fish ponds, pond fertilization, the use of short-cycle fish strains (e.g. tilapia), fish rearing in ponds, the use of above-ground tanks, and so on. (Table 10.1).

10.1.4 Forestry

The main objective of forestry practices is the conservation of forest ecosystems as carbon sinks (sequestration). It encompasses all rational natural resource management practices, such as agro-forestry, afforestation, reforestation and assisted natural regeneration.

10.1.5 Development of value chains and energy

The promotion of value chains involves bringing together stakeholders from various segments of the value chain (producers, processors, transport, regulator, etc.) to make coordinated decisions. The practices/technologies developed target storage, product conservation, local processing of agricultural products and the rational use of natural resources (FAO, 2017) (Table 10.1). The practices/technologies for adaptation to CC in the value chains and energy sub-sectors are geared towards: (i) the development of solar energy in agricultural production (power supply for solar pumps for irrigation), animal production (lighting of henhouses with solar panels), value chains (solar dryer).

Table 10-1: Inventory of potential CSA practices by sub-sector in each country

Sector	Country	Benin	Togo	Niger	Burkina-Faso	Ghana
Crop production		FAO, ICRISAT, CIAT (2018); FAO (2017); Djenontin et al. (2012); Adebiyi et al. (2019) Hinvi et al. (2012) Kpadonou et al. (2019); Amidou et al. (2003); Djenontin et al. (2011) Moutouama et al. (2022) INuWam project (2011-2014) ProSOL Benin (2018); (PROFI, 2017; 2018); Djohy and Edja, (2018).	Gorobani et al. (2017) Sanu et al. (2018) GRAPH (2012) Livestock and Family Solidarity in Togo and Livestock Without Borders (2017); Abalo-Esso et al. (2021)	FAO, ICRISAT, CIAT (2020); Sow (2018); Matthew et al. (2014) ; Dutordoir (2006)	Chia and Dugue (2008) Dakuo et al. (2011) Zougmore et al. (2004), Pale et al. (2021) Kabore et al. (2011); Boufaroua, M. (2002); Gomgnimbou et al. (2020)	Owuso Essegbey et al. (2016); Daadi et al. (2021); Avane et al. (2022) Daadi and Latacz-Lohmann (2022) Botchway et al. (2016); Upboff (2008); Balana et al. (2017)
	Soil management	Use of manure to improve agricultural production	Use of mineral and organic manure Composting (compost enriched with Mycotri)	Soil fertility management (microdose of mineral fertilizers, integrated soil fertility management and composting)	Application of manure, compost	Organic amendment (composting), manure, Chemical fertilizers

Country / Sector		Benin	Togo	Niger	Burkina-Faso	Ghana
		Mulching in crop production (use of crop residues, straw, or polyethylene film)	Use of water and soil conservation techniques	Conservation agriculture practices (mulching, intercropping, crop rotation)	Mulching, Flat andW compartmentalized plowing Scarification Crop associations, Alley cropping	Mulching, intercropping, cover crops (Mucuna)
		Water and soil conservation practices (stone bunds, compartmentalized plowing)	Water and soil conservation practices (stone bunds, compartmentalized plowing	Water and soil conservation practices (stone bunds, spreading dykes and weirs, *Zaï*, agricultural and agro-pastoral benches and the fixing of sand dunes	Water and soil conservation practices (stone bunds, filtering dams, grass strips, *Zaï*, half-moons, dune fixation	Promotion of water and soil conservation practices
	Management of planting materials	Use of improved varieties (early maturing varieties, resistant to drought, diseases)	Use of improved crop varieties (early maturing varieties, resistant to drought, diseases)	Use of improved crop varieties (early maturing varieties, varieties, resistant to drought, diseases)	Use of improved crop varieties (early maturing varieties, varieties, resistant to drought, diseases)	Use of improved crop varieties (early maturing, resistant to drought, diseases)

Sector	Country	Benin	Togo	Niger	Burkina-Faso	Ghana
	Water Management	System of Rice Intensification (SRI)	System of Rice Intensification (SRI)	System of Rice Intensification (SRI)	System of Rice Intensification (SRI)	System of Rice Intensification (SRI)
	Pest management	Practice of localized irrigation (drip or micro diffuser)	Practice of localized irrigation (drip or micro diffuser)	Practice of localized irrigation (drip or micro diffuser)	Practice of localized irrigation (drip or micro diffuser)	Practice of localized irrigation (drip or microdiffuser)
		Use of botanical extracts and biological agents in pest management	Use of organic insecticides made from cayenne peppers and neem seeds	Use of botanical extracts and biological agents in pest management	Use of botanical extracts and biological agents in pest management	Use of botanical extracts and biological agents in pest management

Sector	Country	Benin	Togo	Niger	Burkina-Faso	Ghana
Animal production	**Breed management**	FAO (2017); Youssao et al. (2009); Gbangboche et al. (2002); Djohy and Edja, (2018).	Livestock and Family Solidarity in Togo and Livestock Without Borders (2017); ITTO and Government of Togo (2014)	Lawal et al. (2018) Planchenault et al. (1986); Abdou et al. (2020); Savadogo et al. (1999); Karimata (2001).	Roessler (2019)	Botchway et al. (2016)
		Introduction of improved breeds	Introduction of improved breeds	Promotion of forage crops and crop residues	Introduction of improved breeds	
	Feed management	Constitution of food reserves for the dry season (hay, silage, etc.)	Constitution of food reserves for the dry season (hay, silage, etc.)	Preservation of quality green fodder	Mowing and conservation of fodder	
		Cultivation of locally adapted forage varieties and the practice of seasonal livestock mobility.	Promotion of forage crops	Promotion of forage crops	Promotion of forage crops	Promotion of forage crops: excessive seeding of communal grazing areas

Sector	Country	Benin	Togo	Niger	Burkina-Faso	Ghana
Fish production	**Species management**	FAO (2017) PROVAC (2014); Rurangwa et al. (2014) ; Imorou Toko et al. (2012)	Fiagan (2018)	Parrell et al. (1986); FAO (2007)	Kabre (2000); Coulibaly et al. (2010) Kabre et al. (2014)	FAO (2022); APDRA (Association of Pisciculture and Rural Development in Humid Tropical Africa) (2015); Kassam, L. (2014)
		Introduction of short cycle and fast-growing fish species (tilapia)	Introduction of short cycle and fast-growing fish species (tilapia)	Introduction of short cycle and fast-growing fish species (tilapia)	Introduction of short cycle and fast-growing fish species (tilapia)	Use of native, short cycle and fast-growing species
	Breeding habitat	Breeding fish in ponds, and in above ground tanks	Use of above ground tanks	Use of above-ground tanks (raceways), Use of cages, enclosures		Introduction of salinity or shock tolerant fish species and the use of quality fingerlings and broodstock
		Use of floating cages and fish ponds and fertilization of fish ponds				Use of floating cages

Sector	Country	Benin	Togo	Niger	Burkina-Faso	Ghana
Value chains and energy	**Food processing**	FAO (2017); Yo et al. (2020); Lokonon (2020) Medjigbodo (2004)	Segbefia et al. (2018) https://vert-togo.com/tcha-tcha-les-nouveaux-foyers-ameliores-economes/	UN Women Niger (2021)	BIO (2013) Women Environmental Program & Climate Development Network (2013); AgriLogic (2019).	Energy Commission and Global Alliance for Clean Cookstoves; Climate Impact Partners (2022).
		Processing and promotion of new agri-food products (fruit juice, vinegar, fermented baobab nuts, pineapple alcohol, etc.);	Processing of tomato into tomato puree, Processing of tropical fruits (production of mango nectar)	Agri-food processing (moringa seed capsules, moringa leaf capsules, flour, dried onion, powdered onion, onion salt)	Agri-food processing (Dried mango pulp, Mango jam, puree and concentrate, Mango juice, Frozen mango, mango syrup)	Food processing
	Renewable energies	Use of solar pumps for pumping water in agriculture	Use of solar pumps for pumping water in agriculture	Use of solar pumps for pumping water in agriculture	Use of solar pumps for pumping water in agriculture	Use of solar pumps for pumping water in agriculture
		Use of improved stoves (Wanrou stoves, traditional improved stoves, stoves developed by INRAB)	Use of improved stoves	Use of improved stoves	Use of improved stoves	Use of improved stoves (Gyapa, Toyola stoves)

Sector	Country	Benin	Togo	Niger	Burkina-Faso	Ghana
Forestry		FAO (2017)	Atakpama et al. (2018) ITTO and Government of Togo (2014)	Porporato et al. (2009) Giumbo et al. (2016) Situ et al. (2020)	CTA (1994) APAF-Burkina Faso (2014) Bengali MM (2018) SEMAFAO Foundation (Beekeeping) Kabore et al. (2021); Kabore et al. (2022), Kanazoe et al. (2021) Alexander (2002); Numbered (2003); West Africa Competitiveness Support Program (PACAO) Arnaud Aebi A. (2014)	Botchway et al. (2016)
	Restoration of forest cover	Plantations/reforestation (state, communal or large-scale)	Plantations/reforestation Restoration of classified/ community forests	Farmer assisted natural regeneration	Reforestation, afforestation Assisted natural regeneration (ANR)	Development of community forests

Country / Sector		Benin	Togo	Niger	Burkina-Faso	Ghana
	Promotion of biodiversity	Alley cropping/ agroforestry (annual crops between rows of trees)	Alley cropping/ agroforestry	Promotion of agroforestry (community nurseries), alley cropping	Agroforestry	Agroforestry
		Promotion of beekeeping for the improvement of plant pollination	Promotion of beekeeping for the improvement of plant pollination	Promotion of beekeeping for the improvement of plant pollination	Promotion of beekeeping for the improvement of plant pollination	Promotion of beekeeping for the improvement of plant pollination
		Domestication and planting of locally adapted fruit species				

Table 10-2: Description of some potential CSA practices

Sector	Practice	Country	Description	Illustration
Crop production	Use of manure, compost for the improvement of agricultural production	Benin, Togo, Niger, Burkina Faso, Ghana	Manure production in parks Mobilization and application as basal dressing during soil preparation	
	Crop mulching (use of crop residues, straw, or polyethylene film to mulch the soil)	Benin, Togo, Niger, Burkina Faso, Ghana	Covering the soil with materials forming a screen or cover to limit the germination of weeds or slow down their development and/or to disrupt the biological cycles of pests (http://ephytia.inra.fr/fr/C/23201/Tropileg-Mulching) Materials used for mulching: crop residues, Straw Polyethylene film	 Mulched tomato field Source: https://www.calendrier-lunaire.fr/non-classifiee/le-paillage/
	Use of improved varieties (early maturing varieties, tolerant to drought, resistant to diseases)	Benin, Togo, Niger, Burkina Faso, Ghana	Grow seeds of improved varieties developed by agricultural research centers. These are early maturing varieties, tolerant to drought and resistant to diseases.	-

Sector	Practice	Country	Description	Illustration
	Use of botanical extracts and biological agents in pest management	Benin, Togo, Niger, Burkina Faso, Ghana	Production of organic products from plant extracts (garlic, chilli, neem leaves and seeds, etc.) to manage crop pests	 Aqueous extract of plants for phytosanitary treatment Source: Agropolis International (2022)
	System of Rice Intensification (SRI)	Benin, Togo, Niger, Burkina Faso, Ghana	Alternating periods of flooding and drying of the rice fields Rational use of water and seeds.	 Rice growing under IRS in Grand-Popo (South Benin) Photo: Sounon Bio Zimé

Sector	Practice	Country	Description	Illustration
	Practice of localized irrigation (drip or microdiffuser)	Benin, Togo, Niger, Burkina Faso, Ghana	Supply of water directly to the plant root zone to meet its needs.	 Localized irrigation on tomatoes in Parakou (Photo, Akponikpè PBI)
Animal production	Introduction of improved breeds	Benin, Togo, Niger, Burkina Faso, Ghana	Introduction of exotic breeds of animals (Landrace and Large White for pigs, Girrolando cattle, azawak, Gir) in Benin for their production performance.	 Zebu Azawak (CORAF/WECARD, 2013)

Sector	Practice	Country	Description	Illustration
	Crossbreeding with local breeds for good disease resistance	Benin, Togo, Niger, Burkina Faso, Ghana	Crossbreeding of imported and local cattle breeds to improve dairy/meat productivity and disease resistance	 Cattle crossed Montbéliard x Zébu Peul (CORAF/ WECARD, 2013)
	Feed storage for the dry season (hay, silage, etc.)	Benin, Togo, Niger, Burkina Faso, Ghana	Storage of crop stalks after harvest or storage of fodder in sheds or on the roofs of houses. Stored crop residues: sorghum straw, cowpea haulms and peanuts These stored crop haulms are used to feed the animals during the dry season.	 Conservation of millet stalks for livestock feedSource: Karimata (2001).

Sector	Practice	Country	Description	Illustration
	Cultivation of locally adapted forage varieties and the practice of seasonal livestock mobility.	Benin, Togo, Niger, Burkina Faso, Ghana	Use of varieties and ecotypes of forage crops that are particularly resistant to water stress. For example, the ecotype of Panicum maximum or maize	-
Fish production	Introduction of short cycle and fast-growing fish strains (tilapia)	Benin, Togo, Niger, Burkina Faso, Ghana	Production of short cycle and fast-growing fish strains. These include Tilapia strains: Oreochromis niloticus INRAB strain (Benin), Akosombo strain (Ghana), Naturally male Tilapia from the Netherlands	 Oreochromis niloticusAmoussou et al. (2016)

Sector	Practice	Country	Description	Illustration
	Breeding fish in ponds	Benin, Togo, Niger, Burkina Faso, Ghana	Aquaculture species are raised in tanks which are cement concrete infrastructures of circular or preferably rectangular shapes. This technique is similar to that of Above Ground Tanks, but it allows both the breeding of the African catfish Clarias gariepinus and tilapia Oreochromis niloticus.	 Fish farming in ponds (UAC) Source: FAO (2017)
	Use of above ground bins	Benin, Togo, Niger, Burkina Faso, Ghana	Raising fish in controlled systems where the water used is not in contact with the ground. The tanks can be of different shapes (cylindrical or rectangular and made of different materials: plastic (Storex, Betra type tanks, etc.) or tarpaulin reinforced with boxes or fiberglass also called Tanks. The African catfish Clarias gariepinus is the most reared species because of its hardiness.	 Plastic above ground container Source: FAO (2017)

Sector	Practice	Country	Description	Illustration
	Use of floating cages and fish ponds and fertilization of fish ponds	Benin, Togo, Ghana	Fish farming (Clarias gariepinus and Oreochromis niloticus) is done in a fish pocket supported by a floating structure that is installed in open water, called a floating cage. It can be made with planks, galvanized pipes, synthetic net tank, nails, tarpaulin, flat iron bar, screws, PVC pipes, wire or with recycled cans). A fish enclosure is a piece of water delimited by stakes, made of wood or any other material, surrounded by a small-mesh net.	 Floating cages Source: PANA 1 (2013)
	Promotion of beekeeping for the improvement of plant pollination	Benin, Togo, Niger, Burkina Faso, Ghana	Integrating beekeeping into agricultural production to improve plant pollination	 Beehives Fortier et al. (2020)

Sector	Practice	Country	Description	Illustration
	Alley cropping/ agroforestry (annual crops between rows of trees), Assisted Natural Regeneration (ANR)	Benin, Togo, Niger, Burkina Faso, Ghana	"Alley farming" or "alley cropping" consists in exploiting seasonal food crops (preferably legumes for their ability to fix atmospheric nitrogen) in corridors at regular intervals of hedgerows. In the case of agroforestry, food crops (including vegetable crops) are grown between hedgerows of regularly pruned fertilizer trees. The trees are more or less one meter apart in the hedge, the corridors having a width of more or less eight meters and oriented East-West.	 Samanea Saman (Albizia Saman or Rain Tree), Burkina Faso Source: APAF (2014)
	Plantations/ reforestation (state, communal or large-scale)	Benin, Togo, Niger, Burkina Faso, Ghana	Planting and maintenance of trees. It is most practiced on estates (private and public), in cultivated systems and in natural forests, including mangroves. The most used species are Gmelina arborea, Tectona grandis, Afzelia africana.	 Teak plantation Source: FAO (2017)

Sector	Practice	Country	Description	Illustration
	Domestication and planting of local fruit species adapted to the climate	Benin	Promotion of local species that are more hardy and more resistant to climatic variability, and adapted to local pedoclimatic conditions. They are planted both for wood and for fruit.	-
	Water and soil conservation	Benin, Togo, Niger, Burkina Faso, Ghana	Methods of erosion control, rainwater harvesting and its conservation in the ground. We can distinguish: stone bund, gabions, half-moons, Zaï, etc.	 Stone bund in North-West Benin Source: FAO (2017)

Sector	Practice	Country	Description	Illustration
Development of value chains	Processing and promotion of new agri-food products (fruit juice, vinegar, fermented baobab nut, pineapple alcohol	Benin, Togo, Niger, Burkina Faso,	This technology refers to the processing of various products into juice (fruit juice, ginger, turmeric juice, etc.), vinegar, fermented baobab nut, pineapple alcohol, mango nectar, the processing of tomato into puree. Most of the processes used are manual. However, some operations such as pressing, crushing, milling are carried out using equipment and machines in semi-industrial units.	 Baobab juice Source: https://bj.coinafrique.com/annonce/alimentation/jus-de-baobab-menthele-au-lait-3460415
Energy	Use of improved stoves (Wanrou stoves, traditional improved stoves, stoves developed by INRAB)	Benin, Togo, Niger, Burkina Faso, Ghana	An improved cookstove is a stove built to use the same local materials as the traditional cookstove but with the aim of reducing smoke emissions, the common diseases and illnesses caused by smokes, and deforestation.	 Improved traditional stoves Source: https://www.agriculture-afrique.com/manuel-de-construction-des-foyers-ameliores-en-banco-pour-les-menages/

Sector	Practice	Country	Description	Illustration
	Development of steam cookers for local dishes (e.g. Ablo) and solar dryers			 Stone Steamer for Ablo Source: FAO (2017)

Table 10-3: Level of contribution of practices to CSA pillars

Table 10.3 presents the level of smartness of the potential CSA practices identified

Pillars / Sector		Practice	Productivity	Adaptation	Mitigation
Crop production	Soil management	Use of manure, compost for the improvement of agricultural production	🟢	🟡	🟡
		Mulching (use of crop residues, straw, or polyethylene film)	🟢	🟢	🟡
		Water and soil conservation practices (stone bunds, compartmentalized plowing)	🟢	🟢	🟢
	Management of planting material	Use of improved varieties (early maturing varieties, resistant to drought, diseases)	🟢	🟢	🟢
	Water Management	System of Rice Intensification (SRI)	🟢	🟢	🟢
		Practice of localized irrigation (drip or micro diffuser)	🟢	🟢	🟢
	Pest management	Use of botanical extracts and biological agents in pest management	🟢	🟢	⚪
Animal production	Species management	Introduction of improved breeds	🟢	🟢	🟠
	Food management	Constitution of food reserves for the dry season (hay, silage, etc.)	🟢	🟢	🟠
		Cultivation of resistant forage varieties and the practice of seasonal livestock mobility.	🟢	🟢	🟠

Legend:

🟢	Good contribution to CSA pillar	🟡	Average contribution to CSA pillar
🟠	Low contribution to CSA pillar	⚪	Has no effect on CSA Pillar

Pillars / Sector		Practice	Productivity	Adaptation	Mitigation
Fish production	Species management	Introduction of short cycle fish strains (tilapia)	Green	Yellow	Grey
	Breeding habitat	Breeding fish in ponds, above ground tanks	Green	Yellow	Grey
		Use of floating cages and fish ponds and fertilization of fish ponds	Green	Yellow	Orange
Development of value chains and renewable energies	Food processing	Processing and promotion of new agri-food products (fruit juice, vinegar, fermented baobab almonds, pineapple alcohol, etc.);	Yellow	Yellow	Grey
	Renewable energies	Use of solar pumps for pumping water in agriculture	Green	Yellow	Green
		Use of improved stoves (Wanrou stoves, traditional improved stoves, stoves developed by INRAB)	Green	Yellow	Green
Forest	Restoration of forest cover	Plantations/reforestation (state, communal or large-scale)	Green	Yellow	Green
	Promotion of biodiversity	Alley cropping/agroforestry (annual crops between rows of trees)	Green	Yellow	Green
		Promotion of beekeeping for the improvement of plant pollination	Green	Yellow	Green
		Domestication and planting of local fruit species adapted to the climate	Green	Yellow	Green

Legend:

Green	Good contribution to CSA pillar	Yellow	Average contribution to CSA pillar
Orange	Low contribution to CSA pillar	Grey	Has no effect on CSA Pillar

10.1.6. Experiences and skills sharing

The application of SRI technology in the 13 WAAPP countries led to 56% yield improvement of for the irrigated system and 86% for the lowland rainfed system compared to conventional practice (PPAAO, 2016). Its implementation in southern Benin has resulted in a 29% rice yield improvement compared to the conventional and traditional rice growing system. This has increased the income of producers (PROFI, 2017; 2018).

Gyapa stoves efficiently reduce the amount of charcoal and fuel needed to prepare daily meals. A stove saves more than 12 kg of wood per day and 44 trees per year, which reduces greenhouse gas emissions (Energy Commission and Global Alliance for Clean Cookstoves). Reducing the amount of wood used for cooking has saved families up to $100 a year, while protecting Ghana's forest cover, which has shrunk by 19% since 2000 according to Global Forest Watch (Climate Impact Partners, 2022). A reduction in CO_2 emissions of more than 400,000 tons per year has been observed thanks to the activities of the Man and Man Enterprise in Kumasi, Ghana (Aera-group, 2021).

Incorporating grain legume haulms into the soil can improve or even double maize or rice yields in Burkina Faso (FAO, 2010). In addition, the adoption of *Zaï* by producers in the province of Yatenga, Burkina Faso has improved yields from 300 kg/ha to 1,500 kg/ha depending on the rainfall regime (FAO, 2010).

Instructions: List and then share with the other participants the CSA practices implemented in your country that were not discussed during this training.

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Session IV:
Integration of the CSA concept in projects and programs

Objectives: To explain the general methods and techniques for the design and managemen projects/programs as well as the integration of CSA into projects/programs to facilitate re mobilization.

Expected results: At the end of this session, your skills in the design and management of p programs will be strengthened. You will be able to design and pilot climate-smart agricultu programs. You will acquire skills to pitch and defend your project/program to mobilize reso

Animation methods and tools

- Theoretical course
- Practical individual and group assignment
- Questions and answers

Training materials (intermediate and final)

- Training manual (course notes)
- PowerPoint presentations/supports
- Guidelines on the assignments
- Other sources for additional information

Duration: 4 hours (see details in the syllabus

Content

11. Module 1 : Basic concepts, general principles, and methods for designing projects/programs

11.1. Basic concepts

A **project** is a set of well-planned and coherent actions or activities to achieve specific objectives within a defined timeframe, and based on allocated resources. A project evokes **(i) the future** because it is always future-oriented, **(ii) a need/desire**, because it seeks to satisfy some need or solve a specific problem and **(iii) an action**, because it allows for operating based on defined mechanisms. In brief, a project aims to satisfy one or more needs through precise and coherent actions.

A **program** is a set of projects or sub-projects connected to each other to achieve a specific goal. The main objective of a program is to synergistically coordinate resources for the same purpose. As such, a program differs from a project whose main objective is the achievement of a specific result while a program can provide continuous results from the implementation of different interconnected and integrated activities of its projects.

The **main characteristics of a project** are:

- **The central idea is decoupled into actions:** the succession of planned tasks/actions revolves around a general idea which is somehow the aim/objective of the project;
- **Time**: a project must necessarily take place over a specific period time. A project is born, grows and ends;
- **The Cost:** it is the objective financial resources to be allocated to the implementation of the project;
- **Quality:** this is the project's acceptability threshold. It defines the level of combination of material and human resources to be assigned to the implementation of the project. These different elements vary from one project to another and are called the extrinsic characteristics of the project.

11.2. Project life cycle

The life cycle of a project is the process of implementing and managing the project. It starts from the identification of the project idea to the closing of the project.

In general, the life cycle of a project comprises **four major phases** but these phases can be more or detailed depending on the institutions or funding mechanisms. (**Figure 11.1)**:

(i) **The initiation or design of the project:** it starts from the initial idea of the project, to the definition of the objectives, the specifications, the tasks, and the responsibilities. The initial idea is always rooted in an identified need or an opportunity from which the project is designed.

(iii) **Planning:** it is the coherent planning of the activities and tasks of the project including development of schedules, budgets, identification and mobilization of resources, risk analysis, recruitment, and assignment of project staff.

(iv) **Execution:** this is the implementation of the project, with the establishment of progress reports, change management, forecasting, and quality control. This phase includes the **monitoring-evaluation phase** which can also be considered as a phase on its own.

(v) **Closure:** this is the transfer of the achievements of the project to a permanent organization. During this phase, users are trained, documents are finalized and transferred, resources and people are released (they return to their mission in the permanent organization). Following the project's closure, there is a post-implementation review, otherwise known as an evaluation period. It takes place sometime later after the closure to assess the achieved outputs against the set outputs at the start of the project.

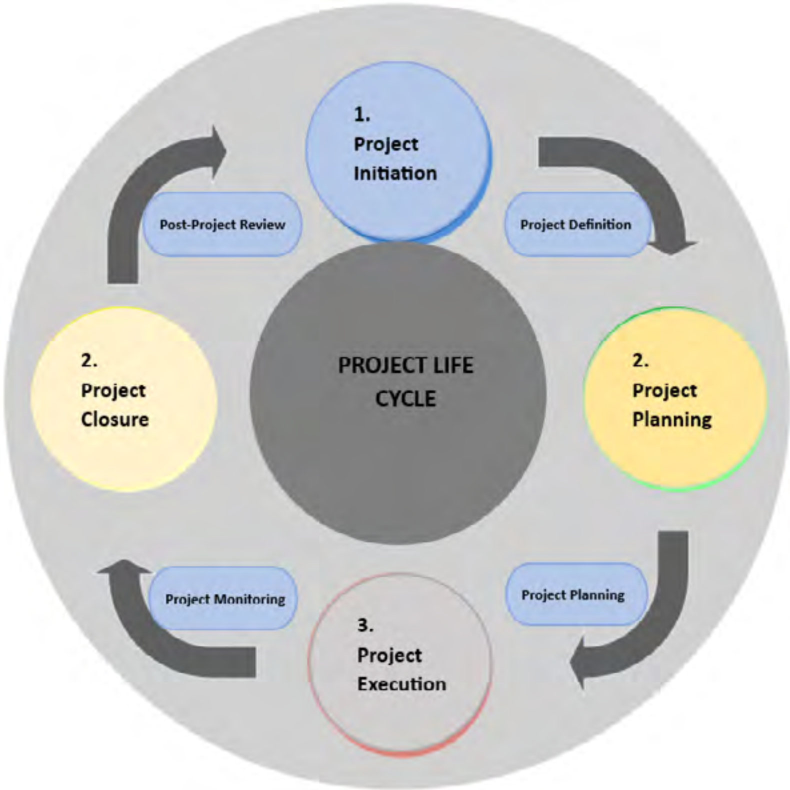

Figure 11-1: Project life cycle

11.3. Processes, principles, and general techniques for formulating and managing projects

The process of developing and managing a project has **5 main stages** (**Figure 11.2**): (i) project design, (ii) preparation/planning, (iii) implementation, (iv) monitoring-evaluation and (v) project closure. Here the monitoring-evaluation phase is detached from the implementation phase (previous section).

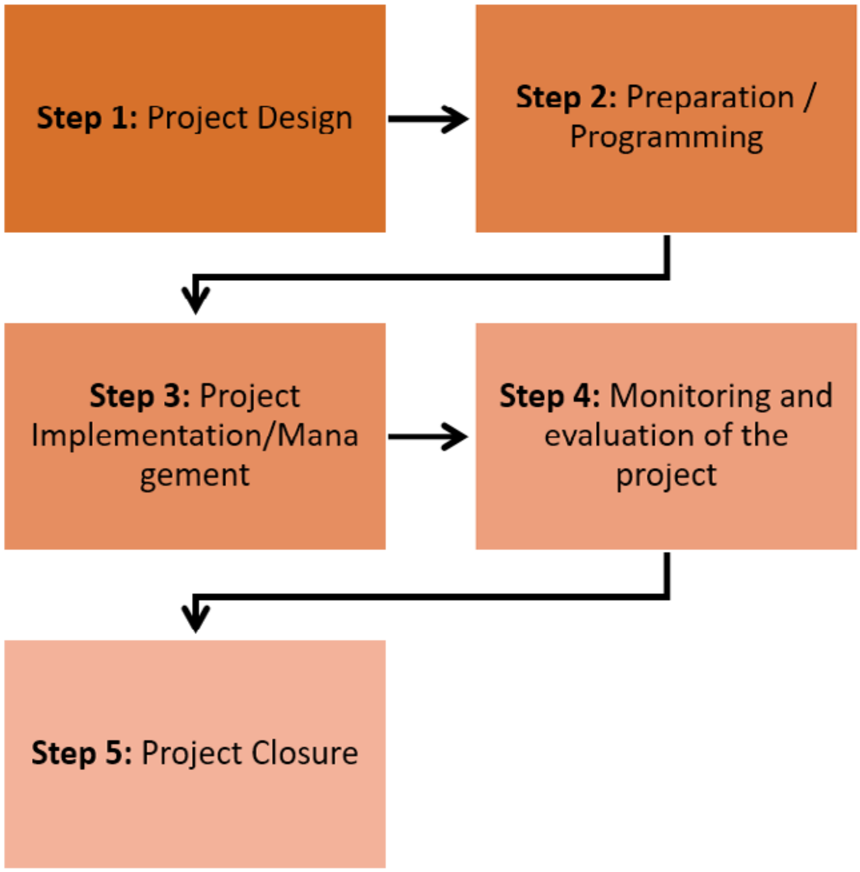

Figure 11-2: Project development and management stages

11.3.1. Project conceptualization

This step starts from the diagnosis of the current situation, the identification and analysis of the problem/need and the potential solutions. The detailed process for this step, from the identification of the project idea to project formulation, is presented in **Figure 11.4**.

At this stage, one must:

(i) identify the problems/needs;
(ii) determine/identify the main problem (the "starter" problem, the "node" of the problem);
(iii) identify the causes and consequences of the main problem; and
(iv) create a problem tree (Figure 11.3).

The problem tree is an important tool for classifying the causes and consequences of the identified problem(s). In the specific case of climate change, the problem tree tool is substituted by vulnerability assessment.

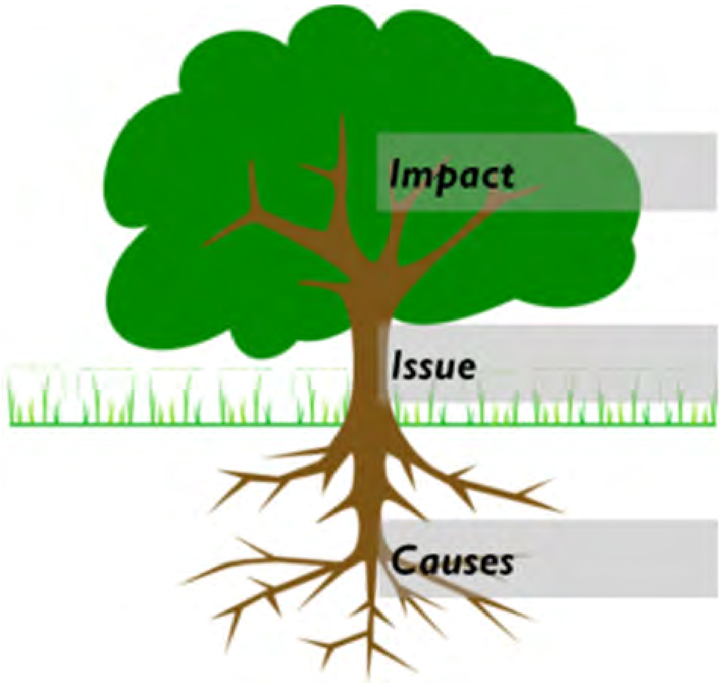

Figure 11-3: Problem tree
Source: Civil society space: Practical guide to drafting a project document (access document here)

Thereafter, it is critical to identify possible solutions. For this purpose, it is necessary to act on the causes to generate positive effects and therefore to build a coherent intervention logic. Thus, we move **from the problem tree to the solution tree**. The proposed solutions should be innovative, relevant, and sustainable.

11.3.2. Preparation/planning

This step involves moving from **the solution tree to the logical framework**. The logical framework is a Matrix that summarizes in a logical way the general plan of a project by presenting the key elements included in the different levels of the project planning. This tool required by most donors was developed in the 1970s and is used by most international organizations (GCF, World Bank, USAID, AfDB, etc.) (Rosenberg & Posner, 1979).

The logical framework aims at identifying and logically formulate the key elements of a project following the identification of problems and needs. It clearly and concisely presents the general plan of the project in a single framework and unravel the key factors which condition the success of the project. Finally, it provides a basis for monitoring and evaluating the project.

The logical framework is formulated in the form of a **synoptic table presenting the overall objective, expected results and activities, assumptions, objectively verifiable indicators, and sources of verification**. The logical framework is a monitoring and evaluation tool aimed at clearly establishing the logic of the proposed project as well as the elements that contribute to its achievement. It allows you to structure and formulate ideas in a standardized format, linking the different elements of the project in a logical way. Thus, if the activities are properly carried out and the assumptions are met, then the results will be achieved. If the results are achieved and the assumptions are met then the objective will be reached, and so on. The logical framework defines the project in terms of overall goal, specific objectives-expected results-activities and quantity-quality-schedule.

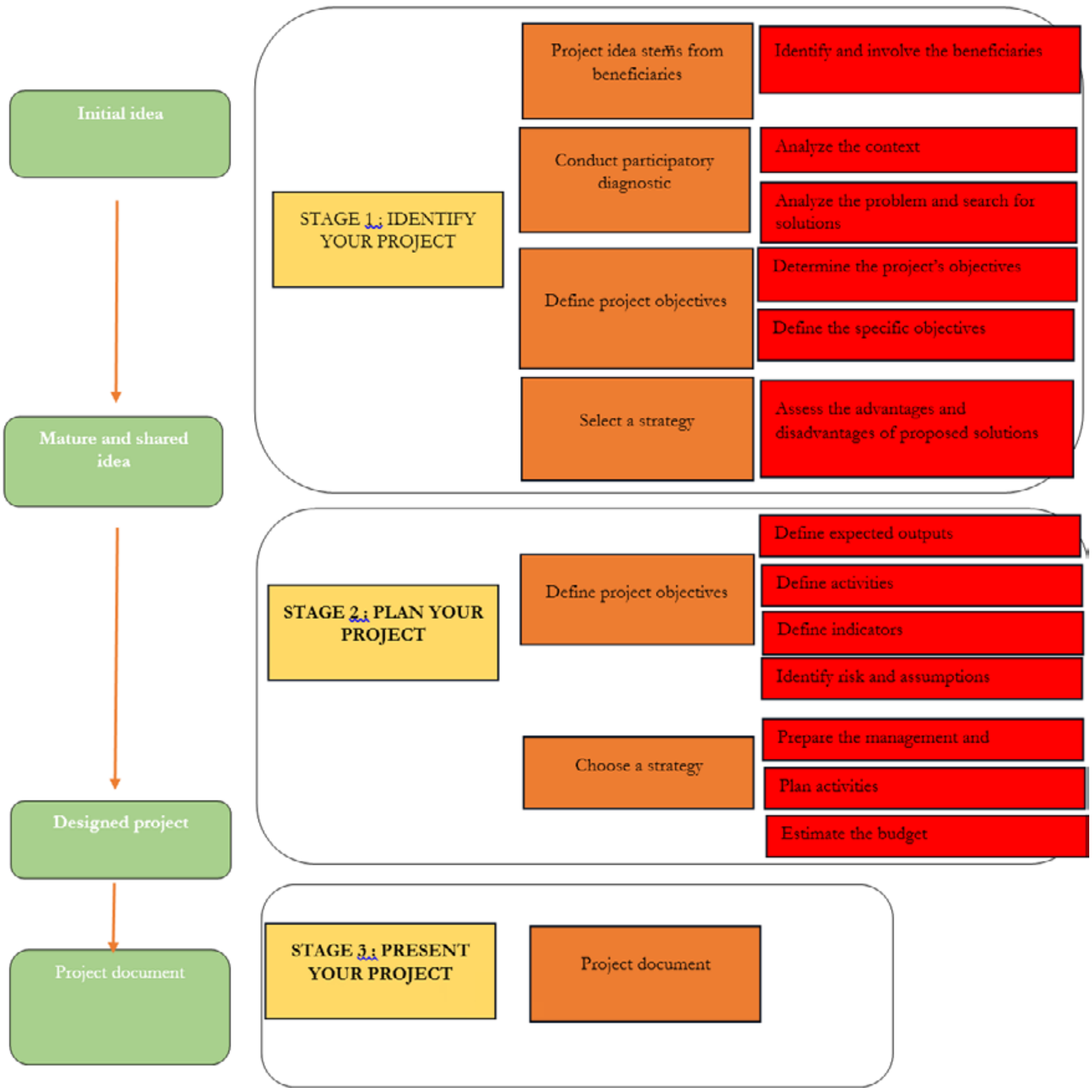

Figure 11-4: Project development process: from project idea to project formulation

Source: ESC, Practical guide for the elaboration of a project document

The logical framework is presented in the form **of a 4 x 4 matrix** (**Table 11.1**) depicting several hierarchical levels: 1) goal, 2) specific objectives, 3) expected results, 4) **activities.** For each level, the horizontal elements allowing access from one level to another are: 1) the descriptive summary of the project and the intervention logic, 2) the indicators allowing the success of the project to be measured, 3) the sources of verification of the indicators, 4) the important assumptions to the success of the project

Table 11-1: Template of the Logical Framework

Project description	Objectively Verifiable Indicators (OVI)	Verification sources	Hypotheses/Assumptions
Overall objective			
Specific objectives			
Results			
Activities			
			Preconditions

The preparation and planning phase also includes the definition of the required technical composition of the project management team, the project/program budget, and we make an estimate of the schedule for the preparation of the project/program with the deadlines for execution of each activity; this is the establishment of an operational or project management plan. This process allows to go from the concept note to the project/program proposal. During this phase, the preparatory studies are carried out (technical feasibility, market study, etc.).

At the end of this phase, we have the project documents. Project documents can be either a concept note, a pre-project document (summary or detailed) or the final project document. The classic structure of a project document (whatever the type) varies according to the type of project, the objectives/orientations, and the region (Francophone/Anglo-Saxon). The Anglo-Saxons canvas for a concept note is structured around 11 elements, namely: the Title, the Summary, the Problem/justification, the Objectives, the Assumptions, the Methodology, the Expected results (Scientific), the Products results obtained at the end of the Project, the Beneficiaries/target groups, the Budget, and the Bibliographical references. This structuring includes fundamental elements that can be found in most frameworks proposed by different research or project/program funding institutions. For example, the European Union proposes the following canvas: the Title of the action, the Themes of the call for tenders, the Locations, the Total duration of the action (months), the Amount required from the EU, Objectives, Target Groups, Final Beneficiaries, Estimated Results and Main Activities.

11.3.3. Project implementation/execution

The project execution consists in the implementation of the planned activities within the framework of the project. This stage is often connected with the monitoring-evaluation stage because each activity carried out or action taken will require supervision, monitoring and evaluation.

11.3.4. Monitoring and evaluation of projects/programs

11.3.4.1. Supervision

This sub-step consists of verifying the proper execution of project activities, identifying difficulties, and readjusting necessary means to achieve the expected results. Monitoring takes place during the implementation stage of the project. Supervision missions attempt to review the status of project/program implementation against the annual operational plan and budget. A supervision mission is also an opportunity to discuss with experts how to improve operations and adapt the interventions. It is essential to engage the whole project/program team and to have sufficient exchanges and consultations with a wide range of implementing actors and key beneficiaries. If possible, a climate change expert should be part of project/program supervision missions.

11.3.4.2. Assessment

The evaluation generally takes place at the end of the project, but intermediate evaluations guide a reorientation of the project activities. The evaluation consists of assessing the project by examining its design, its implementation, and its results according to the initial objectives. The evaluation is a decision support tool for the design of a future project. During the evaluation, the members of the team first seek the basic information through baseline surveys and then move on to the mid-term evaluation (EMP, or Mid Term Review MTR).

(i) If sufficient **baseline information** was not collected during project/program preparation, it may be necessary to collect baseline data early in the implementation phase to support the indicators identified during project/programs preparation. These data serve as a benchmark for M&E and provide the basis for measuring progress in achieving project/program objectives, outcomes, and outputs. If precise figures are not available or if it is too expensive and/or complex to collect data, rough approximations can be used instead. During a baseline assessment, team members should review existing data to see if it meets their needs.

(ii) **The EMP assessment of a** climate change project, for example, will determine:

- whether climate change issues to be addressed by the project/program are effectively mainstreamed;
- whether the planned outputs and outcomes are consistent with the project/program climate change adaptation and/or mitigation activities;
- whether it is necessary to adjust or reorient the project/program due to a weakness in the integration of climate change in the design of the project/program; and
- the extent to which the expected results of the project/program will be achieved.

11.3.4.3. Finalization of the assessment

The final evaluation of the project/program and its completion report should be used to generate lessons learned on the integration of climate change into the project/program, on institutional capacities, and strengths and weaknesses. It is also an opportunity to assess whether the project/program has been linked to broader national processes.

12. Module 2 : Incorporating CSA into projects/programs

12.1. Basic Considerations

The integration of CSA in projects and programs must be consciously and rigorously done at all phases of the project cycle from design to completion.

Project design: Integrating the three pillars of CSA into the objectives/activities of the projects/program must be done from the design of the project. The negative effects of climate change in agriculture must be the entry point.

12.2. Preparation of CSA Projects/Programs

At this stage, for the integration of CSA in the project/program development process, it is important to:

i **Define the objectives and strategies** that will respond to the climate change problems identified during the conceptualization phase. The general problems identified during the design are deepened by a good vulnerability assessment and impact chains to highlight the climate risks that can be addressed by the CSA approach;

ii **Review the capacity of collaborating institutions** and identify actions to set up the institutional/organizational framework for mainstreaming climate change and specifically CSA;

iii **Review the processes** put in place by the project/program funder or the proposed implementing agency **for multi-stakeholder consultation and coordination** and/or cooperation during the project/program and reorient them, if necessary, towards, the objectives and characteristics of the CSA,

iv **Define activities** used to address climate change issues and challenges and bottlenecks for effective implementation of CSA options/strategies (*e.g.* who, when, how many). The integration of CSA in projects/programs must be done by considering the pillars of CSA, namely: productivity, adaptation to and mitigation of climate change. The indicators for these three pillars have been extensively developed in Session 3 of this manual. For example, productivity can be based on indicators such as yield, access to food, labor, and income. Important indicators of adaptation are related to water productivity, fertilizer productivity, productivity of other agrochemical resources, etc. Mitigation is mainly based on emissions and particularly the intensity of emissions. In the process of developing a project/program, the integration of CSA goes through three essential stages (a) the identification of potential agricultural strategies/practices in the study environment (b) the evaluation of these strategies/practices to select the potential CSA ones (c) choice/incorporation of the most suitable CSA strategies/practices in the objectives/activities of the project being developed.

v **Identify the indicators** related to CSA (and falling under the three pillars) to be integrated into the project's logical framework as well as the expected results of the project/program. These indicators will also be used in the context of monitoring and evaluation (M&E) and therefore form part of the verification indicators.

vi **Ensure that the activities are correctly aligned with** or grouped in the different components/expected results of the projects/program,

vii **Estimate the adaptation and mitigation costs** of the options to be included in the project/program budget, and highlight the added values (even the most subtle.; for example, ecosystem services such as air/environment purification) of adopting CSA strategies/practices.

viii **Assess whether there are governance risks.** Determine whether possible cross-sector linkages have been properly considered.

12.3. Implementation of CSA in projects/ programs and the search of trade-off

The transition to climate-smart agriculture requires investment. These investments aim to achieve positive results on productivity/income, resilience, and adaptation to CC, and GHG mitigation where possible. These three objectives are not always compatible, sometimes trade-offs exist and must be considered. Moreover, the benefits and costs of these objectives are both public and private. This has important implications on risk and benefits sharing resulting from the transition to CSA. Overall investments to achieve CSA results aim to maximize synergies between the three objectives and minimize trade-offs.

Achieving CSA goals requires financing models that can help farmers and other food system actors transition to production practices and business model that may result in delayed and uncertain direct or private benefits. Managing and allocating this risk, through mechanisms to transform public benefits into private benefits to support adoption, is a critical component of successful CSA financing. Thus, developing successful CSA funding strategies requires a solid understanding of the costs and benefits of adopting and sustaining practices and approaches that contribute to the three pillars of CSA.

Incorporating CSA into projects/programs requires consideration of field, landscape, national and regional scale issues, as well as institutional and policy issues. In each of these levels, the CSA strategies identified could therefore be inserted into the activities of the project/program. The previous session proposed several climate change adaptation strategies that are good field-scale CSA practices that could be used as a basis for considering CSA in projects/programs. Figure 12.1 provides guidance for the other levels.

Figure 12-1: Pillars of CSA and potential CSA climate change adaptation strategies usable in projects/programs (adapted from Hanne Knaepen et al., 2015)

	Food security (sustainable productivity improvement)	**Adaptation (building resilience)**	**Mitigation (reducing GHG emissions and enhancing GHG removal)**
Farm issues	Sustainable intensification Integrated farming Improved nutrient and water management	Conservation agriculture Adjusting cropping calendars Using different cultivars and animal species and strains Integrated pest, disease and weed management	Precision agriculture Improve soil carbon storage / Develop carbon sequestration options (conservation tillage, cover crops, crop rotation)
Landscape and regional issues	Landscape approach Restoration of degraded farmland, wetlands and forests	Ecosystem-based agriculture (to enhance ecosystem services) Agroforestry (strengthening the role of forests)	Agroecology
Institutional and political issues	Strengthening science-policy links Integrating CSA into agricultural development policy frameworks Trade-offs between diversification vs. specialization Gender, youth involvement and reducing inequalities	Improving weather information systems and advisory services Empowering women and the poor Pro-poor financing, insurance mechanisms and safety nets	Incentives for pro-poor mitigation

Thus, **a good CSA project** must meet the following criteria:

- Formulating activities/tasks with the participation of beneficiaries;
- Activities should focus on potential synergies between the CSA pillars (productivity, adaptation and mitigation), rather than focusing on finding trade-offs between them (*e.g.* mechanization creating trade-offs between productivity and mitigation);
- Activities should focus on delivering CSA interventions and measure their secondary environmental co-benefits;
- The objectives of implementing these activities are to increase resilience to climate variability and shocks, to define and measure resilience, *i.e.* to identify common factors of success in building resilience and minimizing GHG emissions;
- The project objectives must consider the characteristics of CSA at all possible levels of smartness and the monitoring and evaluation of activities must integrate indicators of productivity, adaptation, and mitigation results.

13. Module 3 : Implementation of CSA projects/programs

The implementation of CSA in projects/programs goes through **five fundamental actions** (**Figure 13.1**):

- i Increase evidence and success stories to generate enthusiasm among stakeholders
- ii Defining, supporting, and directing policies concerning CSA;
- iii Set up or strengthen local, national, and regional institutions dealing with the subject;
- iv Improve funding mechanisms on the subject;
- v Facilitate the implementation of CSA practices in the field with CSA-specific agricultural advisory technical agents who support the process.

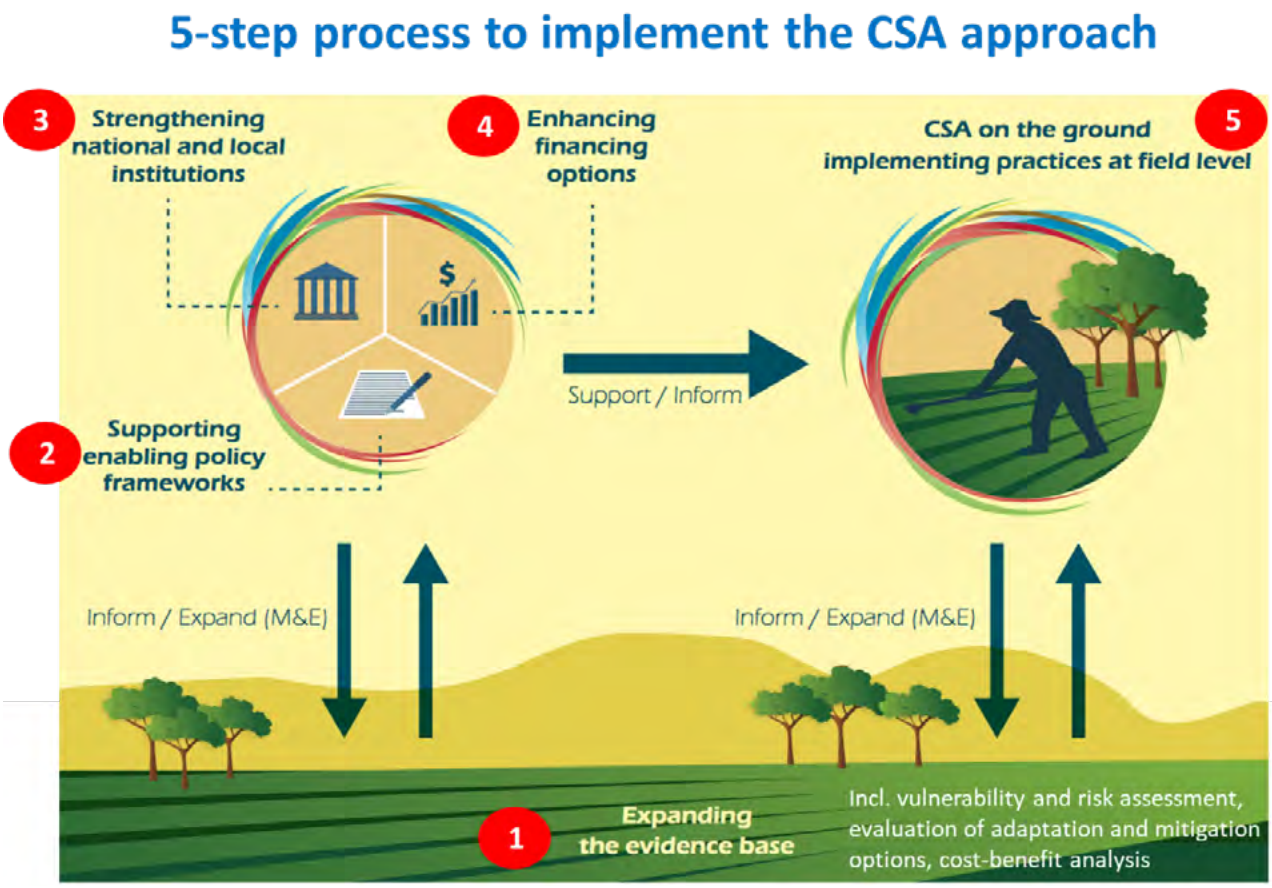

Figure 13-1: Steps for implementing CSA

Source: FAO, 2017

To achieve this, the actions are organized around four areas (**Figure 13.2**):

i Knowledge

The effective implementation of CSA practices requires technical capacities, knowledge, training, and capacity building. An essential element to support the dissemination of knowledge as well as to support the scaling up of good practices is the awareness of all stakeholders (i.e. their understanding of the climate problem, the solutions and the current practices). Usually, the question of how exactly to operationalize policy objectives in terms of program development as well as investment priorities and measures often remains unanswered. Additionally, knowledge gaps require increased research on context-specific CSA methods based on risk profiling, vulnerability, and readiness assessments. In addition, indigenous knowledge should feed directly into research results and concrete actions on the ground. In this regard, efforts are needed to build an "African CSA approach", based on mapping successful initiatives and identifying specific projects that can work in different areas in Africa with similar ecological conditions and climate impacts.

ii Stakeholders

Only a multi-stakeholder approach, involving all actors, ranging from businesses to civil society to farmers, can provide an efficient pathway for the effective implementation of CSA. Through alliances, gatherings, and conferences, these actors should be offered **CSA platforms** to communicate approaches and scale up local knowledge, innovations, and technical skills (the CGIAR calls these platforms "learning alliances"). This type of stakeholder engagement process can tangibly bring together different ministries having CSA-related portfolios and lead to cost-benefit analyses, identifying CSA investment opportunities for Small and Medium Size Enterprises (SMEs). The fight against climate change is first and foremost a community-based effort. Strengthening local capacities for adaptation, mitigation and resilience building requires enhanced multi-stakeholder cooperation. Engagement with the private sector is essential. Women and young people should also be involved.

iii Policies

Governments can create an enabling environment, by mainstreaming climate change actions and CSA into agricultural policies. These policies should be based on a mapping of lessons learned to be disseminated to other parts of the country or region. Based on a governance structure and a better coordination of institutional arrangements, programs are then designed, proposing tangible orientations for their implementation. The public sector should also provide an enabling environment for the private sector to make climate-smart investments in agriculture. Against this background, FAO (2011) has published *"Saving and Growing: A Policymaker's Guide to Sustainable Intensification of Smallholder Agricultural Production"*, which suggests that a careful assessment of (financial) incentives and laws is needed to strengthen policy coherence between climate and agricultural policies, and to better integrate the private sector into input development efforts for greening agriculture (FAO, 2011).

iv Resources

Adequate funding is essential for the successful implementation of CSA. The way forward is to link climate and agricultural finance and use innovative funding sources. At the same time, investments in climate-friendly agriculture are an opportunity for the private sector.

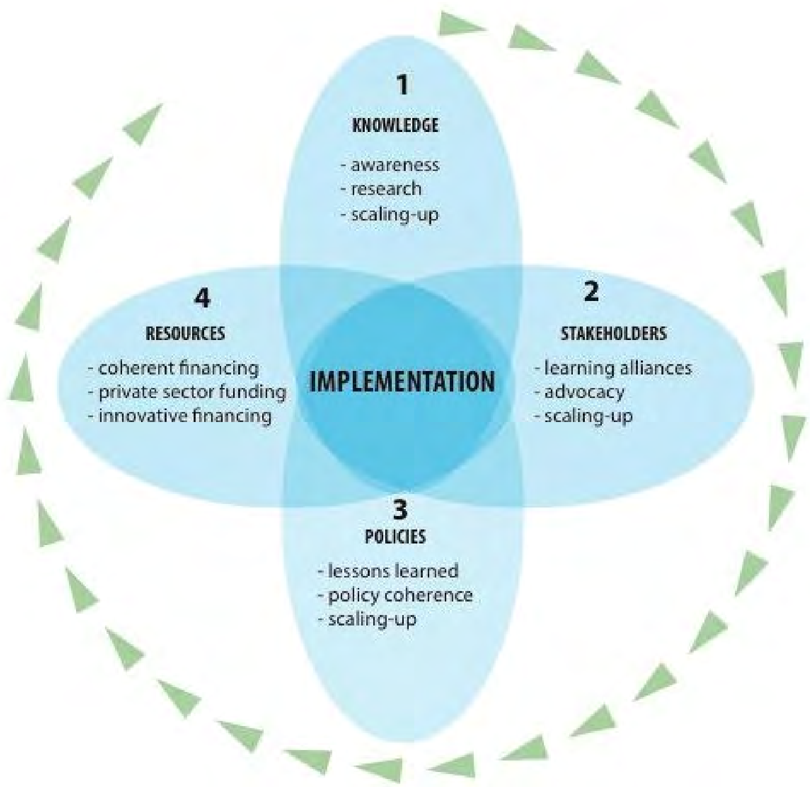

Figure 13-2: Fields of action for the successful implementation of CSA.

13.1. Practical assignment:

Integration of CSA in projects/programs:

- Logical context
- CSA indicators
- Monitoring and evaluation

Indicative bibliography

1. FAO (2011) Save and Grow: A Policymaker's Guide to Sustainable Smallholder Agricultural Production Intensification, FAO, Rome
2. GIZ, 2014, A Framework for Climate Change Vulnerability Assessments.
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Session V:
Integrated and participatory approaches in CSA: concepts, design, and implementation

Learning objectives: Become familiar with integrated, participatory approaches, with an application to the concept of Climate-Smart Village (CSV). Know the challenges of implementing CSA and the CSV approach. Know the steps and implementation of the CSV approach. Case study of some CSV implementation.

Expected results: At the end of this workshop, you will have a clear idea of the approach and the main characteristics of CSV. You will also know the challenges of CSA and the CSV approach and the steps and implementation of the CSV approach. Finally, you will master the CSV process and its implementation.

Animation methods and tools

- Theoretical course
- Refreshing discussion on solutions/efforts by sector of activity
- Practical assignment
- Questions and answers

Training materials (intermediate and final)

- Syllabus, Training Manual
- PowerPoint presentation
- Short videos, graphics and photos
- Instructions for the assignments
- Other sources for additional information

Duration: 6 hours (see details in syllabus)

Content

14. Module 1.1 : Climate-Smart Village (CSV) Concepts, Approach and Visions

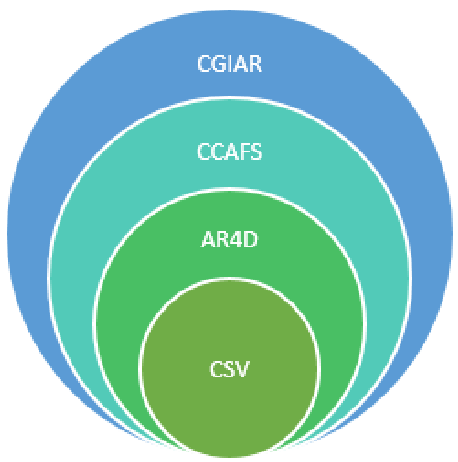
The Climate Smart Village (CSV) approach is a scaling up of the CSA concept which can take on different dimensions such as the climate-smart village or the climate-smart valley. Here, the focus is much more on the climate-smart village component which is the most implemented in West African regions.

14.1. Concept of climate-smart villages

Challenges: Despite the success of several Climate-Smart Agriculture (CSA) programs, there is still low uptake of these programs by farming communities. This is due to the lack of evidence available to development professionals on how to practically integrate innovations into farming systems.

Source: The Climate-Smart Village (CSV) approach was developed by the Consultative Group on International Agricultural Research (CGIAR) research program on Climate Change, Agriculture and Food Security (CCAFS) as an Agricultural Research for Development (AR4D) method in the context of climate change, *i.e*. a process of building resilience through CSA interventions (see box).

Options: CSVs generate evidence on the effectiveness of climate-smart options in various agro-climatic and production systems, *i.e* evidence of CSA options that work best or do not work in local context. CSV options target factors such as subsidized costs and their expected co-benefits or disadvantages (including gender and labor aspects).



Source of CSV

14.2. Conceptual approach and main characteristics of CSVs

The CSV approach is an integrative strategy for scaling up adaptation options in agriculture to reduce the negative impacts of climate change. Therefore, this offers a platform to test, evaluate and select the best options and practices to help build resilience, and reduce emissions from the agricultural sector. As a platform, CSVs help generate evidence of CSA options that work best or don't work from local scale for a range of stakeholders – policy makers, agricultural development practitioners, investors among others to take informed decisions. The CSV approach then offers an opportunity to test technological and institutional options to deal with climate change in agriculture through a participatory approach. It is based on the principles of Participatory Action Research (PAR). Research is conducted on appropriate and site/context-specific conditions to produce larger evidence of the effectiveness of CSA in a real-life setting, and to facilitate the co-development of scaling-up mechanisms to localities at sub-national and national levels.

CSVs have the following characteristics:

- sites for trials, using participatory methods, technological and institutional options;
- sites where climate change, in its broadest context, is considered in relation to local realities: long-term adaptation, prevention of maladaptation, climate risk management, low carbon development;
- a holistic vision for action on climate change not a magic bullet;
- a platform for socially inclusive multi-stakeholder collaboration;
- a principle of scaling up CSA, and
- a linkage between global and local knowledge.

Each CSV site has its own Theory of Change (TOC) linked to national priorities to ensure consistency with initiatives and actions at different scales. The approach focuses on building the capacity of local beneficiaries to make the model self-sustaining rather than relying entirely on external funding.

14.3. CSV components and vision

Several components are considered on the CSV sites:

- climate information and insurance services ;
- CSA practices and technologies ;
- local and national public and private institutions;
- climate finance and agricultural development;
- farmers' knowledge, and
- national and subnational plans and policies.

The local contextualization of the CSV depends on choice of options for the CSV site, namely the agro-ecological characteristics, and the development levels as well as the capacities of the farming community and local authorities. Thus, the CSV are:

- multi-stakeholder learning platforms;
- participatory test-sites for generating more evidence of the effectiveness of CSA; and
- cornerstones for generating important lessons for decision-makers from the local to the global level.

Broadly, CSA is considered to include appropriate practices, techniques, services, and institutional options (Figure 14.1).

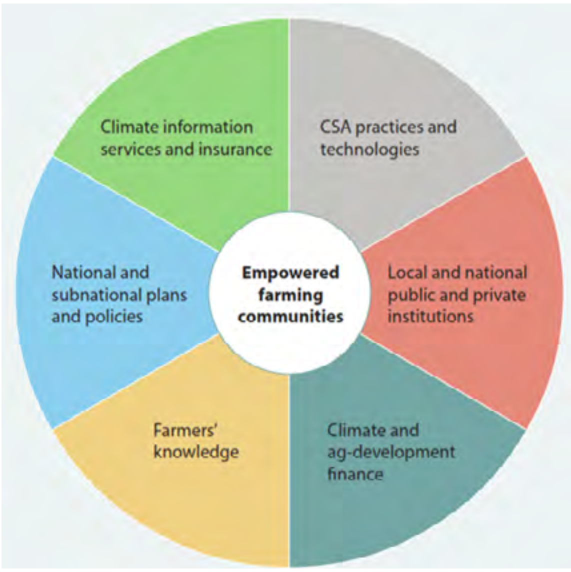


Figure 14-1: Components considered in CSV AR4D sites
Source: CCAFS (2016)

CSVs therefore feature a portfolio (weather, water, seed/breed, carbon/nutrient, institutional/market intelligence) of interventions instead of single technologies (Figure 14.2).

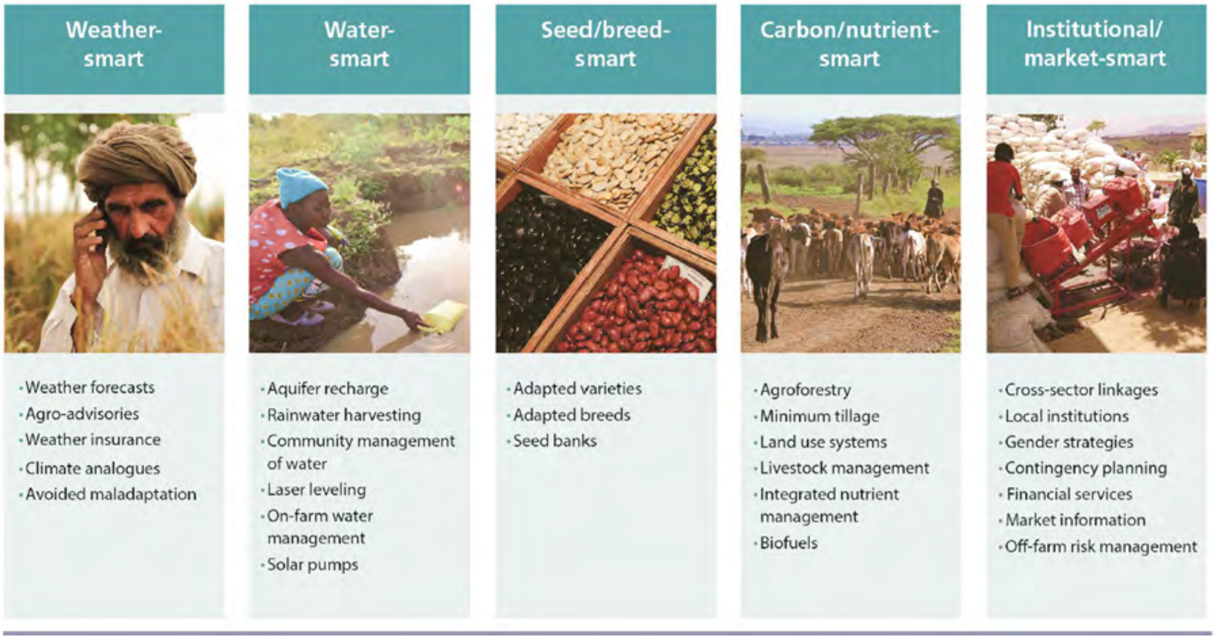


Figure 14-2: Types of climate-smart options
Source: CCAFS (2016)

15. Module 2 : Steps and implementation of the CSV approach

Three critical factors are essential for a successful CSV implementation:

- building strong partnerships to co-design and develop agricultural systems that improve ecosystems and population resilience;
- building the capacities of key actors (researchers, farmers, development agents and students) through professional and academic training; and
- the use of climate information for livelihood planning at all scales.

CSV stages are based on stakeholder engagement and rarely follow a simple linear model. The first step to creating a CSV site is to develop trust and establish partnerships between the various stakeholders; as well as obtaining agreement on and adherence to a common approach.

Once the partners have agreed on the creation of a CSV site, the main steps include (Figure 3):

- **baseline assessment**, including climate risk analysis, and gender and social inclusion analysis;
- the **design of the CSV**: identification and prioritization of climate-smart techniques, practices, and services according to the biophysical, socio-economic, gender, strategic and institutional context; also taking into account the synergies and possible trade-offs between the different activities;
- **evidence generation**: assessment and development of climate-smart intervention portfolios (including providing value-added weather services to farmers, promoting climate insurance, building capacity to adapt to climate change and facilitating community partnerships for knowledge sharing),
- **scaling up** of proven practices through policies and institutions and extending to large areas through farm-to-farm and ICT-enabled approaches.

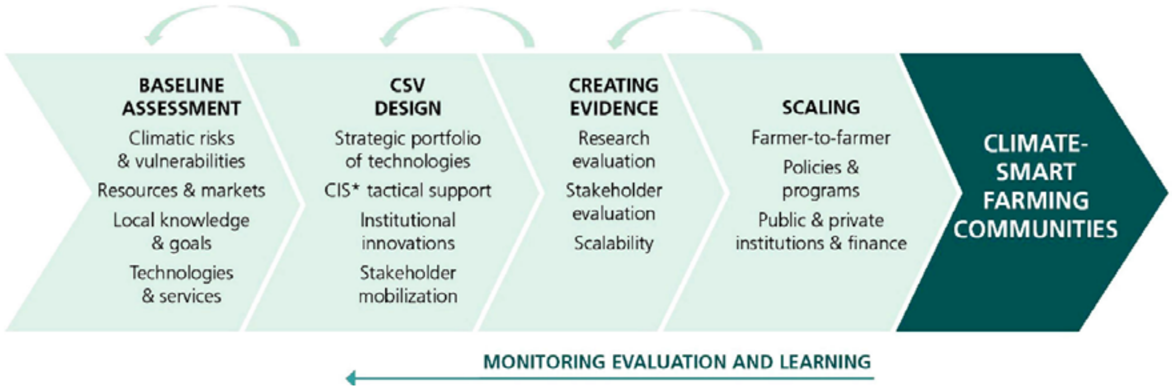


Figure 15 1: Implementation steps of the CSV approach.
Source: CCAFS (2016)

An ideal CSV site generally provides five types of decision support to farmers and other stakeholders, and allows research to evaluate the effectiveness of such support:

- village/community agricultural land use plans and contingency plans considering current and future climate risks, soil and socio-economic conditions and markets;
- CSA portfolios, which do not become maladapted to future climate and market scenarios – assessed using models;
- strategic direction before the planting season, where possible, based on seasonal forecasts, as well as the most appropriate CSA practices, techniques, services, processes, and institutional options. This is done in a participatory manner with local farmer groups and with due consideration of active institutions in the area, including farmer empowerment groups, and water user associations, markets and funding availability for climate and agricultural development;
- guiding farmers to the use of real-time weather forecasts and value-added ICTs based on agro-advice; access to good quality inputs and improved water/nutrient/energy use techniques; and on risk transfer through insurance mechanisms, in case of crop and livestock losses;
- policy-level guidance on policy barriers and policy options to enable CSA and development at local and national levels. This includes consideration of financial needs to guide scale-up.

CSV location and scale

CSV sites are groups of villages, jurisdictions, local administrations, or territories (comprising one or more villages). They vary in size, depending on cultural context, specific options being tested, research questions to be addressed and/or stakeholder preferences.

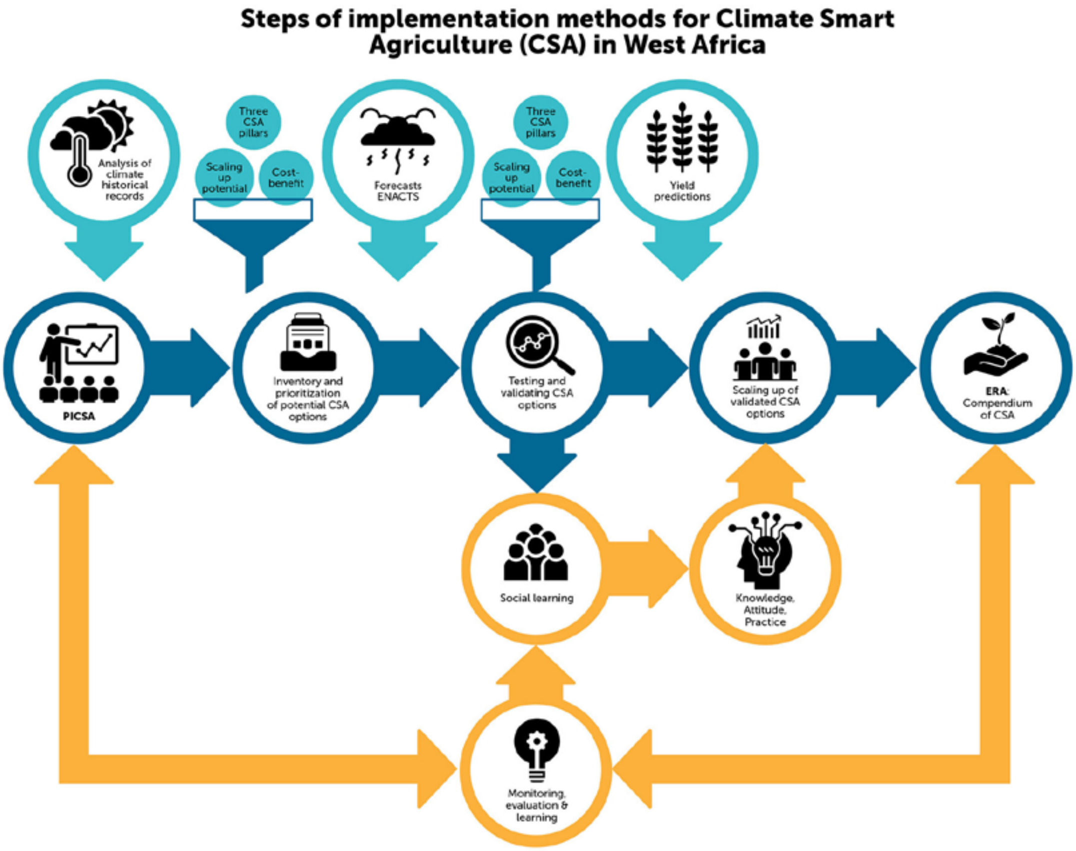


Figure 15-2: Framework for selection and application of CSA approaches in West Africa
Source: J. Bayala et al., 2021

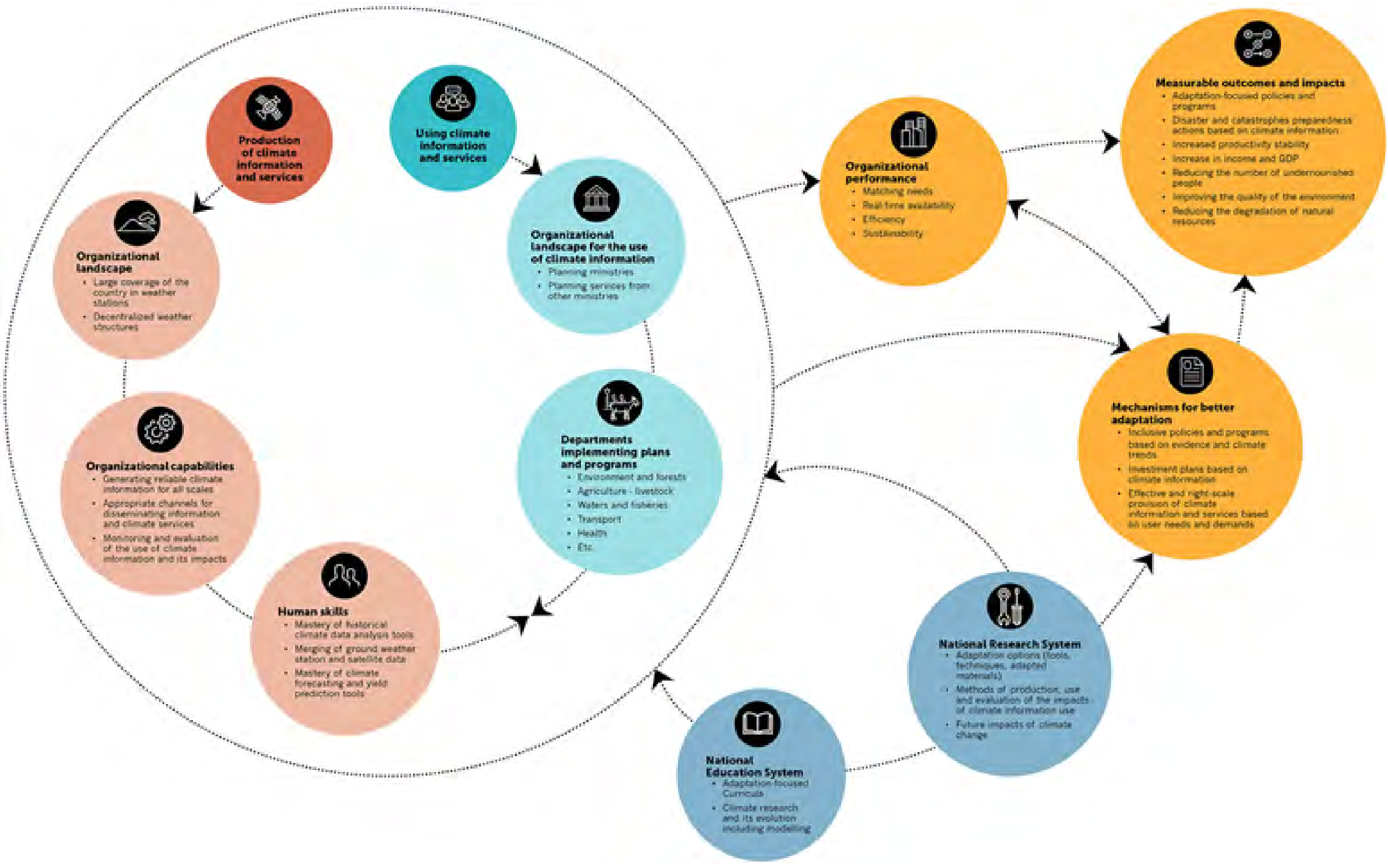


Figure 15-3: Suggested institutional setup for the provision of tailored climate information and advice.
Source: Adapted from J. Bayala et al., 2021

16. Module 3 : Experiences and lessons learned

16.1. Success stories

A. CCAFS/ICRAF-CGIAR: Scaling up climate information services in Kaffrine, Senegal

Pilot project: de Kaffrine in 2011

Technical support team: CCAFS and partner, the National Agency for Civil Aviation and Meteorology (ANACIM)

Objective: Improve access to weather forecasts and agricultural advice for farmers.

Methods: Establishment of platforms composed of farmers, climatologists, agricultural researchers, extension agents, non-governmental organizations, and the media.

Success: Changes in input purchases, labor allocation, planting dates and crop varieties.

Scaling up: Regions of Diourbel, Fatick, Louga and Thiès and extended to the rest of the country.

B. CCAFS-CGIAR: Extension to other localities

1. Targeted localities

Other CSVs were set up by the CCAFS in 2012 after the success of that of Kaffrine in Senegal, namely in:

- Africa (Burkina Faso, Ethiopia, Ghana, Kenya, Mali, Niger, Senegal, Tanzania, and Uganda)
- South Asia (Bangladesh, India, and Nepal),
- This project was also extended outside the African continent in 2014. Thus, CSVs were set up and tested in:
- Latin America (Colombia, Guatemala, Honduras, and Nicaragua)
- Southeast Asia (Cambodia, Laos, Philippines, and Vietnam).

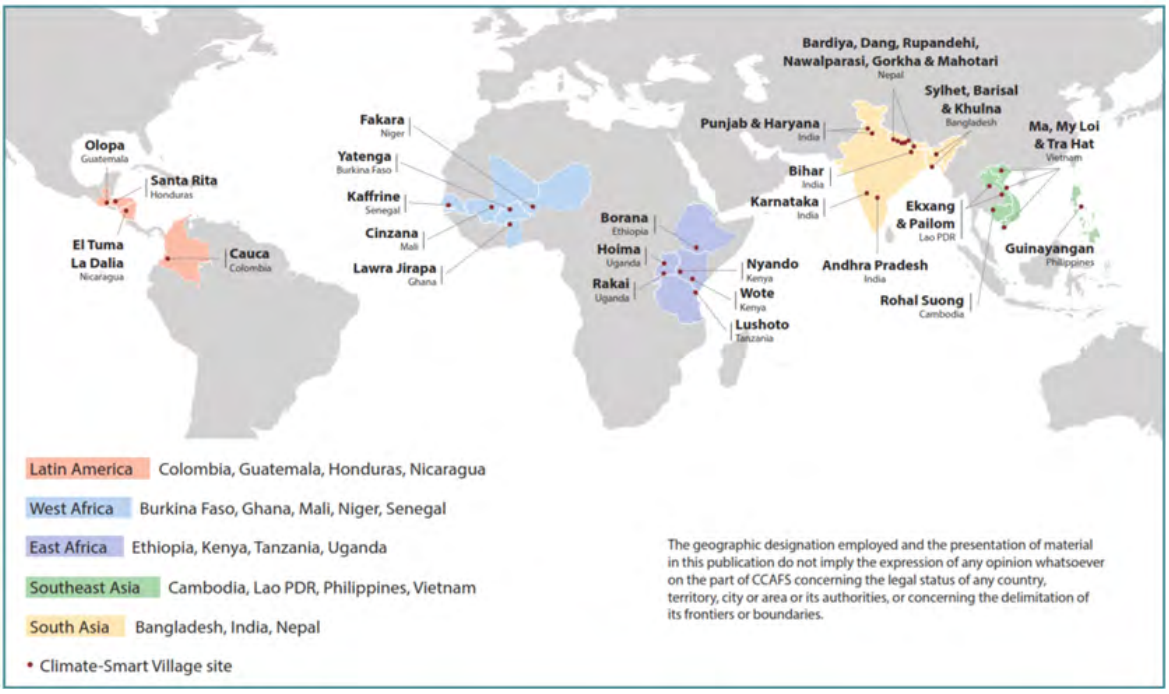


Figure 16 1: Locations of AR4D sites for climate-smart villages. This map shows the CSV sites promoted by CCAFS.
Source: CCAFS (2016)

Climate-smart interventions

Several climate-smart interventions have been implemented by CCAFS. These interventions depend on region, agro-ecological characteristics, economic development level, capacities and interests of farmers and local administration. These interventions include:

- weather-smart activities (weather forecasting, climate-informed agro-advice, climate insurance, climate analog analyses as a tool for forward planning, strategies to prevent maladaptation);
- water-smart practices (aquifer recharge, rainwater harvesting, community water management, laser land leveling, micro-irrigation, sowing on ridges, solar pumps);
- seed/breed-smart practices (adapted varieties and breeds, seed banks, including community-based activities);
- carbon/nutrient-smart practices (agroforestry, minimum tillage, land use systems, livestock management, integrated nutrient management, biofuel);
- institution/market-smart activities (cross-sector linkages, local institutions, including learning platforms or farmer-to-farmer learning and ca-

pacity building);
- emergency planning;
- financial services;
- market information; and
- gender-equitable approaches and non-agricultural risk management strategies.

C. CCAFS/ICRAF in West Africa

1. Technical Support and National Implementation Team

The technical support team of the ICRAF project for the implementation of the CSV is made up of experts from:

- CCAFS-West Africa Program;
- World Agroforestry-West and Central Africa (ICRAF-WCA);
- International Union for Conservation of Nature (IUCN);
- Universities, and
- Regional Center for Training in and Application of Agro-meteorology and Operational Hydrology (AGRHYMET).
- This team helped train the national team made up of managers and technicians from:
- National Research and Extension Systems (NARES);
- National Meteorological Services (NMS);
- Non-profit organizations (NGOs), and
- Local radio programs.

2. Goals

The aim here is to identify and effectively test agricultural technology practices that address climate variability and change at the farm, community, and landscape levels.

3. Method

To achieve the goals of successful implementation of the CSV, ICRAF used the Participatory Action Research (PAR) method through testing CSA scalability options in Agricultural Research for Development (AR4D). Participatory action research uses past, present, and future climate change to select, test and validate climate-smart options for crop and livestock research and social innovations.

The TOPSECAC tool (Toolkit for Planning and Monitoring and Evaluation of Climate Change Adaptation Capacities) developed by the IUCN has been used along with the PAR to achieve the objectives.

4. Target localities

The project was implemented in localities in Ghana, Burkina Faso, Senegal, Mali, and Niger (Figure 16.2).

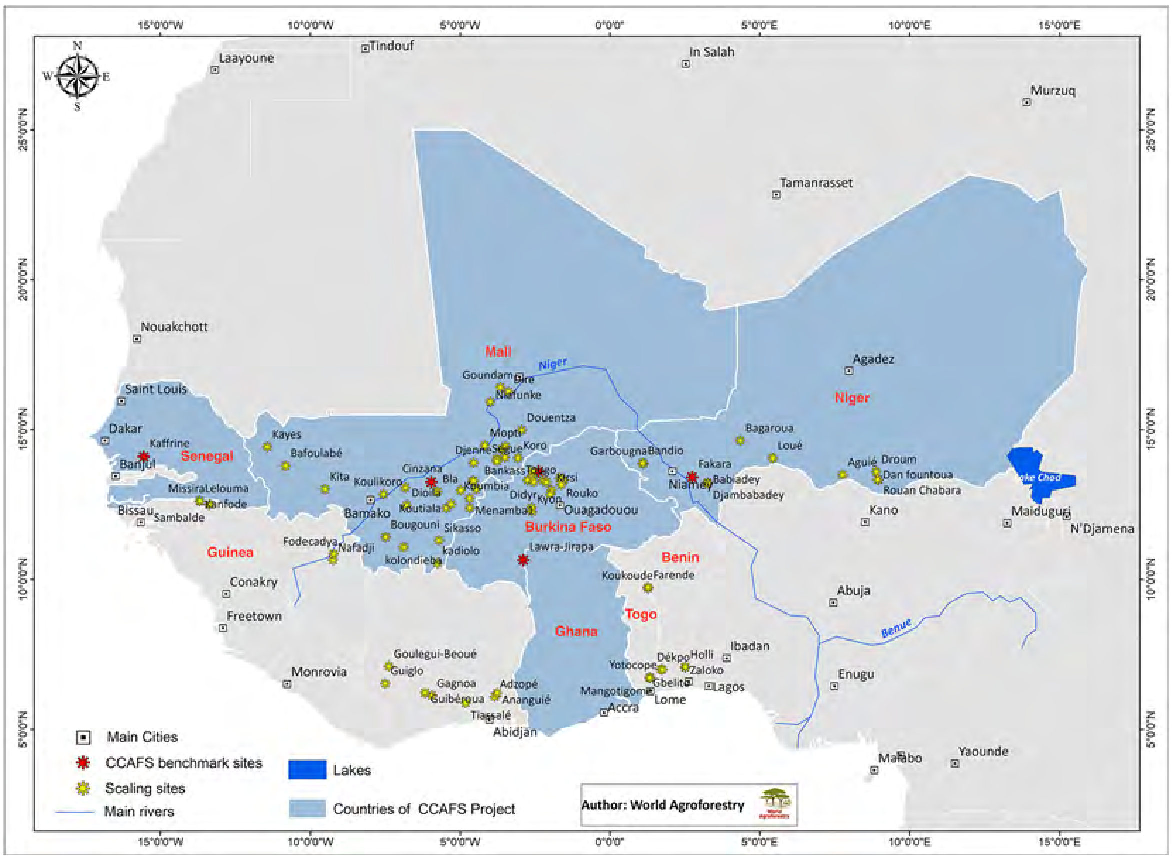


Figure 16-2: West African Climate-Smart Villages (CSV) Agricultural Research for Development (AR4D) and Scale-Up Sites (ICRAF).
Source: J. Bayala et al., 2021

5. Success stories

Success stories have been particularly recorded in: (1) communication (climate information and tested practices), (2) knowledge sharing tools (field schools, etc.) and (3) scaling up. These successes have made it possible to:

- build strong partnerships to co-design and develop agricultural systems that improve the ecosystems and populations resilience;
- strengthen the capacities of key actors (researchers, farmers, development agents and students) through professional and academic training, and
- to use climate information for livelihood planning at all scales.

- Four types of climate information were used in most countries in the implementation of the CSV by ICRAF:
- climate profiles to identify potential climate-smart technologies and practices;
- historical climatic records to match production choices with local climatic characteristics and individual circumstances;
- seasonal and short-term forecasts to adjust operational plans and test climate variability, for example: practices such as early/late planting or use of an early maturing variety (Ghana only), and
- climate analogues to learn about sites with similar climate to that of their predicted climate (Senegal only).

6. Process

The implementation began with the establishment of the PAR platform and is composed of the following activities:

- setting up PAR Platform;
- identification of climate adaptation technology options for on-farm testing, and participatory evaluation and validation;
- helps translate common program goals into contextualized actions at each of the trial sites;
- PAR training of National Agricultural Research Systems (NARS) scientists to test and validate CSA options;
- training of farmers, extension staff and NGO staff on inclusion of climate change in planning activities;
- working with rural communities to create visions of desired CSVs and address the effects of climate change and associated hazards;
- visit of participating farmers to villages with a comparable climate (climate analogue sites) to that of their predicted climate, to allow direct observation of production systems and exchanges with locals and to offer ideas for potential adaptation approaches;
- use of climate analogue sites to build the capacity of local actors to further analyze possible climate changes in their environments and plan for the desired future;
- sharing the first results with regional rural development actors to refine the model and identify strategic actors;
- building partnerships between researchers, extension services, non-governmental organizations (NGOs), private sector actors, policy makers and communities,
- practice of site selections and tests;
- monitoring and evaluation: monitoring and evaluation (M&E) has been designed and implemented in a participatory manner, so that adaptation and mitigation activities are supported by "adaptive behavior" leading to increased food security.

7. Some practices tested on the different sites

Overall, the practices tested on the various sites are as follows:

- minimum tillage, crop rotation, use of organic and inorganic fertilizers (micro-dosing);
- land reclamation and water conservation techniques (*Zaï*, half-moons, earth, or stone bunds);
- species restoration and diversification (assisted natural regeneration of trees, also known as farmer-managed natural regeneration or FMNR);
- early maturing, drought-tolerant varieties (sorghum, millet, cowpea and groundnut);
- biofortified varieties (cereals and orange-fleshed potatoes); and
- new energy options that use agricultural systems based on *Jatropha curcas* with cereal crops.

However, some practices have been specifically tested in certain countries.

Niger/Burkina Faso: stone bunds, mowing and saving fodder or housing livestock, improved seeds; seedling production, *Zaï*, reforestation, revegetation of anti-erosion sites (stone and earth bunds), construction of biodigester, natural regeneration managed by farmers; heap and pit composting, stone bund on bare ground (restoration), fodder crops, water basin, earth bunds, half-moon.

Ghana: stone bunds, pasture management, crop rotation, agroforestry or tree planting, earth bunds, improved habitat, pruning, farmer-managed natural regeneration, intercropping, supplementary feeding (fruits of acacia spp.), processing crop residues, improved varieties, retention of crop residues, prevention of bush fires (firewall), composting, gift transmission, minimum tillage, mulching, grafting, production of forage plants (*Cajanus cajan*), improved breeds, community forest protection.

16.2. Lessons learned and recommendations

A. ICRAF in West Africa

Increased multifunctional capacities of stakeholders to develop a climate-smart village;

- climate Information Services (CIS) have increasingly become a key entry point to guide farmers' decisions and selections regarding crops, varieties, agro-silvo-pastoral systems, technologies, production area, degree of intensification, planting calendar and investment levels;
- a total of 18 PICSA trainings, 4 CSA trainings, 8 data collection trainings and 2 M&E trainings directly reached 630 extension workers, researchers, NGO staff, NMS staff and NARS staff. Stakeholders have been trained to generate and use quality historical CIs at the relevant scale; assess the climate-smart potential of projects and programs; PAR; crop yield prediction modeling; delivery of the CIS; and leveraging participatory M&E methods;
- farmers received training through demonstration plots, future farms, farmer field schools, farmer-to-farmer learning field days, traditional annual agricultural festivals, radio broadcasts local, mobile phones, etc;
- through the M&E processes, the IUCN Social Learning Approach team has captured gender-differentiated social learning methods, institutions, and socio-cultural events;
- co-developed CSA options contributed to the compendium of CSA technologies developed by the CCAFS program for scalable CSA.

Barriers to CSA adoption: low technical capacity due to:

- low access to knowledge as evidenced by limited access to information, knowledge, and new skills on CSA options; and
- low access to inputs and equipment.

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