Food and Agriculture Organization of the United Nations

Climate-Smart Agriculture Sourcebook

Summary

Second edition

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Contents

Significant developments

This booklet presents a summary of the contents of the second edition of the Climate-Smart Agriculture Sourcebook. The landscape of international climate action has changed considerably since FAO introduced the concept of climate-smart agriculture (CSA) at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, and followed up with the publication of the first edition of the CSA Sourcebook in 2013. Most importantly, in 2015 the international community adopted the 2030 Agenda for Sustainable Development, which encompasses the Paris Agreement on Climate Change, the Sustainable Development Goals (SDGs) and the Addis Ababa Action Agenda, and provides an unprecedented international framework for increasing the effectiveness of national actions and collective international efforts to achieve sustainable development.

In order to implement the 2030 Agenda, FAO member states have endorsed five principles of sustainable food and agriculture. FAO understands agriculture to comprise crop and crops livestock production, fisheries and aquaculture and forestry. Balancing social, economic and environmental considerations, the five principles provide a framework for policy dialogue and for developing appropriate policies, strategies, regulations and incentives. These principles state that:

- ✓ Improving efficiency in the use of resources is crucial to sustainable agriculture;
- ✓ Sustainability requires direct action to conserve, protect and enhance natural resources;
- ✓ Agriculture that fails to protect and improve rural livelihoods, equity and social well-being is unsustainable;
- ✓ Enhanced resilience of people, communities and ecosystems is key to sustainable agriculture;
- ✓ Sustainable food and agriculture requires responsible and effective governance mechanisms.

To address the specific challenges climate change poses to sustainable food and agriculture, FAO promotes climate-smart agriculture (CSA) as an approach that can transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. In this new international landscape, the three interlinked objectives of CSA are more relevant than ever. These objectives are:

- ✓ Sustainably increasing agricultural productivity and incomes;
- ✓ Adapting and building resilience to climate change;
- ✓ Reducing and/or removing greenhouse gas emissions, where possible

SDG2 integrates the promotion of sustainable agriculture into its overarching goal to end hunger, achieve food security and improve nutrition by 2030. This is a clear recognition that the world's agricultural ecosystems will not be able to deliver the 50 percent increase in demand for food and other agricultural products by 2050, if current unsustainable natural resource management practices are maintained. The impacts of climate change on agriculture undermine the food security and livelihoods of the world's most vulnerable people and threaten Earth's ecosystems. Action on closely related objectives, such as clean water and sanitation (SDG6), sustainable consumption and production (SDG12), life below water (SDG14) and life on land (SDG15) must be mobilized in tandem, to meet SDG13's targets on combatting climate change and its impacts.

New content

The revised digital CSA Sourcebook contains updated versions of the original 18 modules and includes five new modules:

- ✓ Climate change, adaptation and mitigation;
- ✓ Integrated production systems;
- ✓ Supporting rural producers with knowledge of climate-smart practices;
- ✓ The role of gender in CSA;
- ✓ The step-by-step implementation of CSA at the national level.

Adopting the CSA approach

Many countries have embraced the concept of CSA. This was evidenced in a FAO study issued in 2016, showing that 32 of the 189 countries that had submitted Intended Nationally Determined Contributions for the Paris Agreement specifically referenced CSA. Approximately 50 countries endorse, or even prioritize, actions intended to harness the potential synergies between mitigation and adaptation in agriculture. Through research and activities supported by FAO and many other groups, the knowledge base underpinning CSA has also grown significantly. The insights gained in recent years, the success stories and the experiences that have created a better understanding of potential accelerators and barriers to the adoption of CSA practices, are all essential for preparing the ground for the further expansion of CSA at all levels. These insights need to be made available in a timely and accessible manner to support ongoing efforts to promote CSA.

Going digital

To do this, the CSA Sourcebook is being transformed into a 'living', digital resource. The digital CSA Sourcebook draws together a wide range of knowledge and expertise into a more interactive and easy-to-navigate platform. In this format, the CSA Sourcebook will be able to guide policy makers, programme managers, sectoral experts, academics, extension agents, and development practitioners in their efforts to make all the agricultural sectors more climate-smart. By launching the fully revised second edition of the CSA Sourcebook online, it will be possible to update individual modules or case studies when needed. This will allow the information available on CSA to be shared in pace with this rapidly evolving field.

SECTION A - Concept

The first section of the CSA Sourcebook provides a comprehensive introduction to the CSA concept, defining what CSA is and what it is not. It looks at what the application of the CSA approach entails, and identifies key areas of intervention. It also outlines how CSA can support countries to build their resilience to the impacts of climate change while increasing the sustainability and productivity of their food systems. It positions CSA within the broader international climate and sustainable development agenda. It also indicates how the implementation of CSA on the ground should consider a landscape approach. A new module, Climate change, adaptation and mitigation, explores the co-benefits and synergies between adaptation and mitigation in CSA.

Introduction

To contribute to achieving the SDGs under a changing climate, agricultural production systems need to simultaneously tackle three intertwined challenges: sustainably increasing agricultural productivity and incomes; building resilience to the impacts of climate change; and contributing to climate change mitigation where possible. CSA was developed as a framework to address these three challenges.

CSA can facilitate a transition to agriculture and food systems that are more productive, more sustainable and more climate-friendly. This is achieved by promoting the adoption of climate-smart practices that have been proven to be effective based on solid evidence, and providing an enabling environment that includes conducive policies, institutions and finance. CSA is not a technique, a new production system or a one-size-fits all set of practices, but rather a three-tiered action-based approach to identify existing production systems that can best respond to the impacts of climate change. CSA approaches help identify which production systems are suitable for adaptation and, where possible, mitigation, and enable institutions to scale up their response to tackle the challenges of climate change in specific locations. They provide the means to help stakeholders at local, national or international levels choose the agricultural strategies that are the most readily adaptable to specific climate conditions. CSA approaches set out to isolate and address trade-offs that may need to be made between the three objectives of CSA. Out of this process emerge pragmatic, context-specific options that can guide evidence-based decision making. The key to success is a long-term, coordinated effort by stakeholders at all levels – from the producer level to the global level.

This module introduces key climate change issues that need to be addressed in agricultural sectors to help achieve the SDGs, including the role of the agricultural sectors as a contributor to global greenhouse gas emissions. It revisits the evolution of CSA and looks at its relationship with broader policy goals and frameworks, as well as complementary approaches to sustainable food and agriculture, such as sustainable production intensification and agroecology. It provides guidance on how to operationalize and implement CSA, and clarifies core concepts related to creating enabling environments, mobilizing synergies, managing trade-offs and overcoming barriers to adoption.

Climate change adaptation & mitigation

A strong scientific consensus has been reached regarding the projected long-term impacts of climate change. It is expected that there will be an increase in the frequency and intensity of extreme weather events, such as droughts, floods and storms, and that there will be changes in local weather patterns that will affect ecosystems. Communities and ecosystems will need to adapt to new conditions and build resilience to the potential negative impacts that are projected for the future. The concentrations of greenhouse gases in the atmosphere also needs to be reduced to minimize global warming and climate change and avoid reaching environmental tipping points beyond which the damage done becomes irreversible.

The Paris Agreement on climate change aims at "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels". To achieve this goal, all sectors, including the agricultural sectors, must reduce their greenhouse gas emissions. It is undisputed that the agricultural sectors will also need to increase their output to meet the dietary needs of a growing world population. However, the agricultural sectors currently account for approximately one fifth of global emissions. If future growth in agriculture follows the emissions trajectories of the recent past, agriculture's share of total emissions will increase and compromise global efforts to reach the Paris Agreement's temperature goal. Maintaining this same trajectory will also continue the global trends in deforestation and land degradation, which are being driven by an increasing demand for food, wood and other agriculture-related products.

The agricultural sectors offer unique opportunities to contribute to climate change mitigation. Sustainable management practices can avoid further losses in the carbon that is currently stored in soils, trees and coastal ecosystems. Sustainable soil, rangeland and forestry management can create carbon sinks that capture carbon dioxide from the atmosphere and store the carbon in the soil and biomass. CSA seeks to maximise these opportunities. Often, CSA approaches can simultaneously bring about gains in adaptation, mitigation and/or productivity. CSA seeks to take advantage of opportunities to maximise synergies and co-benefits, and minimize or avoid trade-offs.

This module makes the case for adaptation and mitigation actions in the agricultural sectors, particularly in the context of countries' Nationally Determined Contributions under the Paris Agreement. It first considers climate change adaptation and mitigation approaches and methodologies individually and then brings them together to identify potential synergies and trade-offs. It highlights the complexities that must be addressed during the process of designing a CSA intervention.

Managing landscapes for climate-smart systems

Integrated landscape management can be used as an instrument to scale up CSA in a holistic, equitable and inclusive manner. As CSA requires complex, context-specific decision making, it is essential to continue balancing multiple objectives when designing larger-scale CSA interventions. Landscape interventions explicitly consider the multiple functions of ecosystems at multiple scales. For instance, a balance may need to be struck between land-use planning, agricultural production and tourism. By taking into account the social, economic, and environmental dimension, natural resources (including biodiversity) can be conserved while multiplying the opportunities and benefits for diverse stakeholders.

When implementing interventions at the landscape level, an overarching process is necessary for the management of production systems and natural resources over an area large enough to produce vital ecosystem services. This process must be complemented by decentralized mechanisms that can take into account the smaller scales at which the people actually operate. Fostering interactions between groups with different types of knowledge and different levels of expertise is highly beneficial.

As an approach inherently focused on scaling up sustainable practices, integrated landscape management facilitates the targeting and alignment of policies to attain desired results. Because of this, the landscape approach can also be used to improve practices related to land use and management so that they contribute to meeting local, subnational and national development goals, which can in turn support progress towards achieving multiple SDGs.

This module introduces the concept of integrated landscape management and describes how it can help CSA achieve national and international development goals. It provide case studies, describes common obstacles and potential solutions, and offers step-by-step instructions to indicate how CSA can be implemented on a large scale using a landscape approach.

SECTION B - *Agricultural production and natural resource use*

The second section of the CSA Sourcebook is divided into two parts. In the first part, the modules focus on agricultural production, with individual modules dedicated to each of the four agricultural sectors: crop production, livestock production, forestry, and fisheries and aquaculture. Each module considers the climate impacts and climate-smart options that are specific to that particular sector. A new module on Integrated Production Systems describes the principles that underpin integrated agricultural production and how they align with the objectives of CSA, and provides concrete examples of these systems. In the second part of the section, the modules focus on the climate-smart use of natural resources, with individual modules dedicated to water, land, and genetic resources. The second part also includes a module on energy management and CSA, and a module on approaches for making the value chains within the wider food system more climate-smart.

Climate-smart crop production

Crop production is highly sensitive to climate. It is affected by a variety of climate factors: long-term trends in average rainfall and temperatures; interannual variability in temperatures and precipitation; the occurrence of shocks during specific stages in plant development; and extreme weather events. As the climate changes, crop production strategies must change too.

There are many options for climate change adaptation and mitigation across different cropping systems. The suitability of these options will vary according to the specific types of stress the system is facing, the farmers' coping and adaptive mechanisms, and the degree to which each climate factor affects yields. The sustainable intensification of crop production is the cornerstone on which all climate-smart crop production options are based. It guides decisions on how to overcome inefficiencies that result in yield and productivity gaps and minimize the negative environmental and social impacts of production.

Sustainable crop production intensification calls for farming practices that make use of good quality seeds and planting materials of well-adapted varieties; the cultivation of a varied range of crop species and varieties in associations, intercrops or rotations; the control of pests through integrated pest management; and the adoption of conservation agriculture and sustainable mechanization to maintain healthy soils and manage water efficiently to achieve the highest possible output by unit of input within the carrying capacity of the ecosystem.

Critically, climatic changes can also cause dysfunctions in plant-pollinator interactions, as many pollinators are sensitive to high temperatures and drought. When pushed beyond their tolerance levels, this has grave consequences for crop pollination. Undertaking climate change mitigation hand-in-hand with adaptation strategies is therefore key. One important synergy can be found in the important role of grasslands in sequestering organic carbon. This can be improved by controlling grazing to sustainable levels which promotes growth of herbaceous species and reduces the degradation of grasslands. Introduction of deep-rooted grasses and legumes can also play an important role in improving the sequestration of soil carbon.

If farmers have access to good knowledge of ecological dynamics and to technological innovations as well as a good understanding of the type and extent of change in the climatic factors that affect crop production, they can work better rather than harder. They can maintain ecosystem functions and leverage the biogeochemical processes of their agricultural ecosystem for best results. They can also manage the trade-offs and synergies that are involved in adapting to new local climate conditions, and respond to fluctuations in international markets.

This module presents the principles, practices and technologies for the sustainable and profitable production of annual and perennial crops to meet food, feed, energy and fibre needs, and promote economic growth in a world where populations are expanding, the climate is changing, dietary patterns are evolving and pressure on natural resources are increasing. It looks at the projected impacts of climate change on crop production, such as increased concentrations of atmospheric carbon dioxide, higher temperatures, alterations in precipitation regimes, and increased pests outbreaks; and specific crop systems. The module also describes the off-farm elements that enable farmers to adopt climate-smart crop production practices.

FAO/IFAD/WFP/Michael Tewe

Climate-smart livestock production

Farming is the source of livelihood for one-third of the world's population. About 60 percent of the people who rely on farming for their livelihoods own livestock. Livestock production is a rapidly growing sector. It currently accounts for 40 percent of global agricultural gross domestic product and is crucial for food security in all regions. Livestock makes a necessary and important contribution to the world's supply of calories and protein. Livestock are also a major asset for households in rural communities: several hundred million pastoralists depend on this lifestyle and grasslands ecosystems for their living. They provide a range of essential services, including a means for savings, collateral for obtaining credit and a buffer against climatic shocks and other crises. In mixed systems, livestock consume crop residues and by-products and their manure is used to fertilize crops. Cattle, camels, horses and donkeys also provide transport and draught power for field operations. Furthermore, livestock, especially small ruminants and poultry, are key to empowering women and making progress toward gender equity. The contribution that livestock makes to rural livelihoods goes far beyond agriculture production and food security; it directly supports social welfare, education and human health.

It is essential that livestock are managed carefully to maximize the range of services they provide and reduce the vulnerability of the sector to the impacts of climate change. Action in this area is especially urgent given that nearly 800 million livestock keepers currently live on less than USD 2 per day. Their livelihoods are particularly at risk from the impacts of climate change. Increased temperatures, shifts in rainfall distribution, greater frequency of extreme weather events, increased heat stress and reduced water availability are expected to adversely affect both directly and indirectly livestock production and productivity around the world. The livestock sector is also a major contributor to climate change. FAO estimates that the sector is responsible for about 14.5 percent of the total anthropogenic greenhouse gas emissions. Identifying suitable options for making livestock production more climate-smart is critical. There are many synergistic options capable of delivering benefits for both adaptation and mitigation that can be implemented in the livestock sector, including shifts in species and breeds, improved feed management, sustainable grazing practices, silvopastoralism and on-and off-farm diversification to name but a few.

This module assesses the role of livestock in CSA. It considers the impacts of climate change on livestock production and presents an overview of the emissions associated with the sector. It describes the principles of climate-smart livestock production, focusing on increased efficiency in the use of resources and building resilience. The module gives insights into the main strategies for achieving climate-smart livestock production and outlines specific practices suitable for the main production systems. It also looks at what is needed to establish an enabling environment for climate-smart livestock production.

Climate-smart forestry

Over a quarter of the world's population depends on forests and trees outside forests for their livelihoods. They depend on them directly through the consumption and sale of foods, medicines and woodfuel; and indirectly through forest-related employment, the provision of ecosystem services, and the domestication of forest-derived foods.

Forests and trees are long-term presences in landscapes and are essential for the well-being of urban and rural communities. They act as buffers against shocks and provide ecosystem services that underpin agricultural production. They protect water and soil resources, assist in soil development and enhance soil fertility, regulate climate, and provide habitats for wild pollinators and predators of agricultural pests. Forested wetlands and mangrove forests help protect coastal areas from flooding, which contributes to stabilizing food production on vulnerable coastal lands. Forests also play a central role in river-based and coastal fisheries. Mountain forests protect valuable water catchments, ensuring that downstream communities and agricultural lands receive high-quality, evenly discharged water.

There are strong interactions between climate change and forests. Air temperature, solar radiation, rainfall, and atmospheric carbon dioxide concentrations are major drivers of forest productivity and forest dynamics. In turn, forests help to control climate by removing large amounts of carbon dioxide from the atmosphere and acting as carbon sinks, storing the carbon in the soil and biomass. They are also a source of carbon dioxide emission in that they release carbon dioxide into the atmosphere through respiration. Forest vegetation and soils contain about half the planet's terrestrial carbon. However, terrestrial ecosystems have the potential to sequester much more carbon dioxide than they currently do. Deforestation and forest degradation account for an estimated 17 percent of global greenhouse gas emissions.

Climate change and increased climate variability have both direct and indirect effects on forests and forest-dependent people. In boreal and tropical regions, climate change is making forests more susceptible to stresses. Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (known as REDD+) will play a central part in global efforts to combat climate change. In the Paris Agreement, countries agreed to conserve and enhance sinks and reservoirs of greenhouse gases, including forests. Many countries made specific commitments to forest-related actions in their Nationally Determined Contributions in the Paris Agreement.

This module focuses on sustainable forest management as the foundation for climate-smart forestry. The module looks at the risks climate change poses to forests and trees outside forests and how the ecosystem services provided by forests can improve the resilience of agricultural production systems. It also discusses the sector's actual and potential role in climate change mitigation.

Climate-smart fisheries & aquaculture

The fisheries and aquaculture sector provides millions of people with food, income and livelihoods. An estimated 660 to 820 million people, about 10 to 12 percent of the world's population, derive their income and livelihoods from capture fisheries and aquaculture, and the post-harvest activities associated with processing, marketing and trade. Ninety percent of those working in capture fisheries are engaged in small-scale operations. Oceans and inland waters provide significant benefits to the world's population, especially in the most impoverished communities.

Climate change is affecting the abundance and distribution of fisheries resources and the suitability of some geographical locations for aquaculture systems. Climate-related physical and chemical changes are linked to increasing carbon dioxide emissions. These emissions are being absorbed in large part by aquatic ecosystems, which is triggering substantial changes in these environments and affecting the important ecological services they provide.

Other factors, such as pollution, dam construction and unsustainable fishing, are further exacerbating the harmful impacts of climate change. Population growth is increasing the demand for food, and unsustainable fishing practices have caused production from marine fisheries to level off. Aquaculture will have to bridge this gap between supply and demand. To do this, the aquaculture subsector will need to increase production by 70 to 100 percent above current levels over the next two decades. There are numerous options for supporting such growth in a climate-smart and sustainable manner, including improved siting and design; sustainable water management practices; selective breeding and genetic improvements; improved feed management; strengthened emergency procedures and biosecurity measures. However, it must also be noted that aquaculture development faces growing constraints, as the competition for land, water, energy and feed resources intensifies.

The impacts of climate change and related adaptation options vary by region. The impacts are expected to be largely negative, but in some areas climate change may have a positive effect on the sector. For instance, in some cases, rising sea levels may create new environments and new opportunities, for example in marine aquaculture and the expansion of mangrove forests. Context-specific, climate-smart agriculture solutions based on a solid base of evidence will be required to guide the sector toward a sustainable future.

This module describes the principles of integrated production systems and provides concrete examples of how these systems can support the objectives of CSA. The module details the contribution each integrated system can make to the sustainable intensification of production, and to climate change adaptation and mitigation. It also provides guidance on adaptive management and looks at barriers to the adoption of climate-smart integrated production systems and the enabling environment needed to overcome them.

Integrated production systems

Integrated production systems use some of the products, by-products or services of one production component as inputs for another production component within the agricultural unit. In integrated systems, production components are mutually supportive and mutually dependent. Examples of integrated production systems include agroforestry and crop-livestock, rice-fish, fish-livestock and food-energy systems.

By increasing efficiency in the use of resources, integrated production can help reach the mutually supporting objectives of CSA. Higher efficiency in the recycling of resources (e.g. converting waste into biogas) creates systems that have a minimum environmental impact and require fewer expenditures on inputs (e.g. fertilizer, feed and energy). The diversification of resources and incomes associated with integrated production offers producers a greater number of risk management strategies and options to adapt to the impacts of climate change. Also, the greenhouse gas emissions intensities of integrated systems are typically lower than those of specialized systems.

Successful integration depends on flexibility to reduce trade-offs and competition between the various production components of the agricultural system. This requires substantial knowledge, labour and sometimes initial investments that may pay off only over a relatively long period of time.

The sustainable intensification of production on integrated agricultural systems requires a better understanding of the impacts of climate changes and climate variability on these systems. This can be achieved by generating and exchanging knowledge at all level, developing capacities, and supporting greater coordination of policies and enabling institutions.

This module describes the principles of integrated production systems and provides concrete examples of how these systems can support the objectives of CSA. The module details the contribution each integrated system can make to the sustainable intensification of production, and to climate change adaptation and mitigation. It also provides guidance on adaptive management and looks at barriers to the adoption of climate-smart integrated production systems and the enabling environment needed to overcome them.

Water management

Water is one of the prime channel through which the impacts of climate change on the world's ecosystems and on livelihoods will be felt. Climate change will have an impact on every element in the water cycle. Agriculture will be affected by increased evaporative demand due to warmer temperatures. Changes in the amount of rainfall and variations in rainfall patterns will affect the two sources of water for irrigation: river runoff and groundwater recharge.

The most immediate impacts of climate change will be the increased variability of rainfall, higher temperatures, and extreme weather events, such as droughts and floods. In the medium to long term, climate change will reduce the availability or reliability of water supplies in many places already subject to water scarcity. These impacts must be considered in the bigger picture of water scarcity and agricultural development. Agriculture is responsible for 70 percent of freshwater withdrawal globally. Other factors, such as population growth, urbanization and changing dietary habits, are also driving changes in water use, meaning climate change is placing additional burdens on already stressed systems.

As the climate changes, sustainable water management will play an increasingly important role in maintaining agricultural productivity and supporting food security and nutrition. This has been emphasized in countries' Intended Nationally Determined Contributions for the Paris Agreement. Of the 189 countries that presented Intended Nationally Determined Contributions, 132 mention water services in relation to adaptation actions in general, and 74 countries explicitly refer to water resources in the context of adaptation actions in the agricultural sectors. Rainwater harvesting, use of marginal water and wastewater resources, water use efficiency measures and watershed management procedures are some examples of options countries identified.

This module provides an overview of the current status, trends and challenges of water management for agriculture. It considers the impacts of climate change on water management and the vulnerability of rural populations and farming systems. It presents a range of possible adaptation and mitigation options at different scales of intervention. The module also introduces approaches and tools to assess climate change risks and select climate-smart water management options.

Sustainable soil & land management

As a result of climate change, land degradation and losses in biodiversity, soils have become one of the world's most pressing problems. The degradation of the ecosystem services provided by soils undermines food security and nutrition, water quality and availability, human health, and social and economic development. In cropping, grazing and forest systems, climate change and variability is expected to affect soil health and plant growth in a variety of ways. Reduced or erratic rainfall and more frequent and severe periods of drought will lower the capacity of soils to supply water and nutrients to plants. Higher evaporation and transpiration rates will lead to increased erosion, reduced groundwater recharge and reduced soil moisture for plant growth, and a higher incidence of soil salinization. Warmer soil surface temperatures will increase the rates of mineralization of soil organic matter and, in turn, impair the soil's capacity to sequester carbon and retain water, which will also ultimately reduce the soil's potential to support plant growth.

Sustainable land management can make an important contribution to CSA, as it also guides actions to strike the right balance between using resources sustainably and safeguarding their long-term productive potential. Soils host the largest terrestrial carbon pool and their biogeochemical processes regulate the exchange of greenhouse gases with the atmosphere. These emissions are strongly affected by factors, such as land use, land-use change, vegetation cover and soil management. The stocks of soil organic carbon in the upper soil layers are responsive to these factors, and provide an opportunity to influence greenhouse gases levels in the atmosphere. Sustainable crop, grazing and forest systems can sequester substantial amounts of carbon from the atmosphere and store it in soils and vegetation. Sustainable soil and land management initiatives that build up soil organic matter are a good example of climate-smart interventions that can deliver co-benefits at all levels, by contributing to climate change mitigation while also maintaining soil-supported ecosystem services, and thereby increasing the resilience of agricultural ecosystems to climate change and other stressors.

This module looks at soil and land management in the context of climate change. It provides technical details on the concepts of sustainable soil management, and considers how the large-scale implementation of climate-smart soil and land management practices could enhance climate change adaptation and mitigation. The module also highlights the types of institutions and policies that can support the wider adoption of sustainable soil and land management practices, and offers tools and assessment methodologies to assist decision makers in this regard.

Genetic resources for food & agriculture

Genetic resources for food and agriculture are the basis for life on Earth: genetic diversity is vital for the survival and adaptability of any species. From the perspective of sustainable agriculture and food security, genetic resources are the raw materials on which humanity relies to sustainably increase agricultural production and improve livelihoods; adapt and build resilience to climate change; and mitigate greenhouse gas emissions. Over centuries, selective breeding and domestication, combined with natural selection, have added to the immense diversity of wild genetic resources that contribute to food and agriculture and led to the development of numerous and diverse varieties, breeds, stocks and strains of plant, animals and micro-organisms.

However, genetic diversity is being lost due to changes in the way land and water is being used; agricultural intensification; excessive use of pesticides and fertilizers; changing consumer demands; invasive alien species; inadequate policies; and the impacts of climate change.

As different plants, animals and micro-organisms have different capacities to survive or adapt to shocks and changes, safeguarding and sustainably managing the diversity of genetic resources is a vital component of climate change adaptation and mitigation strategies. For example, valuable traits, such as water stress tolerance, drought resistance, or resistance to pest or diseases, may be included in breeding or conservation strategies designed to build resilience to climate change, including by putting more emphasis on wild crop relatives. There is also significant, and as yet underexplored, potential to contribute to climate change mitigation through the improved use and development of genetic resources.

This module describes the nature of genetic resources for food and agriculture and outlines why these are essential for CSA. It outlines the expected impacts of climate change on plant, animal, forest, aquatic, and micro-organism and invertebrate genetic resources. It describes the management of these resources, in particular their characterization, evaluation, inventory and monitoring. It also looks at how the sustainable use and development of genetic resources can contribute to climate change adaptation and mitigation, and at the same time support the conservation of genetic resources for food and agriculture. It also considers enabling institutional and policy process.

Energy management

Energy is needed at every stage of agriculture and food production. It is therefore important to consider energy management not only in the production phase, but along the full value chain. The connections between energy and agrifood chains have grown stronger as agriculture has become increasingly reliant on mineral fertilizers, irrigation and machinery. Post-harvest activities, such as food storage, processing and distribution, are also energy-intensive. Over the last decades, the increased use of energy by the agrifood sector has significantly contributed to feeding the world and to greenhouse gas emissions. Energy from fossil fuels has expanded farm mechanization, boosted fertilizer production and improved food processing and transportation. Between 1900 and 2000, the world's arable area doubled, and the energy content of edible crops expanded six-fold. This greater productivity was made possible by an 85-fold increase in energy input per hectare.

The agrifood sector is estimated to contribute about 30 percent of global greenhouse gas emissions. As a result, agrifood chains that are highly dependent upon fossil fuels pose serious challenges to development. Business-as-usual development would lead to a more than 40-percent increase in the demand for water, energy and food by 2030: a development scenario that is clearly unsustainable. A sustainable approach must focus on the water-energy-food nexus, and address trade-offs and capitalize on synergies in the use of these resources. Food losses occur at all stages of the supply chain. The energy embedded in global annual food losses amounts to around 38 percent of the energy consumed by the whole food chain. At the same time, agriculture and forestry have always been a traditional source of energy generated from biomass. The energy produced by agrifood chains can be partially used in food production, or it can be exported outside the agrifood chain and serve as a livelihood diversification strategy. This could be done, for example, through the sale of biogas produced on farms to local households, or through the generation of electricity from agricultural residues that can be fed into the national energy grid.

One of the world's greatest challenges is to develop global food chains that rely less on fossil fuels and emit fewer greenhouse gases; have a secure supply of energy; are resilient to fluctuating energy prices; make efficient use of water, energy and land; and can continue to ensuring food security and foster sustainable development. Energy-smart food chains are a key component of CSA.

This module looks at the relationship between food and energy in a world where the climate is changing and competition for natural resources is increasing. It describes how energy is used in agrifood chains and how the sector can produce energy. The module links the objectives of the energy-smart food programme, which focuses on the water-energy-food nexus, with those of CSA. It outlines possible energy solutions for CSA and indicates potential synergies and trade-offs.

Developing sustainable food systems & value chains

Food systems encompass a diverse range of actors and their interlinked value-adding activities. The stages of the food system's value chain that links the 'farm to fork' include: production, aggregation, processing, distribution, consumption and disposal of products that originate from agriculture, forestry or fisheries. Food systems depend on sustainable agriculture and natural resources management as well as the broader economic, social and natural environments in which they are embedded. Sustainable food systems are those that deliver food and nutrition security for all, in ways that are economically sustainable, in that they are profitable; socially sustainable, in that they deliver broad-based benefits for society; and environmental sustainable, in that they have a positive or neutral impact on the environment. To make food systems environmental sustainability and climate-smart, it is important to examine the food system's carbon footprint, and where possible, identify more efficient, less carbon-intensive approaches. For instance, measures and strategies aiming to reduce food losses and waste are an excellent opportunity for such improvements: globally, about one-third of all food produced is lost or wasted, meaning that the natural resources used and the greenhouse gases emitted in its production were effectively wasted, too.

To identify climate-smart interventions, it is important to take a holistic view of the entire food system and consider how it will be affected by climate change and where it is most vulnerable. Since food systems are extremely complex, analysis must take place at a workable scale. Such an analysis can be realized by adopting a value chain approach. The FAO sustainable food value chain development approach involves an analysis at three interconnected levels: the core value chain, the extended value chain and the enabling environment. The core value chain is comprised of the various stages: production, aggregation, processing, distribution and consumption, including waste disposal, and includes governance mechanisms associated with the vertical coordination of these different stages. The extended value chain includes the available support services. The enabling environment relates to societal and environmental elements and the diverse actors involved in developing climate-smart food systems.

Concrete examples of one possible intervention for each stage in the value chain include:

- ✓ **Production:** Improved fertilizer application practices to improve fertilizer use efficiency;
- ✓ **Aggregation:** Coordinate better within the value chain to reduce transportation distances;
- ✓ **Processing:** Invest in packaging that maintains food quality and safety;
- ✓ **Distribution:** Encourage supermarkets to take measures to minimise refrigerant leakage and reduce energy use;
- ✓ **Consumption:** Promote local food products, particularly for perishable goods and
- ✓ **Disposal:** Invest in weather-proof landfills alongside improved recycling.

This module takes a holistic view of the food system. It uses a sustainable food value chains approach to identify areas of intervention to adapt to climate change and, where possible, mitigate climate change in the food system. It identifies key considerations for selecting appropriate value chains, the roles of the various stakeholders, and possible interventions to develop climate-smart value chains and food systems.

SECTION C - Enabling environment

This section describes the enabling environment required to allow the many independent but interconnected CSA stakeholders – public and private, small and large – to reach decisions that can lead to the implementation of CSA interventions at various scales. It targets project and programme managers, policymakers, producers and other stakeholders engaging in CSA. Modules provide guidance on policies, financing and capacity development for CSA; address decent employment and social protection in CSA; and the synergies between CSA and disaster risk reduction. The section also contains modules that provides an overview of tools and 'how to' guidance for making climate impact assessments, carrying out appraisals of potential options for CSA interventions, and monitoring and evaluating CSA projects. This section includes three new modules. The module on supporting rural producers with knowledge of climate-smart practices describes the role and function of extension services, farmer field schools (encompassing farmers, pastoralists, fishers and other rural producers) and producer organizations. Another new module is dedicated to the role of gender in CSA. The section concludes with a new module that offers guidance for implementing a step-by-step evidence-based approach to CSA planning at the national level.

Enhancing capacities for a country-owned transition towards CSA

Making agricultural systems climate-smart is a knowledge-intensive process that requires strong country ownership. A sustainable transition toward CSA demands a system-wide and inclusive approach to capacity development. Such an approach empowers people and strengthens organizations, institutions and networks, and also helps establish conducive policy and regulatory frameworks. Capacity development encapsulates both the overall aim of development (what) as well as the process (how) by which more sustainable results can be achieved. Contextualized and targeted interventions should be designed based on a system-wide capacity needs assessment, and progress and results should be monitored and documented.

Transitioning towards CSA will require enhanced technical and functional capacities among agricultural stakeholders. For example, enhancing technical capacities to monitor and interpret weather- and climate-related data, particularly at the local level, will allow communities to reach informed decisions on climate-smart agricultural management practices (e.g. when, and what type of crop variety to sow to best adapt to prevailing conditions). Complementing technical expertise with additional functional capacities is key to putting this expertise into practice and achieving sustainable results.

Functional capacities for CSA include the capacity to: formulate and implement policies and undertake policy reforms; generate, manage and exchange data, information and knowledge; implement programmes and projects; and engage in multisectoral networks, alliances and partnerships that include subnational authorities and non-state stakeholders. Dedicated attention must be given to enhancing organizational and institutional capacities, as well as networks. This can be done, for instance through improved interministerial coordination, the synchronization of mandates and the facilitation of multistakeholder processes. Addressing capacity gaps in an iterative manner and tapping into opportunities for capacity building will enable countries to scale up climate-smart interventions in their agricultural sectors.

This module introduces the core principles of a system-wide, country-owned capacity development approach for CSA. It provides operational guidance to support countries to inclusively assess their capacity needs and design, undertake and monitor contextualized capacity development interventions. The module also looks at capacity development methodologies, tools and practices. It also considers other catalytic factors for CSA, including multistakeholder processes and networks, agricultural innovation systems, local institutions at the landscape level, farmer field schools, indigenous knowledge and knowledge sharing, information and communication technologies, and communication for development.

Supporting rural producers with knowledge

Extension services and other rural advisory services, are a key instrument that helps farmers, pastoralists, fishers and foresters to manage change and respond to different challenges and opportunities. Extension services have evolved from a single agency focused on disseminating technology, to a mix of public, private and civil society service providers that offer a broader range of information and services to rural communities. Collectively, extension and advisory services comprise different types of providers, including extension agents, community knowledge workers, agricultural producers, facilitators, advisors, promoters, knowledge intermediaries and programme managers. They provide a range of services to rural communities to assist them in developing their own technical, organizational, entrepreneurial and managerial skills.

Promoting CSA approaches and strengthening capacities for their wider uptake involves changing the behaviour, strategies and agricultural practices of millions of agricultural producers. These producers need to be supported in understanding the impacts of climate change, and the options that are available to them for making a shift towards climate-smart strategies. Extension services have a central role to play in connecting producers with sources of new information and tools, and encouraging and facilitating the behavioural changes that are needed to build the resilience of agricultural livelihoods and contribute to sustainable development. It is worth noting that extension is explicitly mentioned in SDG2 as one of the areas that needs increased investment in order to meet the goal of ending hunger, improving nutrition and promoting sustainable agriculture.

This module outlines the evolution of agricultural extension and advisory services, and describes why they are an important vehicle for fostering the wider uptake of CSA. It also provides examples of how extension and advisory services are already supporting CSA. The module looks at the key challenges and opportunities in this area, and considers the capacity gaps that need to be addressed in order to allow extension services to reach their full potential in promoting CSA.

Enabling policy environment

The transition to climate-smart agricultural systems demands not only strong commitments, but also greater coherence, coordination and integration among various sectors dealing with climate change, agricultural development, food security and nutrition. At the international level, commitments to sustainable development are clearer and stronger today than ever before. The 2030 Agenda for Sustainable Development is made up of explicitly interrelated components, including the Paris Agreement on climate change, the SDGs and the Addis Ababa Action Agenda on means of implementation, and the Sendai Framework for Disaster Risk Reduction. When countries translate these international objectives into national actions, implementing and monitoring these various agendas in an integrated and coherent manner can save resources and deliver greater results. Successful integration will depend on the ability of national governments to develop a set of national targets that serve all three agendas, optimize benefits and co-benefits, and address trade-offs.

The CSA approach offers an equally excellent mechanism to 'deliver as one' on interconnected goals related to climate change and sustainability, agriculture and food security, while also contributing to inclusiveness, poverty reduction, social equity and economic growth. To deliver on these commitments, the public sector may need to support effective and sustainable investments. This could be done in a number of ways, including through regulations, incentives, capacity development, investments in research and innovation, the dissemination of knowledge, the construction of infrastructure and social protection.

This module looks at how key international agreements and policy frameworks can help guide effective national planning and implementation on CSA. It considers the need for integration and coordination among national policy processes related to agriculture, fisheries and forestry climate change. The module provides examples of policy measures that can create incentives for adopting CSA approaches and reduce the different types of barriers to their adoption.

Investing in CSA

Substantial, long-term investments are required in order for producers and policy makers to assess, promote and adopt climate-smart approaches and practices.

Countries' Nationally Determined Contributions to the Paris Agreement have laid a foundation for global action on adaptation and mitigation in all sectors, including the agricultural sectors. However, the financing needs for the agricultural sectors far exceed the funds pledged to date. Available estimates suggest that the private sector is by far the largest source of finance for climate change adaptation and mitigation, with producers being the biggest investors in agriculture. Most agricultural investments are financed from domestic resources, either private or public. Only a small share of the funding comes from international sources. The international public finance landscape has evolved and now includes dedicated multilateral climate funds (e.g. the Green Climate Fund, the Global Environment Facility, the Adaptation Fund and the Pilot Program for Climate Resilience) that explicitly focus on support to climate action. Climate action in the agricultural sectors can be a game-changer in terms of the impact on climate change. There is an urgent need to use the available public resources – both international and domestic – more effectively in support of adaptation and mitigation efforts and in agriculture.

Relative to the rising investments in the agricultural sectors, the scale of public climate finance has been modest. This situation, along with the increasing need to take action to address climate change, indicates that climate funds will be most efficiently used if they strategically leverage agricultural investments in support of CSA. Areas for investment include the creation of an enabling policy environment to overcome barriers to the adoption of CSA; the mainstreaming of climate change adaptation and mitigation efforts in domestic budgets; and unlocking the private sector potential for climate-smart agricultural investment. The incorporation of climate change into national agricultural investment planning and operations, and the design of new types of cross-sectoral investments can be used to scale up CSA practices and approaches and provide for higher investment returns while reducing their climate-related risks. The identification of climate-related risks and opportunities for CSA interventions that can lead to the implementation of context-specific adaptation measures should be part of agricultural investment planning, preparation and appraisal.

This module looks at the challenge of meeting the investment needs of CSA and provides an overview of the available financing sources. It places a specific focus on opportunities related to climate finance. The module also describes main the principles for incorporating CSA into the agricultural investment cycle and provides a summary of practical tools and approaches for mainstreaming CSA into investment processes.

Climate resilience: synergies between disaster risk reduction & CSA

Worldwide, the average yearly economic losses due to natural disasters have reached USD 250 to 300 billion. Between 2006 and 2016, the agricultural sectors in developing countries absorbed 26 percent of the economic impact caused by climate-related disasters. In the case of drought, more than 80 percent of the damage and losses are in the agriculture sectors. The impacts of extreme climate-related events include major disruptions in food production and water supply, and severe damage to critical infrastructure. It is evident that the agricultural sectors and the people who depend on them for their livelihoods are highly vulnerable to extreme weather events.

Experience shows that the negative and cumulative impact of these disasters erodes livelihoods and coping capacities over time, reduces food production and increases the risk of hunger. The link between disasters and hunger is a clear indication of the fragility of food systems and their vulnerability to natural hazards. The most vulnerable group – smallholder agricultural producers – is often the most food insecure and the most exposed to risks. Smallholders have smaller plots of land; water may be scarce; and they may have limited access to seeds, planting materials and animal resources. When a disaster strikes, vulnerable agricultural producers can be deprived of their livelihoods not just in the immediate aftermath of the disaster but for the entire production cycle, and perhaps beyond. Because agricultural households need more time to recover, they can be forced to adopt negative coping strategies, such as selling their assets, to meet their immediate post-disaster needs. These cascading effects of disasters can diminish or even reverse achievements in development and poverty reduction.

CSA approaches tend to promote mid- to longer-term measures to counteract the slow onset threats of climate change to agricultural development. In a similar way, disaster risk prevention, preparedness, and response efforts, provide vital, often even life-saving, support to the most vulnerable populations by enhancing their resilience and coping capacities in case extreme events or disasters strike. The 'building back better' approach in disaster response guides interventions during the recovery and transition period towards risk-informed development that seeks to minimize future risks. This approach spans the spectrum from emergency response to climate change adaptation strategies. This approach is clearly complements CSA's objective to build resilience and adaptive capacity to climate change and offers numerous opportunities for integrated, mutually reinforcing interventions.

This module introduces the concept of country-driven disaster risk reduction and highlights the common ground it shares with sustainable development and climate change adaptation. It demonstrates how policies, institutional mechanisms and practices that have proven successful for disaster risk reduction can also contribute to meeting the interlinked objectives of CSA. The module highlights four core areas of disaster risk reduction that are essential elements for CSA: multihazard risk assessments, disaster risk governance, investments in disaster risk reduction, and emergency preparedness, response and recovery.

The role of gender

Climate change affects everyone, but its impacts are often not gender neutral. Men and women experience climate change in different ways because of the differences in their socially accepted roles and responsibilities. For example, as the impact of climate change the availability of and distance to surface water, women's workloads will increase. In general, women's lack of rights and access to resources, information, and power in the household and at higher levels of decision making render them more vulnerable to the impacts of climate change, restrict their capacity to adapt and their ability to ensure their needs and priorities are addressed.

Climate change can exacerbate existing gender inequalities in agriculture. A nuanced understanding of the ways different types of men and women become vulnerable to climate variability and change is necessary. If the important role women play in agriculture is recognized and they are provided with equal access resources and services, climate change can also open significant opportunities for women to become agents of change. Women represent 43 percent of the world's agricultural labour force, and in some regions the percentage is much higher. Women hold a vast amount of important knowledge that can inform the re-evaluation of agricultural practices that are called for under the umbrella of CSA. Women will also form a major part of the labour force that will be needed to implement CSA.

Advancing gender equality and empowering women must be a core principle of CSA. This also involves engaging with men and boys to ensure that both women's and men's knowledge and priorities are included in CSA plans.

This module introduces basic concepts of gender mainstreaming, analysis and planning. It outlines essential considerations and tools to effectively integrate gender throughout different stages of CSA interventions, from design and implementation to monitoring, evaluation and reporting. It also provides examples, drawn from research and community-based projects, where gender has been successfully integrated into climate change work.

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Social protection & decent rural employment

Climate change, poverty and agriculture are closely connected. In the absence of pro-poor policies, an additional 35 to 122 million people may live in poverty by 2030, as a result of climate change. When pro-poor policies are factored in, the number of people pushed into poverty by climate change are projected to fall to an additional 3 to 16 million. The call to take action against poverty in the face of climate change is loud and clear.

Social protection encompasses all sets of policies and programmes aimed at preventing or protecting all people against poverty, vulnerability, and social exclusion throughout their lives. Examples include cash- or in-kind transfers based on environmental or other risks; temporary subsidies; but also training opportunities. Particular attention is given to the most vulnerable groups, including women, indigenous peoples, the elderly and the young. Social protection systems can insulate vulnerable rural households against the impact of climate-related shocks, and allow them to avoid negative coping strategies that may harm the environment or compromise their long-term adaptive capacities. Social protection systems also have the potential to promote the sustainable intensification of agricultural production among poor agricultural producers.

Employment opportunities for the most vulnerable, rural communities are often precarious, poorly remunerated and even hazardous to their well-being. By making the agricultural sectors more sustainable, CSA can contribute to creating decent rural employment within a 'green economy'. The green economy, which aims to improve well-being, social equity, and economic growth while safeguarding the sustainability of natural systems, is estimated to have the potential to create up to 60 million new jobs, with net employment gains being higher in developing countries. Green jobs in rural areas and agricultural enterprises where CSA techniques are used can create much-needed livelihood opportunities especially for youth, and contribute to building more sustainable, climate-smart food systems.

This module looks at the social dimensions of climate change. It highlights the interconnection between agriculture, climate change and poverty, and describes how social protection and decent rural employment can support the objectives of CSA. Social protection through its protective, preventive, promotive and transformative functions strengthens the capacities of countries and individual households to manage climate-related risks and build climate resilience. The module further examines the linkages between CSA and decent rural employment in relation to 'green jobs'.

Climate impact assessments and appraisals of options

There are a number of potential practices that would improve the productivity of local agricultural systems, enhance food security and support livelihoods. Implementing CSA is a context- and location-specific process. No single solution is applicable to all situations. A careful, strategic assessment needs to be made for each policy or programme to evaluate the potential benefits and trade-offs in various social, economic and environmental conditions. Assessments can determine how local climate conditions, and their impact on the agricultural sectors, food security, and livelihoods, have changed, and how they may continue to change in the future. They can also determine whether certain measures are climate-smart or not in a given context. Effective CSA interventions may differ from more traditional agricultural development initiatives and natural resources management approaches.

Climate impact assessments characterize the effects of climate change and identify the most vulnerable locations and contexts that require adaptation actions. Without proper assessments, it is difficult to justify why a transition to CSA is necessary and which CSA activities will achieve the desired results. Knowing which crops or livelihood activities may be more sensitive to a changing climate, for example, will help practitioners choose more resilient crops and adopt more diversified livelihoods. Impact assessments can also provide essential information to stakeholders regarding changing weather patterns and the spatial distribution of precipitation, allowing them to better allocate resources for the management of water resources. A comprehensive understanding of historical and projected changes in climate will allow for informed decision making regarding to CSA policies and programmes.

This module gives an overview of methodologies, frameworks, and principles that support the assessment of the impacts of climate change on agriculture, food security, and livelihoods. It also looks at appraisals of the effectiveness of CSA interventions in enhancing adaptation, mitigation and food security. It focuses mainly on the subnational and national levels. Some case studies, however, address activities at the producer or project level. The module provides practical guidance on how to conduct assessments and appraisals relating to policies and the project's justification and design.

Programme and project monitoring and evaluation

The overall goal of monitoring and evaluation activities is to effectively guide the transition of well-conceived CSA policies into programmes and projects that are successfully implemented on the ground. Climate change is likely to have the most severe impact on groups that are already the most vulnerable and food insecure. CSA interventions must prioritize their needs and concerns as well as contribute to climate change adaptation and mitigation. Monitoring and evaluation must pay particular attention to vulnerable groups and be accountable to them.

Traditionally, programme and project monitoring predominantly deals with tracking progress and intermediate results, and, if needed, making adjustments during project implementation. Monitoring is complemented by evaluation, which primarily deals with the assessment of results and impacts. Expectations for these results and impacts need to be set out clearly at the beginning of a project, and are of particular significance when the project approaches its conclusion.

Given the complexity of climate change and CSA interventions, flexible monitoring and evaluation processes are particularly valuable. With climate change, considerable uncertainty will exist regarding what the actual (as opposed to the predicted) impacts of climate change will be on a given agricultural system. During and beyond the life of a project, weather patterns and their impacts will change continuously as a result of global warming. Smallholder producers and supporting institutions will need to adapt not just once, but constantly. Knowledge on successful adaptation and mitigation practices in various agricultural sectors also depends upon learning by doing, and this knowledge may need to be reconsidered under variable conditions. CSA also pursues various objectives and often involves multiple sectors, and there are often several intervention pathways that can be taken. This means that simple linear logic models based on known and predictable results may have their limits for CSA project planning and monitoring and evaluation. The challenge of climate change requires an adaptive management approach that involves constant innovation, real-time monitoring and evaluation, learning among stakeholders and re-strategizing.

This module presents an overview of important climate change-related monitoring and evaluation activities in programme processes and project cycles, and describes their various purposes. The module provides guidance on how to address monitoring and evaluation issues in CSA context. The module also considers the importance of adaptive management and developmental evaluation in light of the challenge of complexity that climate change and CSA interventions present for planning, monitoring and evaluation. The module also reviews some of the challenges specific to monitoring and evaluation in the context of CSA and offers some guiding principles to help address them.

The theory of change for the CSA approach: A guide to evidence-based implementation at the country level

CSA has ambitious goals that involves a wide range of sectors, stakeholders and disciplines and requires actions that are carried out over multiple geographic scales and time frames. For this reason, the transition to CSA requires changes at many levels of policy making. To facilitate these changes, a new, step-by-step guide for the country-driven implementation of CSA has been developed.

The module introduces a theory of change for CSA and lays out a recommended set of steps for facilitating the integration of CSA approaches in policy making at the national level. Activities that have proven, based on evidence, to contribute to meeting CSA objectives can be implemented at the local level (e.g. promotion of agroforestry), national level (e.g. the delivery of locally relevant and timely weather forecasts) or regional level (e.g. transboundary management of key natural resources, such as water bodies and forests catchment areas). A holistic CSA approach must encompass all these levels to ensure the systemic transformation of agricultural systems in the face of climate change.

CSA is embedded in the pursuit to achieve sustainable food and agricultural production in a changing climate. The theory of change for CSA involves four broad areas of action that are based on a country's needs:

- ✓ the development of an evidence base to motivate, support and monitor change;
- ✓ continuous dialogue with stakeholders;
- ✓ the formulation of tools to enable change; and
- ✓ innovative and multidisciplinary approaches to create and sustain change in food and agricultural systems.

This module develops a theory of change for CSA in policy making, and lays out a set of steps that need to be taken to implement CSA approaches nationally. The module considers how evidence is generated and prioritized and looks at suitable tools and methodologies for doing this. In the theory of change, system-wide capacity development and partnership-building plays an overarching role. For this reason, the module explores the four categories of capacity enhancement that are essential for the sustainable implementation of CSA.

This summary provides an overview of the second, digital edition of the Climate-Smart Agriculture Sourcebook. The new edition includes new findings, case studies and lessons learned. It also takes into account the changes in the landscape of international climate action since the original edition was published in 2013. The 2030 Agenda for Sustainable Development – which encompasses the Paris Agreement on Climate Change, the Sustainable Development Goals and the Addis Ababa Action Agenda – provides an international framework for strong national actions and collective efforts to achieve sustainable development. Climate-smart agriculture, as an approach to achieve sustainable food and agriculture has a vital role to play.

www.fao.org/climate-smart-agriculture-sourcebook