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MINISTRY OF AGRICULTURE

Ethiopia climate-smart agriculture roadmap

2020-2030

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Preface

Ethiopia is a country propelled by smallholder farmers who bolster more than half of the gross domestic product and dominate the national labor force. Ethiopia's agricultural systems, however, are vulnerable to a warming climate and weather extremes including frequent water stress, droughts, floods, and unpredictable rains heralded by climate variability and change. These put into jeopardy the productivity and resilience of Ethiopia's food systems and the quest for food and nutrition security.

Climate-smart agriculture (CSA) is expected to play a key role in tackling these climate-related challenges to agricultural livelihoods and food systems by supporting the transformation of Ethiopia's agricultural systems. The concept of CSA rests upon three foundational pillars of sustainably boosting agricultural productivity, building resilience and adaptive capacity to climate change, and reducing greenhouse gas emissions to mitigate climate change where possible. Such an approach will be critical in ensuring climate-resilient food systems that lay the framework for a food and nutrition secure Ethiopia.

Ethiopia's CSA Roadmap provides important insights into the foremost significance of agriculture for our country, key risks and vulnerabilities that our food systems and agricultural livelihoods face in a changing climate, as well as the national policy architecture of agricultural systems and climate change. The roadmap proposes key CSA actions that can be implemented at scale to ensure resilient food systems, build the enabling institutional environments that can promote such mainstreaming, promote the centrality of gender and social inclusion for our agricultural systems and develop capacity that can strengthen national efforts for adaptive, resilient and transformative food systems and agricultural livelihoods in Ethiopia.

Minister of Agriculture
of the Federal Democratic Republic of Ethiopia

Acronyms

ACSAA	Africa Climate-Smart Agriculture Alliance
ADLI	Agricultural Development Led Industrialization
AGP	Agricultural Growth Program
AGRA	Alliance for a Green Revolution in Africa
APACC	Agriculture Sector Program of Plan on Adaptation to Climate Change
CAADP	Comprehensive Africa Agriculture Development Programme
CALM	Climate Action through Landscape Management
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Center
CRGE	Climate Resilient Green Economy
CSA	Climate-smart agriculture
DA	Development agents
DRSLP	Drought Resilient and Sustainable Livelihoods Program
DTMA	Drought Tolerance Maize for Africa
EPACC	Ethiopian Program of Adaptation to Climate Change
EthioSIS	Ethiopian Soil Information System
FACASI	Mechanization and Conservation Agriculture for Sustainable Intensification
FAO	Food and Agriculture Organization of the United Nations
FEED	Feed Enhancement for Ethiopian Development
FMNR	Farmer-managed natural regeneration
FTC	Farmer training center
GDP	Gross domestic product
GGWSSI	Great Green Wall for the Sahara and the Sahel Intitive
GHG	Greenhouse gas
GTP	Growth and Transformation Plan
ICT	Information and communications technology
ILRI	International Livestock Research Institute
INDC	Intended Nationally Determined Contribution
LFSDP	Livestock and Fisheries Sector Development Project
LLRP	Lowlands Livelihood Resilience Project
MDGs	Millennium Development Goals
MERET	Managing Environmental Resources to Enable Transitions
MoA	Ministry of Agriculture
MRV	Measurement, reporting and verification
NAFSIPs	National Agricultural Food Security and Investment Plans
NAIPs	National Agricultural Investment Plans
NAP	National Adaptation Plan
NAPA	National Adaptation Program of Action
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organization
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PCSL	Program for Climate-Smart Livestock Systems
PIF	Policy and investment framework
PRIME	Pastoralist Areas Resilience Improvement through Market Expansion
PSNP	Productive Safety Net Program
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RLLP	Resilient Landscapes and Livelihoods Project
RPLRP	Regional Pastoral Livelihoods Resilience Project
SDPRP	Sustainable Development and Poverty Reduction Program
SIMLESA	Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa
SLMP	Sustainable Land Management Program
STMA	Stress Tolerance Maize for Africa
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change

Contents

Executive summary

Photo credit: CCAFS/Dawit Solomon

This roadmap is developed based on a context analysis of Ethiopian agriculture. The roadmap aims to strengthen the role of the Ministry of Agriculture (MoA) in addressing vulnerabilities facing the agriculture sector under changing climatic conditions by institutionalizing climate-smart agriculture. The roadmap is largely informed by the overarching country Climate Resilient Green Economy (CRGE) strategy; review of scientific literature; sectoral documents on Ethiopian agriculture and climate-smart agriculture; and related reports from government, development partners, scientific publications, expert comments on the draft and inputs obtained from several senior experts on two presentations made during climate-smart agriculture platform meetings conducted in May and November 2019.

The context analysis included highlights on the importance of agriculture in Ethiopia, the vulnerabilities of the sector, entry points for climate-smart agriculture interventions, review of policy documents related to agriculture and climate change, review of scientific literature on climate-smart agriculture approaches and its practice in the Ethiopian agriculture, and opportunities and challenges of mainstreaming climate-smart agriculture. The roadmap document also incorporates practices and experiences from Ethiopia and beyond on reducing vulnerability, increasing adaptive capacity, addressing specific risks related to climate variability and climate change, exploring sector-specific opportunities in the context of a changing climate, enhancing sectoral coordination and cooperation, and promoting communication and research. Analysis of crosscutting issues such as enabling institutional and policy factors related to climate-smart agriculture and the gender dimension are also included in the review.

The roadmap is presented in two main parts—farm and landscape levels. The farm level roadmap is focused mainly on farm management practices and trade-offs of transitioning the agricultural sector to withstand the climate change challenge. The landscape level roadmap aims at synergizing the opportunities of current soil and water conservation project-based standalone practices and trade-offs of integration across practices on land, water, energy and other livelihood areas. The roadmap is expected to guide actions on mainstreaming climate-smart agriculture at all levels of the sector including public, private and development partner interventions.

The roadmap is expected to:

- Contribute to increasing productivity and growth of climate-smart agriculture related value chains with nutrition and gender considerations.
- To enhance resilience to climatic and weather shocks on the social, environmental, and economic aspects of agriculture production and food systems;
- Contribute to low carbon development through efficient use of agriculture and agribusiness to reduce national emission intensity in the agriculture production and food systems;
- Contribute to the strengthening of governance and institutional coordination for effective implementation of the climate-smart agriculture at the federal and regional levels.

1. Background

Photo credit: CCAFS/IRI/Jacquelyn Turner

Agriculture is the main source of Ethiopian livelihoods and the backbone of the national economy. Faced with growing climate threats, resilient agricultural systems are vital for Ethiopia's future.

1.1. Agriculture in Ethiopia

Agriculture—which includes crop production[1], livestock, forestry, fisheries and apiculture—remains by far the most important economic sector in Ethiopia. No other economic sector is more vital in safeguarding human livelihoods than agriculture in Ethiopia. More than 85% of the Ethiopian population depend on agriculture directly or indirectly for their livelihoods (FAO 2011a). Of the total number of farming households, 25% are women headed. The sector contributed 34.8% to the country's GDP and accounted for 70% of employment as of 2017 (CIA 2019). It is a major contributor to export earnings with over 85% of exports almost entirely composed of agricultural commodities. Coffee fetches the largest foreign exchange for the country. The sector is also the main source of raw materials for agro-industries. Studies often show that growth based on agriculture makes a stronger contribution than industrial growth since agriculture has greater multiplier effects and the benefits from agricultural growth are often shared equitably among the majority of the population.

Agriculture in Ethiopia is dominated by rainfed smallholder mixed crop-livestock farming (Georgis et al. 2010). Smallholder agriculture with average farm size ranging from 0.5–2 ha contributes to 95% of the total agricultural production and supports the livelihood of millions of people (Jirata et al. 2016). Crop production is the dominant sub-sector

[1]Includes coffee, enset, pulses, oilseeds, cereals, potatoes, sugarcane, fruits and vegetables

within agriculture. Because of diverse agroecological zones, topography and natural vegetation, Ethiopian smallholder farmers have developed complex farming methods and cropping patterns. Farming is practiced under five major farming systems of highland mixed farming, lowland mixed agriculture, pastoral systems, shifting cultivation and commercial agriculture (Degefe and Nega 2000). In crop farming, seven different cereal crops, six pulse crops, seven oilseed crops and a number of other different fruit and tree crops are grown (Mulat et al. 2004). Coffee, sesame, flowers, fruits and vegetables are Ethiopia's major agricultural exports.

The livestock sector is one of the largest in the world in terms of animal head counts and contributes 16–20% to the national GDP and represents a key subsistence source for more than 10 million pastoralists and 10% of the country's foreign currency earnings (MacDonald and Simon 2011; Mulat et al. 2004; Pantuliano and Wekesa 2008). Cattle, sheep, goats, camels, equines and poultry constitute the major livestock herd in Ethiopia. In the highlands, livestock is considered as a security during crop failure, an investment and additional income for farmers. Livestock also serve as source of draught power for crop production, raw material input for industry (e.g. hides and skins, wool, hair, etc.) and source of manure for fertilization. Equines are the major transport services in rural areas. The role of livestock as a source of food is critical for both highland and lowland inhabitants. In the lowland agroecological setup with pastoral production system, livestock do not provide inputs for crop production but are the backbone of life for their owners, providing all of the consumable and saleable outputs, and representing a living bank account and insurance against adversity (Coppock 1994). The main food contributions of livestock include, among other things, meat and meat products, milk and milk products, eggs, and honey. In mixed farming systems of the highlands, 26% of the livestock output is used as food, while in pastoral areas where livestock forms the main source of livelihood, this proportion increases to 61%. Ethiopia exports beef and live animals, especially to the Middle East and North Africa.

1.2. Vulnerabilities of Ethiopian agriculture

Vulnerability describes exposure, sensitivity and capacity to respond to negative impacts of climate change. Agricultural activities are by nature prone to risks and uncertainties of various nature emanating from environmental factors such as climate change, soil erosion and land degradation. Weak extension services also pose a risk. Much of these risks have a climatic component and most of them are affected by climate change, either in intensity, scope, or frequency. Greater frequency of extreme events such as increased temperatures, less predictable rainfalls, changing rainfall patterns, shorter rainy seasons, repeated frequent floods and droughts increase uncertainty and risk in agricultural production. Ethiopian agriculture is not immune to these challenges. Long-term changes in temperature slowly lead to fundamental changes in plant and animal species that can be used for agriculture in a particular location. In Ethiopia for example, the deterioration of rangelands and increase in woody browses can be expected to result in an increasing number of pastoralists maintaining mixed herds of browsing animals like camels and goats with smaller number of cattle and sheep (Kefyalew and Tegene 2012). Emergence of new pests and diseases, as well as new trading patterns are likely. Ethiopian agriculture is extremely sensitive to shifts in weather and is among one of the country's most vulnerable sectors to the impact of climate variability and change (Kassie et al. 2013). Various studies indicate that the trends in inter-annual and inter-seasonal rainfall variability—decline in amount, increase in intensity, variability in the length of growing seasons, increase in temperature—have negative implications on crop and livestock productivity affecting the income of rural households negatively (Kassie et al. 2013; Getachew 2015). Rain-fed, low-input, low-output agriculture, which supports the livelihoods of the majority of the population, is highly sensitive to climatic conditions. Its performance is highly dependent on the timely onset, duration, amount and distribution of rainfall. Changing rainfall patterns, in combination with warming trends, make rainfed agriculture riskier and

aggravate food insecurity in Ethiopia. Recent rainfall data show trends of overall declines in rainfall between March and September from 1980 to the present. These declines have been mostly marked in belg season-(February–May) dependent areas leading to more intense and frequent droughts across different parts of the country. In addition, some analysts suggest that there has been a shift in the timing of rainfall, leading to more erratic and unpredictable precipitation patterns.

Changes in regular crop planting times, length of growing season and shifts in suitable crop types or cultivars are among the main effects of climate change on crop production. For example, in the Central Rift Valley, areas used for growing chick pea, peas and long maturing sorghum varieties are now growing medium or early maturing varieties of other crops (ICRA 1999). The same report mentions that replacement of maize and sorghum over time by teff owing to early maturity, late planting and lower total water consumption has been observed in most of the semi-arid regions. Conventional cultivation practices such as excessive tillage, overgrazing and the complete removal of crop residue at harvest, leave the soil unprotected and trigger soil erosion, particularly during rainy seasons. According to Zeleke and Hurni (2001), an estimated soil loss of 1,493 million tons per year is observed in the Ethiopian highlands, while Tadesse (2001) indicated grain yield loss of up to 1.5 million tons per year. Pests and diseases, atmospheric carbon dioxide and lower nutritional quality of some foods are also other dimensions of the impact. In livestock production, changes in patterns of rainfall and temperature, and frequent and extensive droughts affect feed availability; shrink available water resources; reduce productivity and feed quality of grasslands and rangelands; reduce livestock productivity; and increase weed, pest and disease incidence (Coffey 2008). Moreover, limited agricultural inputs, poor cultivation practices, poor complementary services such as extension and veterinary, credit, marketing and infrastructure, frequent pest and disease outbreaks, and other production and market risks are challenges for the sector.

According to Smith et al. (1996), climate change affects animal production in four ways: changes on livestock feed-grain availability and price; livestock pastures, forage crop production and quality; livestock diseases and pests; and direct effects of weather and extreme events on animal health, growth and reproduction. The effects of climate change on livestock production are further elaborated by Thornton et al. (2009) and Kipkoech et al. (2015). Feed shortage, digestibility and nutritional quality of forage, shortage of water, livestock genetic resources loss, reduced productivity, and decreased mature weight and/or longer time to reach mature weight are among the major ones mentioned. Changes in patterns of rainfall and temperature affect feed availability, grazing ranges, feed quality, weed, pest and disease incidences. The indirect effects of climate-driven changes in animal production may result mainly from alterations in the nutritional environment. Higher temperatures tend to reduce animal feed intake and feed conversion rates (Rowlinson 2008; Topp and Doyle 1996). Thus, changes in climatic factors such as temperature, precipitation and the frequency and severity of extreme events like droughts directly affect livestock yields. During extended dry periods, there is less access to pasture and water for livestock. The combination of drought and overgrazing, particularly near watering points, destroys vegetation cover and increases soil erosion. Livestock diseases cause rapid loss of livestock assets and reduce milk supply, reproduction and draught power during disaster incidence. The physical weakness of livestock at this time makes them susceptible to different diseases. Rrinderpest, pasteurolosis, contagious bovine pleuropneumonia, foot and mouse disease, anthrax, bloody diarrhea, skin and lung diseases, and internal and external parasites are some of the critical infectious diseases and pests attacking livestock during drought and flood hazards (Afar National Regional State 2010).

Ethiopia is characterized by food insecurity emanating from environmental challenges and other structural and institutional factors. Many government initiatives aimed at increasing food production and ensuring national food security have made little progress. As a result, many rural households find it impossible to survive without access to seasonal employment or aid from the productive safety net and related social protection programs. Significant areas with high livestock populations tend to be arid. Hence, the harsh effect of climate change has maximum impact on vulnerable pastoral communities engaged in extensive livestock production systems in drylands (Aklilu et al. 2013). Farmers and herders still rely on age-old technologies and agricultural management practices that are outdated and often unsustainable. There is limited mechanization that

makes farming labor-intensive and time-consuming. Constraints in crop production include limited availability of improved, hybrid or short maturing seeds; lack of seed multiplication capacity; low profitability and efficiency of fertilizer use due to the lack of complimentary improved practices and seed; and limited irrigation due to shortage of water. In addition, lack of transport infrastructure and market access decreases the profitability of adopting improved practices (Kate and Leigh 2010). Concerning livestock, the constraints commonly mentioned are diseases, feed shortage, limited infrastructure and research, limited demand, and institutional policy. Open range free grazing, often with no supplemental feeds, and animals that are predominately local breed with low milk productivity are the dominant characteristics of livestock production in Ethiopia (EPCC 2015; Feleke 2003).

1.3. Objectives and scope of the roadmap

The objective of this document is to develop a climate-smart agriculture roadmap that helps to address land degradation, build resilience and minimize emissions from agricultural farming systems for enhanced food and nutritional security and improved livelihoods.

Developing a climate-smart agriculture roadmap for the agricultural sector requires a review of existing policy and strategy documents. It also requires understanding of the current status of the sector's capacity and institutional coordination that cut across a number of stakeholders. The roadmap is informed by principles of good practice and adapted based on specific circumstances and contexts. It followed a cross-sectoral approach which takes advantage of potential synergies. It entails improving efficiency in the use of resources; direct action to conserve, protect and enhance natural resources; and enhance resilience of people, communities and ecosystems, especially to climate change. Improving coordination and collaboration among institutions and stakeholders in climate-smart agriculture contributes to overcome mainstreaming bottlenecks and challenges.

1.4. Current policies on climate change and agriculture

Ethiopia's policy response to challenges of climate change are many although there is no direct mention of climate-smart agriculture. However, several of Ethiopia's development and sectoral policies and programs already deal with climate change, even before climate change became one of the most important factors in sustainable development. The CRGE objectives and guiding principles, the productive safety net program (PSNP) and the sustainable land management program (SLMP) already share the goals of climate-smart agriculture for sustainable development. Early actions on climate change have allowed the country to prepare for short- and long-term agricultural adaptation and mitigation actions closely linked with national food security and nutrition policies. What remains to be done is creating awareness about the policies and promoting their implementation at all levels. One way of doing this could be mainstreaming the policies into agricultural extension and research. Moreover, establishing a legally binding institutional framework for greater coordination and integration among institutions, and synergy among programs/projects is vital. Some of the key policy responses relevant to climate-smart agriculture are listed in Table 1 below.

Table 1. Summary of key policies, laws and strategies relevant to the adoption of climate-smart agriculture practices in Ethiopia

Policy	Year	Intention/goal
Agricultural development led industrialization (ADLI) strategy	Since 1993	Agriculture is the main source to generate primary surplus that fuel the growth of other sectors; notably, industry, infrastructure, social services and other tailored interventions to address the specific needs of the country's varied agroecological zones.
National energy policy	1994	This is a comprehensive national energy policy with the goal of addressing the problem of energy supply and utilization.
Article 43 and 44 of the Constitution	1995	Provides guidance regarding environmental rights and promoting sustainable development.
Environmental policy of Ethiopia	1997	Gives overall guidance in the conservation and sustainable utilization of the country's environmental resources.
Environmental impact assessment proclamation	2002	Ensures that the environmental implications are taken into account before decisions are made.
Sustainable development and poverty reduction program (SDPRP)	2002–2005	This is a poverty reduction strategy that aimed at achieving the MDGs.
Plan for accelerated and sustained development to end poverty (PASDEP)	2006–2010	This is a poverty reduction program that was formulated to achieve the MDGs.
Community-based participatory watershed development strategy	2005	This is a guide on how to plan, design and implement community watershed development activities. The Guideline provides consolidated and normative information for field workers and woreda sector offices.
Ethiopian policy and strategy on the development, conservation and use of forests	Since 2006	This was designed to meet public demand in forestry products and foster the contribution of forests in enhancing the economy of the country by appropriately conserving and developing forestry resources.
National Adaptation Program of Action (NAPA)	2007	The NAPA represented the first step in coordinating adaptation activities across government sectors.
REDD+ strategy	Since 2008	This shows alternative mechanisms for financing forestry development in Ethiopia and enhancing the country's climate change mitigation potential.
CAADP compact	2009	One of the pillars of CAADP is extending the area under sustainable land management and reliable water control systems.
Growth and Transformation Plan (GTP I and II)	Since 2010	The Growth and Transformation Plan (GTP) strategic framework for the period 2010–2020 recognizes the environment is a vital pillar of sustainable development.
Ethiopia's agricultural sector policy and investment framework (PIF)	2010–2020	Provides a strategic framework for the prioritization and planning of investments that will drive Ethiopia's agricultural growth and development
Agriculture sector program of plan on adaptation to climate change (APACC)	2011	This is the agriculture sector climate change adaptation plan.
Ethiopian program of adaptation to climate change (EPACC)	2011	This provides more programmatic approach to adaptation planning. It seeks to build a climate resilient economy through adaptation at sectoral, regional and community levels. The EPACC updates and replaces Ethiopia's National Adaptation Program of Action (NAPA) which was formulated in 2007 and submitted it to the UNFCCC Secretariat.
Climate resilient green economy strategy	2011	This strategy is Ethiopia's overarching strategy to become carbon-neutral middle-income status before 2025.
Ethiopian soil information system (EthioSIS)	2011	A national soils database and soil fertility map of Ethiopia was developed through a combination of remote sensing and in-field sampling to determine soil nutrient deficiencies and develop tailored fertilization regimes.
Working strategy for strengthening Ethiopia's teff value chain	2013	Includes nutrient management practices through legumes in crop rotations to supply biologically fixed atmospheric nitrogen as a replacement or supplement for inorganic nitrogen fertilizer.
National policy and strategy on disaster risk management	2013	This is a disaster risk management framework, including early warning and risk assessment, information management, capacity building and integration of disaster risk reduction into development plans. It mainly focuses on droughts.
National Strategy for Ethiopia's Agricultural Extension System	2014	To transform Ethiopia's agriculture through implementation of pluralistic extension system and by providing demand-driven and market-led extension services to male, female and youth farmers, pastoralists and agro pastoralists and contribute to the achievements of GTP-2 goals.
Ethiopia's climate-resilient green economy climate resilience strategy: water and energy	2015	This is a sectoral chapter of the resilience strategy of the CRGE. It focuses on water and energy.

Growth and Transformation Plan (GTP-II)	2015	GTP II is the second federal, 5-year national development plan.
Policy	Year	Intention/goal
Agriculture and forestry climate change resilience roadmap	2015	This is a sectoral chapter of the resilience strategy of the CRGE focusing on agricultural crops, livestock, forestry, food security and disaster prevention under a transformation of the agriculture and forestry sectors into services and industry.
Water and energy climate resilience strategy	2015	Another sectoral chapter of the resilience strategy of the CRGE addressing rainfall variability challenges on hydropower and food security.
Intended nationally determined contribution (INDC)	2015	This gives details on emission reduction targets as well as broader climate change mitigation and adaptation strategies. Sectors included are agriculture (livestock and soil), forestry, transport, electric power, industry (including mining) and buildings (including waste and green cities)
Climate smart indicators for GTP II results framework	November 2017	This is a handbook for climate-smart indicators and part of the agriculture sector indicator handbook.
Guideline for mainstreaming CRGE	2018	This guideline is developed to provide guidance for the agriculture sector, particularly for the Ministry of Agriculture and Natural Resources and the Ministry of Livestock and Fishery to mainstream CRGE and climate-smart agriculture into different programs and projects in the sector and at policy level.
Climate-smart agriculture: a field manual for extension workers	2019	This document aims to implement sustainable agriculture production system by capacitating extension workers.
Ethiopia's climate resilient green economy national adaptation plan, Federal Democratic Republic of Ethiopia (NAP-ETH)	2019	The goal of NAP-ETH is to reduce vulnerability to the impacts of climate change by building adaptive capacity and resilience. It aims to strengthen holistic integration of climate change adaptation in Ethiopia's long-term development pathway, supported by effective institutions and governance structures, finance for implementation and capacity development and strengthened systems for disaster risk management and integration among different sectors.
Revised watershed development strategy of Ethiopia	2019	This strategy identifies "poor climate change adaptation" as a bottleneck to watershed development and proposes measures to address it.
Development, Management & Utilization of Community watersheds Proclamation	2020	Emphasizes on the need to rehabilitated degraded areas, natural resources depletion, biodiversity conservation, and reduce GHG to maintain the productivity of land
Updated Community Based Participatory Watershed Development Guideline (under printing)	2020/21	Guide on how to plan, design and implement community watershed development activities. The Guideline provides consolidated and normative information for field workers and woreda sector offices

Source: Ethiopia climate-smart agriculture scoping study (Jirata et al. 2016)

Ethiopia is a signatory to a number of multilateral agreements that have a bearing on the sustainable development efforts of the country. Ethiopia has signed and/or ratified many of the international conventions and protocols related to climate change and land degradation including the United Nations Framework Convention on Climate Change (1994), the Convention on Biological Diversity, the United Nations Convention to Combat Desertification (UNCCD) as well as the UN Sustainable Development Goals. Ethiopia's agricultural sector policy investment framework (PIF) listed in Table 1 above is consistent with the CAADP Pillars.[2]

[2]CAADP technical review summary of key findings for Ethiopia, Addis Ababa (September 2010)

2. Climate-smart agriculture

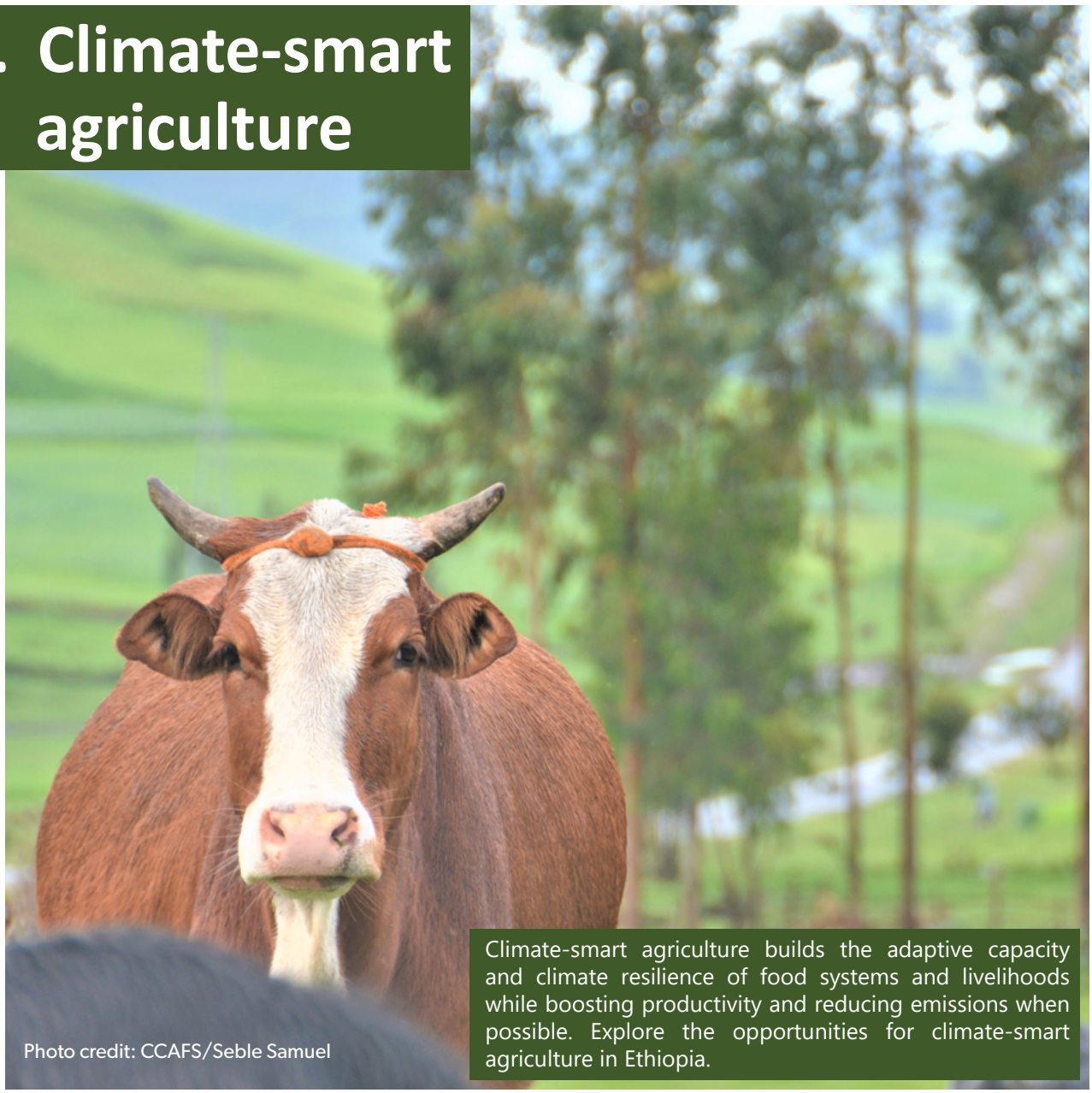


Photo credit: CCAFS/Seble Samuel

Climate-smart agriculture builds the adaptive capacity and climate resilience of food systems and livelihoods while boosting productivity and reducing emissions when possible. Explore the opportunities for climate-smart agriculture in Ethiopia.

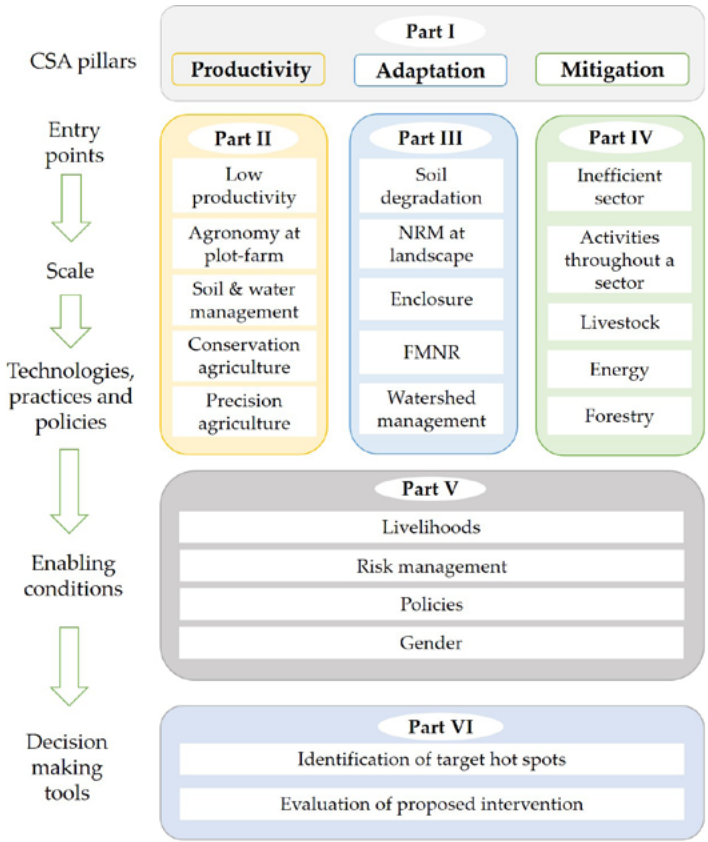
Agriculture has to address three intertwined challenges simultaneously: ensuring food security through increased productivity and income, adapting to climate change and contributing to climate change mitigation (Thornton et al. 2018; FAO 2010). Climate-smart agriculture does not prescribe interventions. Instead, climate risks are addressed by tackling trade-offs and synergies between the three objectives (Rosenstock et al, 2016). It is an approach that brings together agricultural practices, policies, institutions and financing in the context of climate change. It is a way to guide the needed changes in agricultural systems given the necessity to jointly address food security and climate change. It has multiple entry points ranging from the development of technologies and practices to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains, and the strengthening of institutional and political enabling environments. As such, it goes beyond single technologies at the farm level and includes the integration of multiple interventions at the food system, landscape, value chain or policy levels. It also involves innovative practices such as improved weather forecasting, early warning systems and climate risk insurance (Jirata et al. 2016).

Farm landscape in SNNPR
Photo credit: CCAFS/Seble Samuel

Sheep commonly kept in SNNPR
Photo credit: CCAFS/Seble Samuel

It gives farmers tools and a pathway to make their operations and livelihoods more productive and resilient in the face of climate change while also helping reduce their climate impacts. It integrates the three dimensions of sustainable development—social solidarity, environmental responsibility and economic efficiency—by jointly addressing food security and climate change challenges (Nciizah and Isaiah 2015). Figure 1 below provides an illustration of climate-smart agriculture interventions.

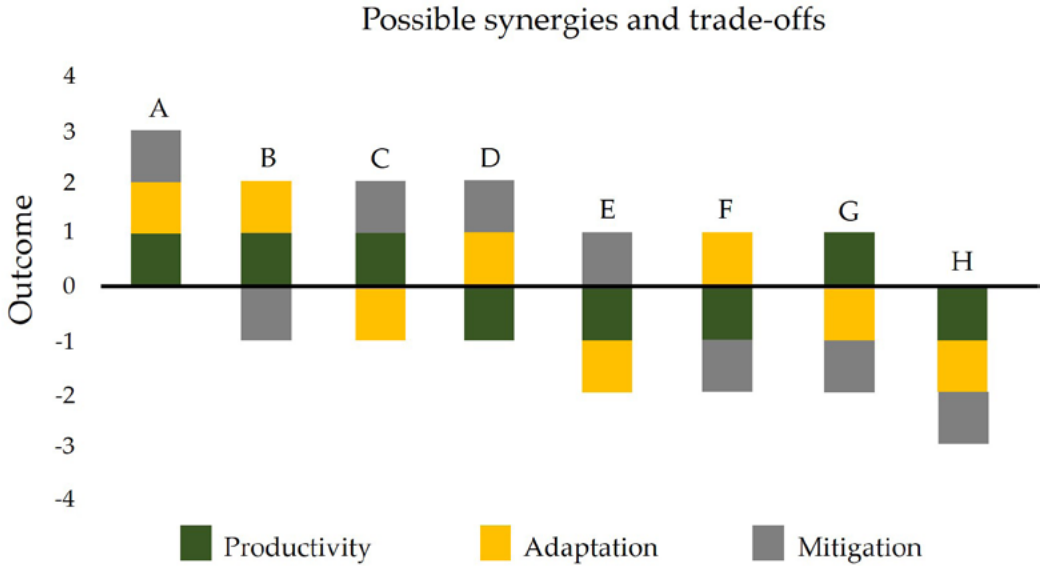
Figure 1: Approach to climate-smart agriculture interventions



Source: Thornton et al. 2018

Climate-smart agriculture systematically integrates climate change into the planning and development of sustainable agricultural systems (Lipper et al. 2014). Interventions take into account how different elements interact at the landscape level, within or among ecosystems and as part of different institutional arrangements and political realities. It assesses the risks and needs of a specific farm or farming community through a climate impact lens, then addresses them using practices chosen for that particular situation. In choosing appropriate climate-smart agriculture interventions for a specific area, it analyzes the site-specific socioeconomic and institutional context, as well as the prevailing agroecological conditions and potential climate change scenarios, risks and impacts. However, this does not imply that every practice applied in every location should produce "triple wins" since achieving benefits in all three dimensions is difficult. Because of this, necessary choices among competing investments and objectives must be made. Hence, climate-smart agriculture seeks to identify and reduce trade-offs and promote synergies by taking these objectives into consideration to inform decisions at all scales and derive nationally and locally acceptable solutions in line with the national development goals over short- and long-term. Figure 2 provides an illustration of how climate-smart agriculture can generate synergies and trade-offs across climate-smart agriculture pillars.

Figure 2: Climate-smart agriculture pillars: outcomes of trade-offs and synergies



Source: Mwongera et al. 2017

For example, Option A in the figure is an ideal situation where all gains from climate-smart agriculture are realized. In option B, there is a gain in productivity and adaptation, but a loss in mitigation. Option F presents a gain in adaptation and a loss in both productivity and mitigation. These two situations are our entry points, where we plan to mainstream site specific climate-smart agriculture intervention to maintain the triple win. Option H is not desirable as it compromises all the three pillars. Option G represents the business-as-usual situation.

Climate-smart agriculture takes into consideration the diversity of social, economic and environmental contexts, including agroecological zones and farming systems where it will be applied. The focus is generally on improving currently existing techniques, such as the usage of fertilizers and pesticides, but with better-applied efficiency and improved seeds (for instance, drought tolerant seeds). Table 2 shows how climate-smart agriculture differs from conventional agriculture.

Examples of proven practical techniques of climate-smart agriculture that could enhance adaptive and resilience capacity include use of drought-resistant crop varieties, stress-adapted livestock breeds, diversified cropping system, intercropping, conservation agriculture, crop rotation, mulching, reducing post-harvest losses, integrated crop-livestock management, agroforestry, improved

grazing, improved water management, integrated soil fertility management market linkages, climate smart value chains, and innovative practices such as better weather forecasting, more resilient food crops and risk insurance (Jirata et al. 2016; FAO 2013; Boto et al. 2012).

Table 2. Climate-smart agriculture versus conventional agriculture

How does climate-smart agriculture differ from conventional agriculture?	
Key features of conventional agriculture intensification	**Key features of climate-smart agriculture**
Conversion of energy source from human to animal and fossil fuel dependent machinery	Use of energy efficient technologies for agricultural power (irrigation or tillage)
Increased use of fertilizers, pesticides and herbicides (highly dependent on fossil fuels) generally very inefficiently applied	Increased efficiency of fertilizers and wider use of organic fertilizers
Expansion of agricultural land area through deforestation and conversion from grasslands to croplands	Intensification on existing land areas as main source of production increase rather than expansion to new areas
Increased specialization in agricultural production and marketing systems	Greater diversification in production, input and output systems
Emphasizing improved and hybrid crop varieties	Valuing the resilience of traditional varieties

2.1. Gender and climate-smart agriculture

Women in Ethiopia contribute up to 40-60%[3] of labor in the production process. However, women face specific constraints that reduce their productivity and limit their contributions to agricultural production and productivity. Climate change affects men, women, boys and girls in different ways. There is a clear linkage between agriculture and women. Women play a major role in agriculture as farmers, workers and entrepreneurs. Women farmers are more exposed to climate risks compared to men for many of the same reasons that farm productivity is lower for female farmers than males—women have fewer endowments and entitlements, less access to advisory information and services, financial capital, and they are less mobile and have limited control over farm labor (Jost et al. 2016). In most cases, women tend to be excluded from decision-making and may not benefit from technologies and practices that could help them adapt to new climatic conditions. There is an international consensus that the design and implementation of climate change response strategies and projects must consider gender-specific differences in the capacity to adapt to and mitigate climate change (FAO and the World Bank 2017). Hence, for climate-smart agriculture interventions to be more effective and sustainable, they must be designed to address gender inequalities and discrimination against people at risk (Twyman et al. 2014). A gender-responsive approach to climate-smart agriculture must identify and address the different constraints faced by men and women and recognize their specific capabilities. Gender-responsive climate-smart agriculture projects must reduce gender inequalities and ensure that men, women, boys and girls can equally benefit from climate-smart agriculture interventions and practices, thus achieving more sustainable and equitable results. A growing body of evidence demonstrates that more equal gender relations within households and communities lead to better agricultural and development outcomes, including increase in farm productivity; improvement in family nutrition; reduction in labor loads; and participation in decision-making in households, communities and national agendas (FAO 2011b; Nyasimi and Huyer 2017). It has been estimated that if rural women had the same access to agricultural resources as men, yields could increase by 20–30% and the total number of hungry people around the world would reduce by 12–17% (FAO 2011b). Researches need to enhance climate-smart agriculture intervention by considering the ergonomics in the working environment of women, women-appropriate farm implements and technologies, etc.

[3]Agricultural Transformation Agency, Ministry of Agriculture, 2014. National Strategy for Ethiopia's Agricultural Extension System - Vision, Systemic Bottlenecks and Priority Interventions

A model female farmer showcasing her climate-smart crops in Doyogena, Ethiopia. Photo credit: CCAFS/Seble Samuel

2.2. Existing and promising climate-smart agriculture practices and services

Ethiopian agriculture is diverse in terms of climatic zones, food production systems and socioeconomic conditions. Agriculture is considered climate-smart when it sustainably increases agricultural productivity and incomes, builds resilience to climate change and reduces greenhouse gas emissions (Harvey et al. 2014; Brandt et al. 2015). A scoping study conducted by FAO (2016) across Ethiopia examined the different agricultural practices and came with the list of climate-smart agricultural practices currently practiced by smallholder farmers in Ethiopia. Despite high usage of traditional production methods, there is evidence of increased use of organic fertilizers; adoption of crop varieties with higher resistance/tolerance to drought, pests, and diseases; increased use of irrigation schemes; agroforestry that combine trees and shrubs with crops; improved livestock feeding practices and rangeland management; switching to livestock species or breeds that are more adapted to water scarcity and resistant to disease; and reduction of herd size while increasing productivity as attempts to increase productivity and resilience.

Women at a market in Hosana. Photo credit: CCAFS/IRI/Jacquelyn Turner

There are also promising landscape natural resource management practices such as exclosures which prohibit people and livestock interference on hillsides and mountainous areas protected for restoration purposes; and farmer managed natural regeneration, which is a systematic regeneration and management of underground vegetation with live roots and seeds within the soil. These methods have already been successfully applied in some parts of northern and southern Ethiopia. In addition, the climate resilient agricultural and forestry strategy has identified 41 promising programmatic options on adaptation that have relevance to climate-smart agriculture intervention. Table 3 below shows the list of most common climate-smart agriculture practices across Ethiopia (FAO and the World Bank 2017; Jirata et al. 2016).

Table 3. Common agricultural practices and their climate-smart agriculture attributes

Agricultural practices	Components	Why it is climate smart
Conservation agriculture	• Reduced tillage • Crop residue management (mulching) • Crop rotation/intercropping with cereals and legumes	• Carbon sequestration • Reduces existing emissions • Resilience to dry and hot spells • Enhances soil fertility resulting in improvement in
Integrated soil fertility management	• Compost and manure management, including green manuring • Efficient fertilizer application techniques (time, method and amount)	• Reduced emission of nitrous oxide and CH4 • Improved soil productivity
Small-scale irrigation	• Year-round cropping • Efficient water utilization	• Creating carbon sink • Improved yields • Improved food security
Agroforestry	• Tree-based conservation agriculture practiced both traditionally and as improved practice • Farmer-managed natural regeneration	• Trees store large quantities of CO2 • Can support resilience and improved productivity of agriculture
Crop diversification	• Popularization of new crops and crop varieties • Pest resistance, high yields, tolerant to drought, short seasons	• Ensuring food security • Resilience to weather variability • Alternative livelihoods and improved incomes
Improved livestock feed and feeding practice	• Reduced open grazing/zero grazing • Forage development and rangeland management • Feed improvement • Livestock breed improvement and diversification	• Improved livestock productivity • GHG reduction • CH4 reduction
Improved animal husbandry	• Animal breed improvement, improved animal health system • improved manure management practices	• Improved livestock productivity • GHG reduction • CH4 reduction
Other	• In situ water conservation/harvesting • Early-warning systems and improved weather information • Support to alternative energy (fuel-efficient stoves and biofuels) • Crop and livestock insurance • Livelihoods diversification, • Post-harvest technologies (geoprocessing and storage)	• Resilience of agriculture • Improved incomes • Reduced emissions • Reduced deforestation • Reduced climate risk

Source: Ethiopia climate-smart agriculture scoping study (Jirata et al. 2016)

Currently, agricultural development activities carried out in the country are supported by a number of policies, strategies and institutions. Of the numerous agricultural development activities conducted, those that are considered important in addressing issues related to climate change and are contributing to climate change adaptation and mitigation should be mentioned. Table 4 below shows some examples of projects implemented in the country.

Table 4. Key country relevant bilateral and multilateral climate related projects

No	Program/project	Intervention year	Project objectives
1	MERET project	Since 2003	Water harvesting, reforestation, seedling production, soil fertility management and construction of farmland terraces
2	PSNP	Since 2005	Enabling the rural poor facing chronic food insecurity to resist shocks, create assets and become food self-sufficient. PSNP builds community assets through climate-smart public works.
3	Humbo Assisted Natural Regeneration project (afforestation and reforestation)	Since 2006	Rehabilitation of degraded forests through assisted natural regeneration. Crops surrounding reforested areas benefit through modification of the microclimate, which comes about through a combination of reduced wind speed, lower temperatures, higher humidity and greater infiltration of water into the soil.
4	SLMP	Since 2008	Reducing land degradation in agricultural landscapes and improving agricultural productivity for smallholder farmers. SLMP promote climate-smart agriculture and integrated land management practices that internalize climate induced risks and the conservation of biodiversity and soil.
5	Great Green Wall for the Sahara and the Sahel Initiative (GGWSSI)	Since 2008	Reinforcing the Climate Resilient Green Economy (CRGE) strategy
6	CIMMYT implemented project, Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA)	Since 2010	Increasing farm-level food security and income through conservation agriculture technologies that ensure sustainability and productivity
7	R4 Rural Resilience Initiative, Oxfam America and the World Food Programme	2010	Building resilience to climate change for long-term food security and livelihood improvement. It was aimed at enabling vulnerable rural households to increase their food and income security in the face of increasing climate risks through a combination of risk management strategies: improved resource management (risk reduction), insurance (risk transfer), microcredit (prudent risk taking) and savings (risk reserves).
8	AGP	Since 2011	Sustainably increase agricultural production and productivity of selected crop and livestock commodities, establish market linkages and accelerate commercialization, build the capacity of smallholder farmers for efficient water and crop management, improve dietary diversification for better health, and strengthen the capacity of smallholder farmers to adopt and implement climate change mitigation and adaptation measures
9	CIMMYT implemented Drought Tolerance Maize for Africa (DTMA) and Stress Tolerance Maize for Africa (STMA)	2012–2019	Develop and deliver drought and other stress tolerant maize varieties to smallholder farmers
10	Climate-Smart Push-Pull Technology Promotion (ICIPE)	Since 2013	Demonstration of green leaf Desmodium and Barachiaria grass for the control of maize stalk borer
11	AGRA soil health project	Since 2013	Enhancing income of smallholder farmers through integrated soil fertility management
12	Farm Mechanization and Conservation Agriculture for Sustainable Intensification (FACASI) program (CIMMYT)	Since 2013	A program that supports the SIMLESA and other conservation agriculture initiatives in the country through evaluation and demonstration of two-wheel tractor based technologies for conservation agriculture
13	PSNP/HABP Climate Smart Initiative II	2013–2015	An initiative to strengthen two important food security programs—the Productive Safety Net Program and the Household Asset Building Program—by piloting approaches to mainstream climate change within existing government approaches and cycles

No	Program/project	Intervention year	Project objectives
14	Africa Climate-Smart Agriculture Alliance (ACSAA)	Since 2014	Support the rapid scaling-up of climate-smart agriculture to six million farming households across Africa through the collaborative efforts and practical experience of alliance members in agricultural research and implementation
15	Drought Resilient and Sustainable Livelihoods Program (DRSLP) in Ethiopia	Since 2014	Improve livelihoods and resilience of the pastoral production system in the Afar and Somali regional states of Ethiopia
16	Climate-smart agriculture in southern Ethiopia (Farm Africa, SoS Sahel, Self Help Africa, and Vita)	Since 2015	Help smallholder farmers to adapt to climate change through adoption of climate-smart technologies and practices, including the provision of ICT based weather and market information
17	Pastoralist Areas Resilience Improvement through Market Expansion (PRIME), USAID	2012–2017	The project sought to build resilience to drought-induced animal mortality by facilitating market systems development in Afar, Oromia, and Somali Regions
18	Regional Pastoral Livelihoods Resilience Project (RPLRP)	Since 2015	Project to enhance livelihood resilience of pastoral and agropastoral communities in cross-border drought prone areas of selected countries and improve their capacity to respond promptly and effectively to an eligible crisis or emergency
19	Participatory Small-scale Irrigation Development Program II, IFAD	Since 2016	Reduce the impact of climate change, enhance economic growth and reduce rural poverty
20	Ethiopia Resilient Landscapes and Livelihoods Project (RLLP), World Bank	Since 2018	To improve climate resilience, land productivity, carbon storage, and increase access to diversified livelihood activities in selected rural watersheds.
21	Livestock and Fisheries Sector Development Project (LFSDP)	Since 2018	The development objective of the Livestock and Fisheries Sector Development Project for Ethiopia is to increase productivity and commercialization of producers and processors in selected value chains, strengthen service delivery systems in livestock and fisheries and respond promptly and effectively to an eligible crisis or emergency.
22	Ethiopia—GCCA+/Climate-smart Mainstreaming into the Productive Safety Net Program (Climate-smart PSNP)	2018–2022	The project provides technical assistance to enable the Ministry of Agriculture to: Mainstream climate-smart initiatives in the watershed and rangeland activities planning and implement the Productive Safety Net Program IV. Enhance institutional and technical capacity in planning, implementation and monitoring for climate-smart outcomes in PSNP4's public works and livelihoods components. Generate evidence to promote dialogue on climate sensitive development programming and future climate financing.
23	ILRI implemented program for climate-smart livestock systems (PCSL)	Since 2019	Support interventions to increase the contribution of livestock production to the three key pillars of climate-smart agriculture—increased productivity, mitigation of GHG emissions and adaptation to climate change across diverse systems and species. It supports governments, the private sector and local stakeholders in realizing their development objectives while also fulfilling their commitments to achieve climate change adaptation and mitigation goals.
24	Lowlands Livelihood Resilience Project (LLRP), World Bank	Since 2019	The development objective of Lowlands Livelihood Resilience Project is to improve livelihood resilience of pastoral and agropastoral communities in Ethiopia. It has four components: 1) integrated rangeland development and management; 2) livelihood improvement and diversification; 3) improving basic services and capacity building; 4) project management, monitoring and evaluation.
25	Climate Action through Landscape Management (CALM) Program for Results Project for Ethiopia	Since 2019	Increase adoption of sustainable land management (SLM) practices and expand access to secure land tenure in non-rangeland rural areas.

Moreover, various types of traditional climate-smart agriculture practices have been implemented and adopted in Ethiopia. Amongst those cited in FAO (2016) are the Derashe traditional conservation agriculture; Konso cultural landscape; Hararghe Highland traditional soil and water conservation; Hararghe cattle fattening; Hararghe small-scale traditional irrigation; Ankober manure management and traditional agroforestry in Gedeo, East Shewa, East Wollega and West Gojam zones; and crop rotation practiced by many crop farmers in the country.

2.3 Opportunities and challenges of mainstreaming climate-smart agriculture in Ethiopia

Opportunities

The government of Ethiopia has developed policies and strategies that are pertinent to ensure food security, as well as address climate change. It has also ratified international climate change-related conventions. The sector's role in producing food, meeting the people's basic survival needs and most of the export income provides it an extraordinary attention compared to other sectors.

The country has developed a comprehensive green growth strategy that encompasses agriculture in the form of the Climate Resilient Green Economy (CRGE) strategy. In the MoA, a directorate for environment and climate change coordination has been established for piloting climate-smart agriculture and mainstreaming the CRGE into the sector's development plans, polices, strategies, projects and programs.

The FTC- and DA-centered interventions with 60, 000 Das, 14,000 FTCs and SMS based agricultural information through a mobile network provide excellent platform for CSA extension.

Adoption of existing agricultural practices ("good management practices") that have been documented to improve agriculture through various indicators such as increased water use efficiency and drought resilience, improved soil structure and fertility, reductions in nutrient losses, etc. can easily be scaled up through the wide extension structure of the MoA. Taking advantage of the entry points that already exist in the climate-smart agriculture technologies and practices undertaken by a number of state and non-state actors listed in Table 4 above.

Sufficient resource endowment in the form of projects and programs by AGP, SLM, PSNP, RLLP and others, and the availability of adequate number of extension and development agents at grassroots level provide a good opportunity to create climate-related awareness, capacity-building training, and large-scale implementation and promotion of climate-smart practices.

SLMP, PSNP, AGP and REDD+ follow a landscape approach based on large-scale processes in an integrated and multidisciplinary formulation that takes into account natural resources management, which includes environmental and livelihood concerns. The integrated watershed management approach addresses a host of land use issues in a catchment area, their effect on soil properties and erosion, the hydrological regime, biomass, energy and biodiversity. The PSNP as a program, through its main components' interventions and the climate-smart mainstreaming project, supports public works and livelihoods planning and implementation to adapt to climate change.

The transition to climate-smart agricultural development pathways requires financial investment. The possibility to tap into international climate financing and climate-smart agriculture experiences help to fast-track implementation.

NEPAD's Comprehensive Africa Agriculture Development Program (CAADP) ensures that climate change is mainstreamed into agricultural development. It provides an opportunity for incorporating climate-smart agriculture into country and regional programs through the development of the National Agricultural Investment Plans (NAIPs) and National Agricultural Food Security and Investment Plans (NAFSIPs), both key instruments in the CAADP process.

The country has prioritized the advancement of gender equality and youth employment with policies and legal provisions and the setting up of institutional mechanisms at all levels of the government's administrative structure.

Challenges

In spite of the potential of climate-smart agriculture to improve resilience and enhance agricultural production and rural livelihoods, systematic response to climate change through adoption of climate-smart agriculture practices and technologies is still very limited in Ethiopia. Among the challenges commonly mentioned are:

- Lack of mechanisms to bring together and coordinate stakeholders involved in different forms of climate-smart agriculture technology promotion and synergies in the implementation of climate-smart agriculture and food security programs and initiatives. There are numerous

projects and programs that are conducting and promoting climate-smart agricultural practices and technologies in the country. However, these programs and projects are being implemented in a fragmented project-based manner although there is an integrative knowledge management platform to avail all climate-smart agriculture stakeholders of past and recent lessons learned and best practices, as well as the more mundane reports and evaluations of programs and projects promoting climate approaches.

- Ethiopian climate is varied and complex. The variation is also compounded by the difference in soil type and cultural practices across the country. This variation complicates policy planning since responses to build resilience must be grounded in local contexts.

- Diversification has allowed farmers to cope with drought or erratic rains but identifying the right technological package for various ecologies and crops has been of considerable challenge to researchers and extension systems.

- Most farmer households in Ethiopia are resource poor and they usually own small parcels of farmlands that are degraded and with low yield. They have limited access to appropriate farm equipment and tools, quality seeds and other basic agricultural inputs, credit, microfinancing and/or insurances, and capacity in implementing improved practices.

- There's gap in policy support to address gender-specific barriers such as advisory information, services and incentive mechanisms for adoption of climate-smart agricultural production systems.

- Farmers in Ethiopia face major risks arising from the effect of climatic hazards and managing risks associated with high costs (at least initial costs) of adopting new technologies (e.g. conservation agriculture and agroforestry) whose benefits often only come after several years/seasons of production.

- Lack of understanding of ecosystems and their link to livestock production. Hence, there is a need to critically identify and enhance positive contributions of livestock in agricultural development that will satisfy current and future human needs while preserving the natural resource base. Lack of knowledge about ecosystems and their links with livestock leads to wrong policy and development decisions.

- Lack of skilled human resources on climate change adaptation and mitigation at all levels, and inadequate information relevant to climate-smart agriculture.

- Climate-smart agriculture is not adequately incorporated into extension guidelines and manuals (and the extension system as a whole) in a way that the great majority of the rural farming population could understand and participate in their implementation.

- Most interventions still depend on the availability of external finance.

- Feeding the country's population in the context of climate change will require gradual and significant expansion of agricultural products.

- Farmers face substantial barriers in adopting climate-smart agriculture practices and lack of information about the potential gains of adopting a new technology. These include significant upfront expenditures required for adopting new technologies.

- The dominant nature of conventional agricultural practices like frequent ploughing and removal and burning of crop residues.

- Climate-smart agriculture requires change in the attitude of farming households, appropriate strategies and planning, as well as change in the normal seasons of agricultural practices.

- Appropriate institutional structures and supporting national policies and strategies may seem overwhelming to smallholder farmers.

- Policies and strategies didn't provide recognition and adequate support for proven technologies of carbon sequestration, conservation agriculture, mulching, intercropping and agroforestry.

- Lack of policy support and capacity enhancement to climate risk management, including insurance and safety nets, as well as improved access to weather information and weather based agro-advisories adapted to the needs of farmers in different agroecological zones.

- The current ability to quantify greenhouse gas (GHG) emissions and mitigation from agriculture is limited. There is lack of baseline data to help use emissions factors and other parameters which are specific to the country.

2.4. Enabling institutional and policy environment related to climate-smart agriculture

Enabling policies and institutions are essential when making use of evidence base to design more effective and sustainable interventions. FAO (2014) mentions the steps to build an enabling environment for climate-smart agriculture technologies should include the following:

- Assessing major barriers to the adoption of climate-smart agriculture options;
- Analyzing the potential of local institutions to overcome these barriers;
- Engaging in dialogues with local communities;
- Developing capacities at different levels;
- Supporting policy coordination; and
- Securing enough financing for implementation.

Climate-smart agriculture technologies that have potential to improve agriculture productivity, increase resilience and reduce emissions do not achieve the desired impact without strong enabling conditions. To make agricultural systems climate-smart requires actions at different levels of policies, institutions, investments and practices. As mentioned earlier, many of Ethiopia's development and sectoral policies and programs already deal with agricultural adaptation and mitigation actions to climate change. However, the policies need to be coordinated to achieve climate-smart agriculture objectives. Financial incentive mechanisms and information through extension services are needed to empower farmers and farming communities to invest in climate-smart agriculture technologies, practices and services. Existing gender policies and laws need to be assessed for their effectiveness in improving the livelihoods of women smallholder farmers. Trade-off analysis need to be carried out to estimate the proportion of the population that gains or loses when a climate-smart agriculture technology is adopted. Similarly, policies and institutional structures at different levels and plans/schemes that include various incentive mechanisms are needed to promote climate-smart agriculture technologies in vulnerable areas. Although current policies, strategies and laws related to climate change and sustainable agriculture in Ethiopia are adequate, aligning climate policy documents with the country's economic and agricultural development policies is still not to the required level. They lack detailed guidelines, manuals and action plans and are not sufficiently mainstreamed into existing programs and projects. There is lack of adequate research findings on climate-smart agriculture practices in Ethiopia for the various agro-ecologies, soil types, rainfall patterns, farming systems, temperatures and moisture ranges. Data on climate-smart agriculture are insufficient at all levels. Research projects on climate-smart agriculture are not to the level required to influence agricultural extension practices. The institutional capacity of the country is not adequate to implement and replicate climate-smart agriculture strategies. For purposes of knowledge dissemination, a comprehensive capacity development approach that builds on sound assessment of the needs of all stakeholders is required. Within diversified extension service delivery, there is a need to build the capacity of all NGOs and conservation agriculture implementing organizations. Above all, the extension directorate of the Ministry of Agriculture requires special support since it is through the extension system that the technologies reach the wider community.

Making the transition to climate-smart agriculture requires not only strong political commitment, but also greater coherence, coordination and integration among the various sectors dealing with the drivers that are influencing climate change, agricultural development and food and nutrition security. In this regard, the development of enabling policies and the promotion of regulatory and legislative initiatives is crucial. Increasing policy coherence calls for a systematic assessment of current policies and their intended and unintended effects on the set of development objectives prioritized by the country, including those pertaining to climate-smart agriculture. Public policies, as well as expenditure and planning frameworks, should work towards integration of climate-smart agriculture policies and support measures at the national, regional and local levels. Representatives from all value chain stakeholder groups involved at all levels need to participate fully in this coordination and integration process. To ensure that the benefits of these

activities are shared equally, it is important for the process to be gender inclusive. Understanding the local and gender-specific barriers and incentive mechanisms for adoption of climate-smart agricultural production systems is key for designing supportive policies. It is also critical to recognize the value of indigenous knowledge and farming practices and engage with representatives from indigenous organizations when developing coherent cross-sectoral policy frameworks. It is also important to identify and enhance synergies between the different policy objectives and compensate for trade-offs where necessary.

The public sector can play a key role in creating an enabling policy and legal environment for climate-smart agriculture, which can permit private sector and civil society stakeholders to make timely, well-informed and efficient decisions related to securing food production, adapting to climate change and reducing or removing greenhouse gases. Many stakeholders, especially smallholder agricultural producers with limited assets, will only be inclined and be able to take necessary actions if their work is supported by a coherent climate-smart agriculture policy framework. The transition to climate-smart agriculture requires transcending sectoral and other boundaries and calls for the full integration of climate change issues into the policymaking process at all levels. This entails the formation of new institutional structures and alliances among private and public stakeholders in different areas, including policymaking, research, extension and financing.

2.5 Need for capacity building in climate-smart agriculture

Considerable efforts are required to develop knowledge and capacity to make climate-smart agriculture a reality. Hence, it is vital to develop effective and systemic capacity development strategy across the entire agricultural value chain for the adoption of climate-smart agriculture. It embodies a complex process involving not only technical, but also essential sociocultural and political aspects. Accordingly, a capacity assessment should be conducted to determine what and whose capacity needs to be developed and provide a benchmark to measure progress, identify what the adoption constraints are and ensure that the envisioned capacity development-related interventions for the climate-smart agriculture project address some of the above mentioned issues (FAO 2013). Moreover, the assessment and analysis of the existing situation and related gaps and opportunities must be grounded in a sound understanding of local knowledge, perceptions, behaviors and values. This foresees the importance to complement a national level capacity assessment with conducting a participatory capacity assessment at the field/project level, and to share insights on how to identify and prioritize the capacity needs that must be addressed to mainstream climate-smart agriculture into the agricultural system.

3. Proposed roadmaps to enhance climate-smart agriculture implementation in Ethiopia

A mixed approach of farm and landscape level roadmaps centered on climate adaptation and mitigation, boosting productivity and creating enabling environments, can support climate-smart agriculture mainstreaming across Ethiopia.

Photo credit: CCAFS/Ayalneh Mulatu

I. Farm level roadmap: improving productivity and resilience of smallholder agriculture

Adaptation	
Strategic issue 1	Vulnerability due to inadequate and erratic rainfall distribution • Agricultural production in Ethiopia is predominantly rain-fed, exposing this major livelihood activity to variability in rainfall patterns.
Roadmap	• Promote adaptive agricultural production methodologies • Use drought tolerant, early maturing and water-efficient crop varieties • Use cropping calendars informed by meteorological data • Use less input dependent animal breeds • Stabilize herd sizes • Use of drought tolerant forage crops • Enhance the conservation and utilization efficiency of the existing feed resource • Support conservation and propagation of germplasm of species with adaptive capacity • Promote the integration of multipurpose tree/shrub species that provide multiple benefits and use of trees that store carbon in the soil and their stems • Support the development of water harvesting and storage technologies, irrigation infrastructure development and other soil moisture conservation technologies • Promote efficient irrigation management that best suits the local condition coupled with reliable agricultural inputs and stable markets for the expected growth in farm products • Promote integrated pest, disease and weed management • Promote precision agriculture which optimizes soil and water management to locally specific conditions • Promote provision of accurate, timely and reliable climate/weather and agricultural information • Promote Irrigated based fodder bank establishment and development
Strategic issue 2	Vulnerabilities due to extreme weather events such as drought, flood, strong winds, hailstorm and frost • Risks arising from the effects of climatic hazards and managing risks associated with the high costs (at least initial costs) of adopting new technologies (e.g. conservation agriculture and agroforestry) whose benefits often only come after several years/seasons of production. • Most of the household farmers in Ethiopia are resource poor and they usually own small parcels of farmland that are degraded and with low yield. They have limited access to appropriate farm equipment and tools, quality seeds and other basic agricultural inputs, credit, microfinancing and/or insurances, and capacity in implementing improved practices.

Roadmap	• Develop and implement strategies for early warning and response
	  • Technical capacity development of proactive risk management at the local level
	  • Enabling institutional mechanisms
	  • Standardization of data collection
	  • Use of diversified communication channels (Radio, ICT based information, mobile based application)
	  • Develop and update databases
	  • Modernizing climate observation and monitoring networks in vulnerable areas
	  • Provision of accurate, timely and reliable climate/weather information
	• Develop risk financing instruments and insurance schemes such as index- and weather-based insurance systems, crop insurance system, etc. Using remote sensing data for managing climate risks is also beneficial.
	• Integrate climate-smart agriculture in disaster risk management and social safety net programs
	• Employ innovative financing mechanisms such as fixing of minimum price for agricultural products and buy back guarantee systems
	• Promote conservation of biodiversity and local crop varieties
	• Establish partnership with nongovernment stakeholders for resource mobilization

Strategic issue 3	Excessive tillage, overgrazing and the complete removal of crop residue at harvest enhance soil erosion • The dominant nature of conventional agricultural practices like frequent ploughing, removal and burning of crop residues trigger soil erosion, particularly during rainy seasons. As a result, soil fertility declines at an alarming rate. This is one of the major challenges contributing to the reduction of agricultural productivity in most parts of Ethiopia.
Roadmap	• Applying organic matter improves soil structure, which in turn increases infiltration and soil water holding capacity. It also increases the nutrient level and the activity of soil organisms. • Promoting climate-smart agriculture technologies and practices that are specific to local needs and agro-ecologies will contribute to water management and soil fertility enhancement at the plot-farm scale. • The integration of conservation agriculture into in situ crop residue management • Integrated soil fertility management through the use of legumes for enhancing nitrogen fixation • Using precision agriculture, which optimizes soil and water management to locally specific conditions

Strategic issue 4	• Limited understanding of the spatial variability of soils and knowledge gaps regarding appropriate levels of nutrients and water to apply to different crops under various soil types
	  • The knowledge gap has prevented resource poor farmers from adopting appropriate integrated water and soil fertility management practices
	  • Significant spatial variability of soils within farms and the wide variability in crop responses to organic and inorganic fertilizers mean the application of fertilizer should not be a blanket recommendation for all areas of all farms.
	  • The soil type and texture, as well as the history of land use, determine the type and amount of nutrient application for the soil.

Roadmap	• Enhancing the coverage and scale of the existing national soils database and soil fertility map of Ethiopia • Taking stock of existing good practices (including traditional practices), demonstrating the economic feasibility of these practices in different locales and identifying what is needed to maintain and expand them • Understanding agronomic practices and management options, particularly water and nutrient management options to improve and stabilize crop yields to promote climate-smart agriculture technologies and practices that are specific to local needs and agroecologies, will contribute to water management and soil fertility enhancement at the farm level. • Strengthening technical, research and material capacity; producing and sharing technical knowledge and supporting knowledge transfer initiatives; and supporting innovation for sustainable and inclusive agriculture production

Productivity	
Strategic issue 1	Limited support in selecting appropriate sets of climate-smart agriculture interventions at relevant scales tailored to local contexts and livelihood needs
Roadmap	• Develop/incorporate extension guidelines and manuals (and the extension system as a whole) in a way that the great majority of the rural farming population could understand and participate in their implementation • Promote irrigation farming, coupled with reliable agricultural inputs and stable markets, for the expected growth in farm products • Promote integrated farming combining crop and livestock operations • Promote Irrigation farming on reliable high value forage crops (e.g. Alfalfa) • Promote the production of improved forage crops • Promote the integration of fishery, aquaculture, and irrigation especially in parts of the country with rich water resources • Promote integrated farming combining crop and livestock operations • Promote fishery and aquaculture, especially in parts of the country with rich water resources • Promote apiculture in parts of the country where it is suitable • Promote improved nutrient and water management • Promote improved feed digestibility through integration of crop residues, fodder trees and shrubs • Increase cattle value chain efficiency (e.g. dairy cooperatives) • Promote poultry consumption • Use precision agriculture, which optimizes soil and water management to locally specific conditions
Strategic issue 2	Limited input supply system to enhance climate-smart agriculture implementation
Roadmap	Promote organic fertilizer, irrigation, improved forage and crop support cooperatives • Improve input and environmentally sound farm service systems • Support the generation of location-specific tools and technologies • Encourage the private sector to establish agricultural business hubs • Promote information and communication technologies to improve agricultural information access • Support agricultural education and training institutions • Support the provision of machinery and equipment • Promote integrated crop management with forage and fodder crops in rotation to reduce competition with livestock and other uses • Promote the use of various cover crops, especially multipurpose crops that are nitrogen-fixing, soil restoring and pest repelling • Reduce pre- and post-harvest losses • Promote and access the use of improved livestock breeds • Promote the use of livestock production and processing technologies

Mitigation	
Strategic issue 1	The need to reduce and/or remove greenhouse gas emissions
Roadmap	• Incentives for pro poor mitigation • Cost sharing or microcredit mechanisms for GHG reduction initiatives in agriculture • Improved livestock breeds, animal nutrition and manure management • Improve soil carbon storage • Develop carbon sequestration agricultural technologies (conservation tillage, cover cropping and crop rotation) • Improve animal nutrition and manure management to cut methane and nitrogen emissions. • Promote the use of livestock Feed Improvement technologies. • Use of Improved feeds • Promote technologies for reducing GHG emissions from livestock manure by using anaerobic digestion to generate clean energies in agricultural systems

Strategic issue 2	Requirements for developing of measurement, reporting and verification (MRV) system in the agriculture sector
Roadmap	• Setting standards and installing an MRV infrastructure to develop an inventory system data bank on the sector • Use emissions factors and other parameters which are specific to the country (moving away from Tier 1 to 2) • Development of structures on data collection and recording, including an inventory on the interventions carried out on mitigation for continuous reporting on GHG emissions status at the country level • Integration of MRV platforms of Ministry of Finance, Ministry of Agriculture, Environment Forestry Climate Change Commission, etc.

Enabling environment	
Strategic issue 1	Weak organizational and institutional linkage among key actors for coordination and intergovernmental relations for implementation of climate-smart agriculture related policies and legislations • There are a number of institutions, organizations and government departments involved in climate-smart agriculture in Ethiopia. There is a need to ensure that these institutions and organizations coordinate their efforts and conduct their work in a manner that adds value to one another rather than duplicating effort or being in conflict with one another. • Efforts underway to design watershed and agroforestry development strategies need to consider this climate-smart agriculture strategy to avoid repetition • Design and implement climate-smart agriculture mainstreaming framework within appropriate institutions
Roadmap	• Assess the major institutional and policy barriers to the adoption of climate-smart agriculture options • Analyze the potential of existing local institutions to overcome these barriers • Facilitate multi-stakeholder processes to support improved governance and promote cross-sectoral coherence, coordination and integration among the government, NGOs, private sector, and development partners to motivate farmers to adapt climate-smart agriculture approaches • Design appropriate institutional structures and promote national policies and strategies to address the overwhelming demand by smallholder farmers • Create an interface between education, research and development to enhance knowledge exchange on climate-smart agriculture • Align the climate-smart agriculture strategy with climate and agricultural policies and strategies scattered around different ministries
Strategic issue 2	Lack of skilled human resources on climate change adaptation and mitigation at all levels; inadequate information, knowledge and skills relevant to climate-smart agriculture, etc. • There are significant gaps in capacity, technical knowledge and financing to address the impact of climate change on agriculture.
Roadmap	• Undertake capacity gap analysis in climate-smart agriculture technologies and practices • Develop training materials to support identified capacity development gaps • Support the development of human capital for research, education and extension • Develop capacity of practitioners to understand and address gender dimensions of climate change and agriculture • Research context-specific gender dynamics of labor allocation for potential CSA practices • Develop a communication strategy and establish communication networks and media for continued public support and improving chances of adoption • Create awareness of climate-smart agriculture technologies and practices through training, demonstration, site visits and campaigns. • Develop, repackage and disseminate knowledge products and services to promote climate-smart agriculture technologies and practices • Support research on climate-smart agriculture and networks of knowledge sharing platforms
Strategic issue 3	Lack of system for tradeoffs and synergy analysis • The analysis provide entry points for targeted climate-smart agriculture planning so as to enhance synergies and reduce trade-offs
Roadmap	• Trade-off analysis of different climate-smart agriculture interventions to identify potential synergies and trade-offs and estimate gains and losses
Strategic issue 4	The need to support systems for capacity development, M&E, and market linkage
Roadmap	• Capacity building support for adoption and scaling up of climate-smart agriculture practices and technologies (provision of proper seed and nutrient supply systems, and marketing of products) • Develop capacity of gender sensitive climate-smart agriculture advisory practices and transfer of knowledge, experience and successful technologies for the different agro-ecologies of the country • Strengthen formal and informal agricultural markets for value added products • Regular upgrading of development agents through training, experience sharing visits, demonstrations, etc. • Use of information and communication technologies (ICTs) such as cell phones and the internet to improve agricultural information access (e.g. market prices, transportation options and weather information) • Promotion of public-private partnerships in climate-smart agriculture technologies and practices • Support the development of appropriate indicators to measure progress and track climate-smart agriculture outcomes on adaptation, mitigation and productivity • Support more applied research projects on climate-smart agriculture • Enhance the capacity of meteorological services to downscale weather and climate information for agriculture • Stimulate mobilization of resources for investment in agricultural mechanization • Promote and regulate quality and standards of agricultural mechanization • Promote agricultural mechanization technologies that are gender responsive

Strategic issue 5	Lack of integration of the climate-smart agriculture approach in planning and measuring its impact • Helps to ground the work into existing governance structures and responsibilities
Roadmap	• Design internal climate-smart agriculture mainstreaming systems and internally agreed mainstreaming policies with defined roles and responsibilities so that climate-smart agriculture is incorporated in every development practice • Promote tools for mainstreaming climate-smart agriculture approaches in agricultural sector planning processes • Promote tools for follow up and impact evaluation for the implementation of technologies, practices and services of the climate-smart agriculture approach • Ensure that all potential climate-smart agriculture related outcomes (beyond the agricultural productivity pillar) are included in the M&E design • Design and implement knowledge management and communication strategy • Enhance the current mainstreaming experience of the Climate Change Coordination Directorate and Transformation Agenda Delivery Unit in the MoA.
Strategic issue 6	Addressing gender issues and youth employment • The roles, responsibilities and capabilities of men and women need to be well understood to ensure that both men and women have access to, and benefit from, climate-smart agriculture practices and policies. • A growing body of evidence demonstrates that equal gender relations within households and communities lead to better agricultural and development outcomes, including increase in farm productivity and improvements in family nutrition. • If climate-smart agriculture is implemented without consideration of gender and social inequalities, it may fail to take advantage of opportunities to improve livelihoods and may instead increase inequalities.
Roadmap	• Enhance capacities of agricultural experts at all levels on practical skills such as gender mainstreaming, gender planning, gender budgeting, gender monitoring and evaluation and other aspects. • Facilitate mechanisms for integrating the equity principle and gender equality, as well as the intergenerational and social inclusion approaches in climate-smart agriculture actions. • Support extension services for climate smart interventions that improve yields, boost income, reduce labor and enhance value-added opportunities for women.

II. Landscape level (NRM): enhancing ecosystem resilience at landscape level through integrated landscape approach that follows the principles of ecosystem management and sustainable land and water use

Productivity	
Strategic issue	Agricultural expansion, free grazing and fuelwood collection have driven deforestation and forest degradation • Deforestation is causing accelerated soil erosion, which negatively affects agricultural production and income sources. Estimated soil loss amounts to 1,493 million tons per year and grain yield loss is up to 1.5 million tons per year (Tadesse 2001); • A substantial proportion of the Ethiopian population relies on firewood from forests and woodlands as its primary energy source.

Roadmap	• Integrating climate-smart sectoral approaches into different sectors
	  • This offers multiple benefits, including improved food security, livelihoods and ecosystem resilience, by making the whole agriculture-livestock-energy-forestry system more sustainable and productive.
	• Promote the adoption of efficient, climate-smart technologies and practices across the sectors
	  • Agricultural intensification
	  • Improved rangeland management, controlled grazing and area closures
	  • Soil fertility management and biological soil conservation measures
	  • Promote the integration of multipurpose tree/shrub species that provide multiple benefits
	• Mobilization of individual farmers and communities to collectively invest in sustainable efforts, e.g., rangeland and forest resource management
	  • Restoration of degraded farmlands, wetlands and forests
	  • Integration of trees into landscapes can help reduce soil erosion, increase nutrient availability in soils and sequester carbon
	  • Area enclosures prohibit people and livestock interference on hillsides and mountainous areas protected for restoration purposes
	  • Farmer-managed natural regeneration (FMNR) or assisted natural regeneration of degraded landscapes
	• Restoration at the landscape level should be prioritized by integrating climate-smart agriculture technologies and practices to create a climate-smart landscapes that provide livelihood and multiple ecosystem benefits and services
	• Expansion of integrated watershed management approaches

Adaptation	
Strategic issue 1	Improve ecosystem services and enhance the role of forests • Micro watershed transformation through land rehabilitation can also be a cost-effective solution to manage climate risks by contributing to both drought and flood risk management.
Roadmap	• Promote ecosystem-based agriculture • Promote agroforestry practices. Integrating trees into landscapes can help reduce soil erosion, increase nutrient availability in soils and sequester carbon. Integration of forage legumes into agroforestry systems is also a useful strategy.

Mitigation	
Strategic issue 1	Livestock's threats to the environment through deforestation, land and pasture degradation
Roadmap	• Sustainable intensification of livestock and feed crop production to reduce carbon dioxide emissions from deforestation and pasture degradation

Enabling environment	
Strategic issue 1	Lack of institutional arrangements and coordination at community and landscape levels • Coordination across agricultural sectors (e.g. crops, livestock, forestry and fisheries) as well as other sectors, such as the energy and water sector development, is essential to capitalize on potential synergies, reduce trade-offs and optimize the use of natural resources and ecosystem services.
Roadmap	• Promotion of cross-sectoral planning and management to make the most efficient use of valuable natural resource • Enhancing enabling institutions and policies that support the mobilization of communities and their resources • Documenting and building experiences that support stakeholders when making informed decisions for the transition to climate-smart agriculture

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