CGIAR

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CCAFS

CCAFS East Africa 2019–2021

Strategy for Supporting Agricultural Transformation, Food and Nutrition Security under Climate Change

Authors:
Dawit Solomon, Maren Radeny, Catherine Mungai, John Recha, Tonya Schuetz and Marianne Gadeberg

Editors:
Dawit Solomon, Maren Radeny, Catherine Mungai and Marianne Gadeberg

Design:
Michael Dougherty

Cover photo credit:
Neil Palmer (CIAT)

Correct citation:
Solomon D, Radeny M, Mungai C, Recha J, Schuetz T, Gadeberg M. 2018. *CCAFS East Africa 2019–2021: Strategy for supporting agricultural transformation, food and nutrition security under climate change.* Addis Ababa: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: www.ccafs.cgiar.org.

Acknowledgments:
This work was produced as part of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), which is carried out with generous financial support from CGIAR Trust Fund and CGIAR Donors through bilateral funding agreements. For details please visit https://ccafs.cgiar.org/donors. The views expressed in this document cannot be taken to reflect the official opinions of these organizations.

Contact:
CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), East Africa.
P.O. Box 5689.
Addis Ababa, Ethiopia
Phone: +251-11 617 2000
Fax: +251-11 617 2001
Email: ccafsea@cgiar.org
Website: http://ccafs.cgiar.org/regions/east-africa

@cgiarclimate_EA

CGIARClimate

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

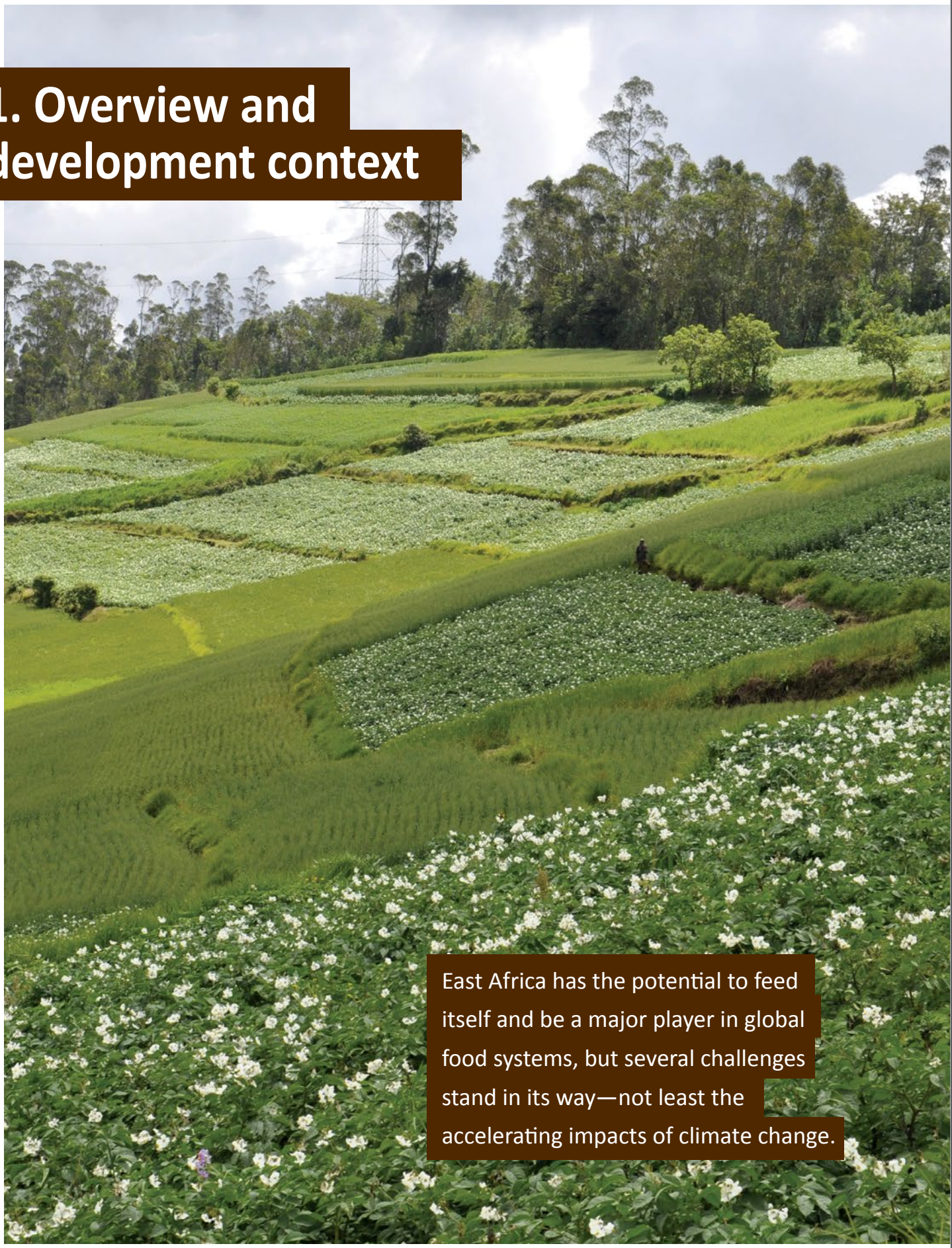
CCAFS East Africa 2019–2021

Strategy for Supporting Agricultural Transformation, Food and Nutrition Security under Climate Change

Contents

Authors: Dawit Solomon, Maren Radeny, Catherine Mungai, John Recha, Tonya Schuetz and Marianne Gadeberg
Editors: Dawit Solomon, Maren Radeny, Catherine Mungai and Marianne Gadeberg
Design: Michael Dougherty
Cover photo credit: Neil Palmer (CIAT)

1. Overview and development context



East Africa has the potential to feed itself and be a major player in global food systems, but several challenges stand in its way—not least the accelerating impacts of climate change.

Doyogena climate-smart landscape site, Doyogena district, Kembata Tembaro zone, Southern Nations, Nationalities, and Peoples' Region (SNNPR) of Ethiopia. Credit: Dawit Solomon (CCAFS)

What is at stake for agriculture, food and nutrition security in East Africa?

East Africa has enormous potential, not only to feed itself and eliminate hunger, but also to be a major player in global food systems.[1] This potential lies in its natural resources, its people and knowledge, and its huge markets. Agriculture represents a significant portion of this potential and constitutes a large part of East African economies. In Ethiopia, for example, agriculture contributed about 44% to the gross domestic product (GDP) over the past five years, while other East African countries generally attain about a third of their GDP from agriculture.[2,3,4] The agriculture sector plays a key role for food and nutrition security, sustainable natural resources management and economic diversification. If leveraged, the sector could boost investment, increase intra-regional trade, provide employment opportunities, contribute to poverty eradication and foster human security, stability and prosperity.[1,5,6]

Acknowledging the sector's huge potential, East African governments have made sustainable transformation of agriculture a priority in their development agendas and long-term visions, and they have increased investments in agriculture. As a result, these countries have started to benefit from growing revenue from agriculture.[5] Similarly, private sector companies in the region are increasingly investing in agriculture and related value chains, enhancing the region's potential to provide farmers with improved access to inputs and services, including better seeds, fertilizers, advisory services and markets to improve productivity, incomes, risk management and on-farm decision making.[1,5]

Despite these positive efforts and developments, the region has seen very little improvement in agricultural productivity, food and nutrition security. Growth in the agriculture sector has primarily been achieved through unsustainable approaches, such as increasing the total area of land under cultivation or mobilizing large agricultural labor forces, without much improvement in yield and productivity.[1,5,6] Besides, the sector is still dominated by smallholder subsistence farmers, who are struggling with deep-rooted poverty and have few productive assets.[5,6]

Agricultural systems in East Africa face many other constraints and barriers to sustainable growth. Degradation of soil, land, water and ecosystems is a persistent environmental challenge limiting the sector's productivity. Economic barriers, including lack of access to inputs, markets, capital, credit and finance, are significant. Poor infrastructure, rising land prices and structural challenges for inclusive growth are further limiting the possibilities for enhancing productivity, profitability as well as food and nutrition security, putting the sector under additional strain. Low human and institutional capacities, poor agro-advisory services, as well as political instability and insecurity also make it difficult to harness the existing potential in agriculture.[1,5]

Furthermore, socio-demographic changes in the region are making improvements to the agriculture sector ever more urgent. About 264 million people live in East Africa, and the region's population is expected to grow to one billion by 2050.[5] Notably, East Africa is a very youthful region; about 80% of the population is below 35 years of age. As a critical majority, youth will determine the shape of the region's future.[7] The population relying on agriculture in the region stands at 185 million people, accounting for up to 70% of the total.[5] While millions of people are involved in agriculture, the number of young people directly engaged in the sector is dropping, and the agricultural population is aging. Several factors are driving this shift, including persistent changes in farmland ownership, continued competition for land and ever-decreasing farm sizes, increasing urbanization, a growing proportion of farmers relying on off-farm employment for income and the resulting change in the labor force towards non-farm activities. These changes in social structures negatively affect food and nutrition security, with around one-third of the region's population currently suffering from malnutrition. The number of malnourished people is estimated to increase to about 320 million by 2050.[8,9]

What is at stake for the region's agriculture is, therefore, meeting food and nutrition needs, raising incomes and increasing employment opportunities, particularly in rural areas—all

while reducing inequalities and protecting the environment. This will be the most daunting challenge for East African governments during the coming decades.

Emerging climate-related challenges for agriculture, food and nutrition security in East Africa

Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.[10] East Africa is among the regions at a disproportionately higher risk of adverse consequences of global warming. It is extremely vulnerable to the various manifestations of climate change, and it is considered a climate hotspot where climate change poses grave threats to human well-being and natural environments.

The accelerating pace of climate change in the region is invariably being felt through increased variability, which affects the frequency, intensity, spatial distribution, duration and timing of extreme weather and climate events.[11,12] The changes in the frequency and severity of extreme climate events and the increasing variability of weather patterns are resulting in substantial challenges for both human and natural systems. To the region's farmers, these emerging changes represent an additional source of risks and increased uncertainty.

Climate variability and change are having significant direct and indirect impacts on agricultural production, agricultural value chains, food and nutrition security as well as the overall sustainable growth of the sector in East Africa. These changes will have a particularly devastating impact on smallholder agriculture, in which the livelihoods of farmers and pastoralists are subject to the vagaries of the weather.[1]

Countries in East Africa are especially vulnerable to climate change due to their reliance on subsistence, rain-fed agriculture.[13,14,15] Approximately 95% of the food in the region is produced under rain-fed agriculture.[16] This is important because climate change impacts are predicted to intensify in the future. Increased, more intense and more erratic rainfall, accompanied by flooding, and changes in temperature, potentially associated with heat waves, water stress and droughts, are likely to severely disrupt rain-fed agriculture.

While the precise impacts of climate variability and change on East African farming systems are likely to vary spatially, two general predictions can be emphasized: greater variability in agricultural production and a possible decline in crop productivity arising from more erratic and extreme weather patterns.[17] The combination of changing temperatures as well as rainfall patterns and quantities will bring about shifts in the onset, cessation and length of growing seasons for a large proportion of cropping and rangeland area in the future. It is estimated that by 2050, the combined impacts of climate change could result in yield reductions of major staple crops, e.g. on average 14% for rice, 22% for wheat and 5% for maize.[18] This is projected to push more people into poverty, chronic hunger and nutrition deficiency, particularly for the millions relying on agriculture for their livelihoods, and to exacerbate the vulnerability of the malnourished population in the region.[9,19]

Because subsistence smallholders dominate the agriculture sector, little capacity and few resources exist for building resilience and adaptive capacity to these emerging and changing realities.[20] Women, who on average make up 73% of the agricultural workforce in the region, are the least prepared and are likely to suffer the greatest consequences.[21,9] Pastoralists may also be particularly vulnerable as a result of direct impacts on livestock productivity and indirect effects on pasture, animal feed, and increased incidences of disease and parasite infestations.[20]

Agriculture and climate change exhibit a feedback relationship; agriculture is not only impacted by climate change, it also contributes to climate change, necessitating both adaptation and mitigation strategies by East African countries. The sector is currently the main source of national greenhouse gas (GHG) emissions in the region, accounting for about 46% in Uganda, 57% in Kenya, 60% in Ethiopia and up to 86% in Tanzania.[9] The emissions from agriculture in the region are largely from the livestock sector, which accounts in some cases for up to 96% of the national agricultural emissions.[22] In the region, there is a general understanding that achieving food and nutrition security as well as related economic, social and environmental targets

requires decoupling agricultural growth from GHG emissions. It is also acknowledged that GHG emissions from the agriculture sector must, where possible, be reduced and opportunities to increase carbon storage in agricultural systems in soils and vegetation must be encouraged in order to mitigate climate change and safeguard long-term agricultural productivity and human well-being.

Considering the multitude of significant and interrelated challenges, it is evident that agricultural systems in East Africa must be transformed, particularly through developing and promoting sustainable agricultural strategies, policies and programs that make the sector more efficient and productive. This is considered key to achieving environmentally and socioeconomically viable and safe agricultural food systems. To achieve food and nutrition security, it is also necessary to increase the resilience of productive landscapes and strengthen farmers' abilities to adapt to the emerging threats of climate variability and change.[16] If undertaking these efforts, the countries in the region will be able to meet present needs and targets without endangering the capacity of natural ecosystems to absorb the effects of human activities and without compromising the ability of the future generations to meet their own needs and aspirations.[16] Finally, addressing climate change risks in the region will not only help eliminate hunger and foster sustainable economic growth, but also contribute towards reducing the risk of conflict, destabilization and mass migration.[23]

Policies, strategies and priority actions in East Africa

Confronted with the triple challenge of achieving food and nutrition security, adapting to climate variability and change, as well as reducing GHG emissions where possible, national governments in East Africa have pinned the agriculture sector as a top priority. Table 1 highlights the visions, targets and priorities of the governments of Ethiopia, Kenya, Tanzania and Uganda.

Table 1: Ethiopia, Kenya, Tanzania and Uganda's vision and priorities

Country	National vision	National priorities
Ethiopia[24]	Achieve carbon-neutral middle-income status by 2025 through implementation of the Climate-Resilient Green Economy strategy.	• Improving efficiency of the agricultural system to enhance production and resilience as well as increase adaptive capacity in an inclusive manner • Identifying options in crop and livestock systems for reducing emissions in the context of the broader agricultural development and food security agenda • Restoring degraded land or preventing deforestation • Improving the response capacity of the agricultural research system
Kenya[6]	A climate-resilient and low-carbon sustainable agriculture that ensures food security and contributes to national development goals.	• Addressing vulnerability due to changes in rainfall and temperature, extreme weather events, and unsustainable land and water management and use • Reducing GHG emissions from agriculture • Establishing enabling policy, legal and institutional frameworks for effective implementation of climate-resilient and low-carbon sustainable agriculture • Minimizing effects of underlying cross-cutting issues such as low human resource capacity and lack of finance
Tanzania[14]	An agriculture sector that sustainably increases productivity, while enhancing climate resilience and food security for national economic development.	• Improving productivity and incomes through sustainable and climate-resilient practices that consider gender • Integrating agricultural value chains and improving infrastructure to support value addition, marketing, trade and post-harvest management • Strengthening policy, legal and institutional frameworks and improving institutional coordination for effective implementation of sustainable and climate-resilient agriculture • Increasing use of climate-smart technologies in agricultural production through research and innovations • Improving and sustaining agricultural advisory services • Developing financing mechanisms to mobilize resources through national, international and public–private partnerships to support sustainable and climate-resilient agriculture
Uganda[15]	Climate-resilient and low-carbon agricultural and food systems contributing to increased food security, wealth creation and sustainable economic growth.	• Increasing agricultural productivity through climate-resilient and low-carbon agriculture and food systems approaches that consider gender • Increasing the contribution of agriculture to low-carbon development pathways through transformation of agricultural practices • Strengthening the enabling environment for efficient and effective scaling up of climate-resilient and low-carbon agriculture and food systems • Increasing partnerships and resource mobilization initiatives to support implementation of climate-resilient and low-carbon agriculture and food systems

In addition to the national policies, strategies and programs designed to deliver progress on climate-resilient and low-carbon agriculture and food systems (Table 1), Ethiopia, Kenya, Tanzania and Uganda are all parties to the United Nations Framework Convention on Climate Change (UNFCCC). All four countries have submitted Nationally Determined Contributions (NDCs) under the UNFCCC framework, communicating their climate goals to the international community.[9,25,26] The NDCs represent key entry points for using scientific evidence to inform policies for sustainable agricultural development and climate action in East Africa. In addition, these four countries, and all other African parties to the UNFCCC, are represented by the African Group of Negotiators (AGN) in the international climate change negotiations, with some being members of the Least Developed Countries Expert Group.[27]

In 2015, the United Nation's Sustainable Development Goals (SDGs) replaced the Millennium Development Goals, with an aim to end poverty, protect the planet and ensure prosperity for everyone by 2030. East African countries embraced the principles for sustainable development and adopted SDGs right from the time of promulgation. They have worked to mainstream sustainability into their development strategies and embarked on a more sustainable development pathway. Many of the long-term strategic planning documents by East African countries developed during the past decade (such as Kenya's Vision 2030) have identified sustainable agricultural development among the pillars of their national development strategies, along with more inclusive growth.

The strategic role that agriculture will play in climate change adaptation and mitigation is also clearly reflected in East African countries' National Adaptation Programmes of Action, National Adaptation Plans and Nationally Appropriate Mitigation Actions.[16,28] Agriculture has also become a main focus of the AGN and UNFCCC focal points as they work to effectively articulate Africa's position on agriculture and climate change, notably through contributions to the roadmap for the Koronivia Joint Work on Agriculture.

At the regional level, members of the East African Community (EAC)—Kenya, Uganda and Tanzania—are also guided by the EAC Climate Change Policy.[16,29] In addition, a number of countries in East Africa have prepared National Agricultural Investment Plans (NAIPs) under the Comprehensive Africa Agriculture Development Programme (CAADP) of the African Union (AU). The NAIPs are designed, among other objectives, to scale up climate change adaptation and mitigation actions to ensure progress towards transforming agriculture under the Africa Agriculture Transformation Scorecard, which was announced at the 30th AU Heads of State Summit in 2018.[16,30]

How CCAFS supports East African countries' priorities

In the context of increasing climate variability and change, agriculture in East Africa is facing enormous challenges of achieving food and nutrition security, adapting to climate change and, where possible, reducing GHG emissions to mitigate climate change. The CGIAR Research Program on Climate Change, Agriculture and Food Security in East Africa (CCAFS EA) seeks to support the countries in East Africa, and the region as a whole, in their pursuits to achieve their sustainable developmental goals as well as fulfill their national, regional and international climate-related commitments. To achieve this, CCAFS EA is promoting climate-smart agriculture (CSA)—a strategic approach to agriculture that aims to solve the region's increasing developmental and climate-related challenges by introducing climate-smart practices and technologies to sustainably increase agricultural productivity and income, enhance resilience and adaptive capacity, while reducing emissions and sequestering carbon. Both CCAFS EA and the countries in East Africa recognize the relevance and efficacy of CSA and no longer consider CSA an option, but a core necessity to transform agriculture to deliver food and nutrition security as well as livelihood improvements in the face of a changing climate.

2. Focus countries and research sites

CCAFS East Africa aims to contribute to a climate-resilient region that is food and nutrition secure and has equitable access to livelihood opportunities for all.

Livestock farmers in the district of Lushoto, in the Tanga region of Tanzania. Credit: Georgina Smith (CIAT)

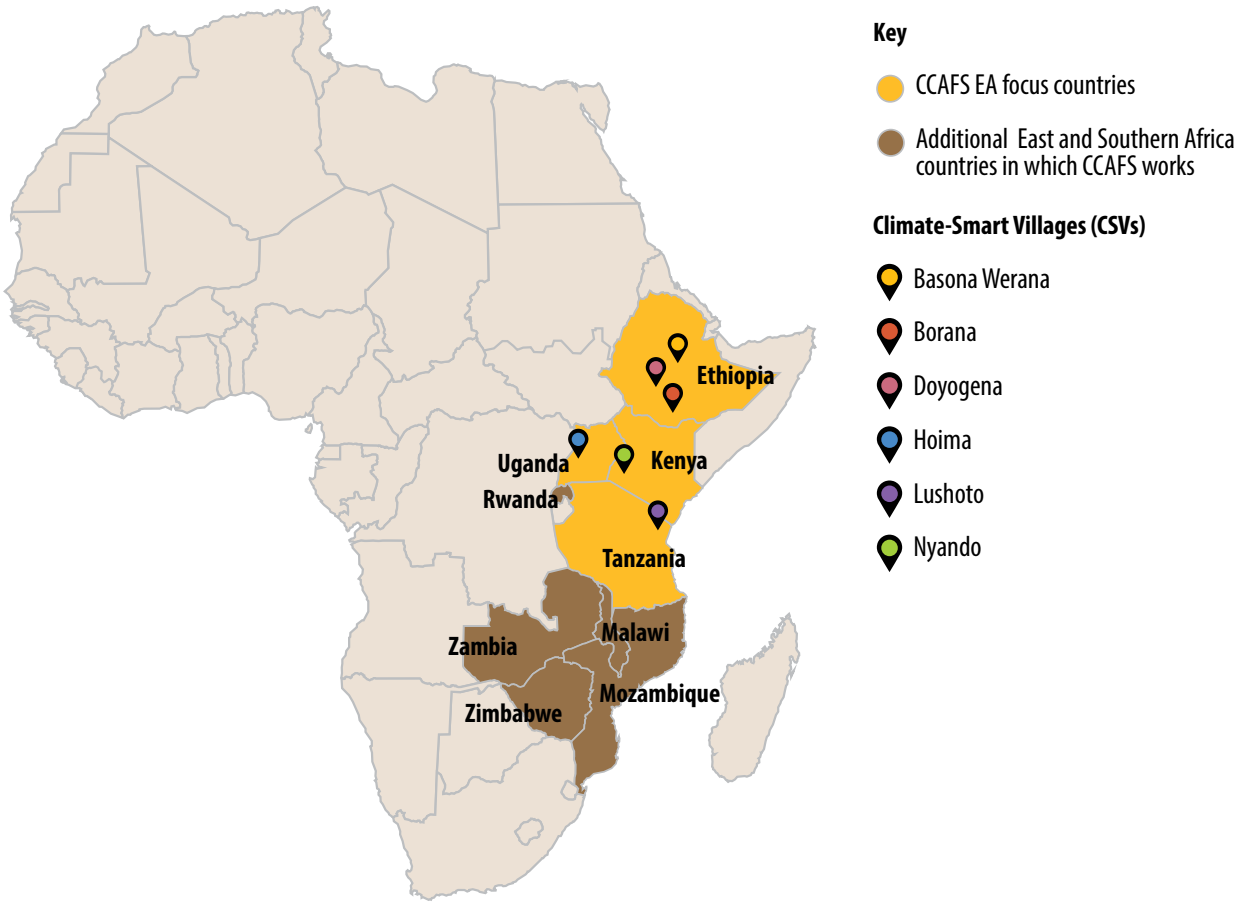
CCAFS EA carries out its research and engagement activities in four focus countries: Ethiopia, Kenya, Tanzania and Uganda. These countries were selected because their farming systems face a wide range of climatic, agro-ecological, environmental and socioeconomic challenges. Besides, the agricultural communities in these countries are highly vulnerable to climate risks and have very low adaptive capacities, leading to very fragile existence.

In these focus countries, CCAFS EA has established six research sites to introduce, test, evaluate and promote technological and institutional CSA options for addressing climate variability and change in agriculture (Figure 1). These research sites cut across the main agro-ecological zones and farming systems in East Africa. The sites include Nyando (Kenya), Lushoto (Tanzania), Hoima (Uganda) as well as Borana, Doyogena and Basona Werana (Ethiopia). These sites have

been established as Climate-Smart Villages (CSVs), a concept developed by CCAFS. The CSVs act as 'lighthouses', allowing communities to test, co-develop and adopt integrated portfolios of CSA practices. The CSVs are expected to continue to provide a solid framework through which the program can investigate how and when CSA practices and technologies can be adopted, building the evidence base to support future scaling up and out of CSA in the region. The interventions tested vary depending on the climate risks of the village, level of development, as well as the capacity and interests of farmers, local government and development partners. Agro-meteorological services, integrated crop, livestock and fisheries schemes, multi-strata agroforestry systems, market and financial services, as well as multi-stress tolerant new crop varieties and livestock breeds are among the most successful interventions piloted in the CSVs in East Africa.[31]

Outside the four primary focus countries, the program is working in Rwanda to build capacity for national climate services and to improve climate risk management for agriculture. In southern Africa, the program is working in Malawi, Mozambique, Zambia and Zimbabwe to make value chains and business models more inclusive and to provide incentives and innovative finance for scaling of CSA.

Figure 1: CCAFS East Africa focus countries and research sites



3. Goals and outcomes

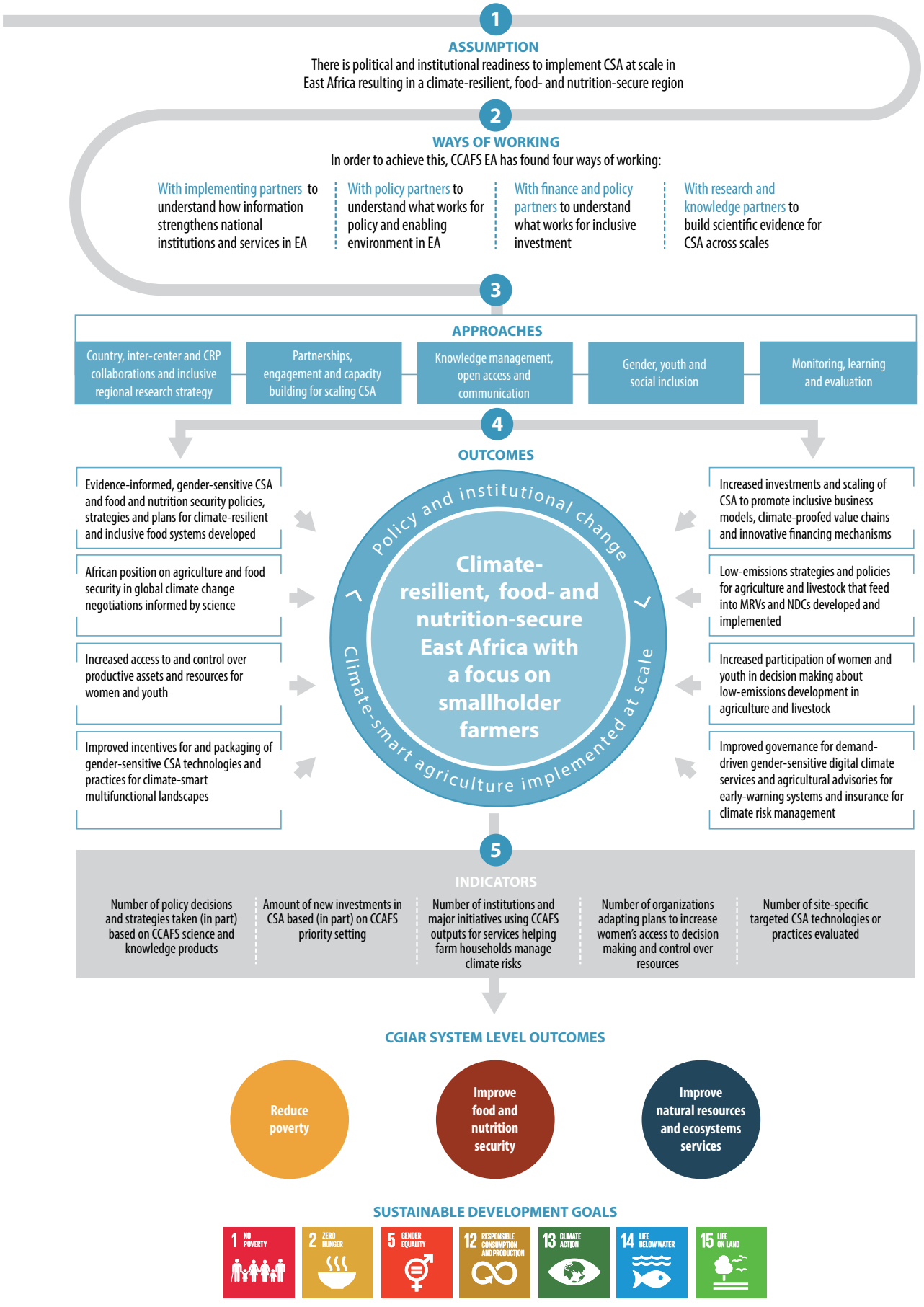
Livestock market in Wajir, northern Kenya.
Credit: Riccardo Gangale (ILRI)

CCAFS EA aims to address persistent constraints and challenges in agriculture through innovative technologies and practices, policies and enabling environments, as well as conducive investments.

CCAFS EA aims to contribute to a climate-resilient East Africa, which is food and nutrition secure and that has equitable access to livelihood opportunities for all. Complementary objectives that support these goals include increasing carbon storage in agricultural systems as well as reducing GHG emissions from food systems and agricultural value chains to mitigate climate change and supporting enabling policies and increased investments in agriculture and natural resource management. These goals are in line with CCAFS' overarching aim to catalyze positive change towards climate-smart agriculture, food systems and landscapes.[32] The goals are also aligned with the national policies and priority actions of East African countries.

By promoting CSA, CCAFS EA aims to address persistent constraints and challenges in agriculture through innovative technologies and practices, policies and enabling environments, and conducive investments. Figure 2 shows CCAFS EA's theory of change, including assumptions, approaches and pursued outcomes in support of East African countries' priorities. This represents the revised regional impact pathway, designed to effectively operationalize the strategy under the CCAFS flagships and cross-cutting learning platforms (LPs) (see Figure 3). The program's envisaged outcomes ultimately contribute to the CGIAR System Level Outcomes and the SDGs. The program's detailed outcomes and targets, which are aligned to the CCAFS flagships and cross-cutting LPs, are presented in Annex 1.

Figure 2: CCAFS East Africa Theory of Change



4. Strategic research pillars

Agroforestry in East Africa. Credit: Dawit Solomon (CCAFS)

CCAFS EA supports the ongoing regional and national efforts to sustainably transform agriculture and achieve food and nutrition security under climate change through scaled up implementation of inclusive CSA initiatives.

CCAFS EA recognizes that with increasing climate variability and change, East Africa is facing significant challenges in meeting national development objectives, international climate commitments and the SDGs. Transforming the region's agricultural system requires a shared vision among the different stakeholders in the development and food security sectors. Success will only be possible through collective actions of national governments, international research organizations and development agencies as well as through regional and international cooperation. Therefore, CCAFS EA is continuously undertaking extensive engagement and consultation with national and regional policy makers. In February 2018, the program organized a regional strategy revision workshop in Arusha, Tanzania. This strategy workshop brought together research and implementing partners, farmer organizations, non-governmental organizations (NGOs), private sector organizations, CGIAR centers in East Africa, CCAFS flagship leaders and other relevant stakeholders.

As a result of this workshop, CCAFS EA identified four interconnected strategic research pillars and a number of emerging opportunities to guide the program's research initiatives, engagement activities and communications for 2019–2021.

These priorities are in line with the CCAFS Phase II proposal, the directions provided by CCAFS' Independent Steering Committee and the regional focus countries' national policy and priority actions. CCAFS EA's revised research strategy puts greater emphasis on enhancing agricultural productivity and incomes, boosting food and nutrition security, building resilience and adaptive capacity, and, where possible, reducing GHG emissions and sequestering carbon in agricultural systems. The program plans to focus more on cross-cutting transformative actions, including using big data and digital solutions to enhance implementation at scale to benefit smallholder farmers and other vulnerable groups. The program's strategy also supports the ongoing regional and national efforts to sustainably transform agriculture and achieve food and nutrition security under climate change through scaled up implementation of inclusive CSA initiatives. The future CCAFS EA research priorities and emerging opportunities, many of which can be pursued as integrated research activities, are as follows:

Climate-smart technologies, innovations and policies

To transition to CSA at scale, CCAFS EA will test, evaluate, increase access to, and promote technologies and innovations to enhance agricultural productivity and incomes, build resilience and adaptive capacities as well as to meet farmers' needs. The technologies and innovations include: i) high-yielding, early maturing and multi-stress tolerant crop varieties (adapted to e.g. elevated temperature, drought, flood and salinity) as well as varieties resistant to emerging diseases and pests triggered by climate variability and shocks; ii) improved livestock breeds that are heat and disease tolerant and have high feed conversion efficiency and productivity to build resilience in the region's livestock systems and value chains; iii) multi-strata agroforestry to diversify farms and enhance resilience; iv) integrated soil and water management as well as integrated soil fertility and crop nutrient management to reduce land degradation, enhance soil health, boost productivity, build soil organic carbon and improve fertilizer use efficiency focusing on type, amount and time of application; v) solar-powered irrigation to expand access to affordable irrigation, enhance resilience and improve water use efficiency to combat recurrent water stress and drought; vi) improved agronomic practices; vii) aquaculture to enhance household nutrition and diversify incomes; and viii) inclusive business models and financing instruments, such as local rotating savings and credit association schemes, to allow smallholder farmers to pool their financial resources and invest in climate-smart technologies.

CCAFS EA will also promote drought-tolerant perennial crops with the potential to sequester greater amounts of soil and biomass carbon to increase the potential for farms and landscapes to mitigate climate change. Overall, the program will develop and promote solutions that are customized to different agro-ecologies and farming systems in East Africa. Promoting a portfolio of contextualized CSA technologies and practices for resource-poor farmers, including women and youth, will be a key priority. Climate, food and nutrition security scenario analyses will also be undertaken to provide evidence for multilevel gender- and nutrition-sensitive policies and to guide targeted investments in and implementation of CSA.

Climate information, agro-advisory and insurance for climate risk management

The frequency and severity of extreme climate events such as droughts, dry spells, heat waves, storms and floods is increasing in East Africa, making it difficult to progress towards more sustainable and productive agriculture.[12] Effective climate services, early-warning systems and climate-informed agro-advisories are part of an enabling environment for the transition towards CSA. Therefore, CCAFS EA will develop such services to ensure that farmers are well informed of climate risks and protected by well-targeted safety nets. The program will focus on early warning, innovative insurance products and climate-informed agro-advisories and market services to help build farmers' capacity for acting on such information and managing climate risks. Climate information services and early warning advisories may be shared via SMS, radio or word of mouth.

Innovative insurance products, such as index-based agricultural insurance, are an attractive approach to managing climate risks as they rely on direct measurement of the loss or damage suffered

Box 1: Sharing better climate information for effective and timely farming decisions in Tanzania and Ethiopia

In Lushoto, Tanzania, CCAFS EA is coordinating an initiative to provide farmers with improved climate information, enabling them to make sound and timely farming decisions, such as what and when to plant, and when to harvest. The initiative combines indigenous knowledge with scientific meteorological weather forecasting. Three weather forecasting teams using indigenous knowledge have been formed in Lushoto, representing three different agro-ecological zones (humid, sub-humid and lowlands). Every three months these teams meet with experts from the Tanzania Meteorological Agency (TMA) to compare indigenous forecasts with seasonal outlook forecasts from TMA. Following the meetings, the forecasts are integrated and packaged for dissemination. The forecasts are shared through a variety of tools: i) a farm SMS tool that sends climate forecast information to subscribing farmers, allowing them to receive timely alerts, advisories and weather forecasts that are issued by TMA in the national language, Swahili; ii) a more traditional mechanism involving dissemination in the community through word of mouth; and iii) printed flyers that help broaden the reach of the forecasts.

The service, which began in 2012, now reaches more than 1,000 households in Lushoto, enabling them to make better farming decisions.

In the northern and southern highlands of Ethiopia, CCAFS EA is using information and communication technologies (ICT) to disseminate climate services and market information to smallholder farmers. The initiative is carried out in partnership with the Ethiopian Ministry of Agriculture and Livestock Resources, research and development partners and a private sector partner (Echnoserve). Echnoserve has developed a tool, called YeZaRe, with an embedded geographic information system technology that allows farmers to receive information specifically tailored to their location. The YeZaRe phone app and SMS service are also available through a web-based system. It provides three-, ten- and thirty-day forecasts as well as seasonal forecasts. The ten-day forecast also comes with agro-advisory services, enabling smallholder farmers to make informed decisions and take relevant actions for optimal agricultural productivity. Currently, the service is reaching 1,000 farmers, with the potential of reaching 55,000 farmers within the next three years.

Farmer with her phone in Dodoma, Tanzania. Credit: Cecilia Schubert (CCAFS)

by individual farmers. CCAFS EA, together with national, regional and international partners, will explore various index-based insurance approaches and develop tools and approaches to reduce the risk of livestock loss, crop yield reduction or crop failure. This can help increase farmers' short- and long-term resilience and adaptive capacity. With insurance, farmers will experience reduced risks and may be incentivized to invest in on-farm innovations to increase agricultural productivity and resilience. Finally, CCAFS EA will provide evidence to inform policies and investments related to climate information services, agricultural advisories and insurance products to ensure that the most significant risks are being addressed, thus providing maximum benefits to vulnerable farmers.

Low-emissions development pathways for agriculture

East African countries have pledged in their NDCs to reduce GHG emissions, in adherence to the Paris Agreement of the UNFCCC.[33] To support these commitments, CCAFS EA will work with governments, the private sector, NGOs, international development partners and other relevant stakeholders to raise awareness on low-emissions development (LED) systems in crop and livestock sectors and to assess the economic and social feasibility for smallholder farmers to scale LED technologies and practices. Critical first steps include establishing baselines for current emission levels from crop and livestock activities, gathering evidence on how low-emissions technologies and practices contribute to food and nutrition security, and identifying farm- and landscape-level mitigation co-benefits. The objectives of the program's LED research will be to i) understand the challenges and barriers for LED in crop and livestock sub-sectors; ii) test whether contextualized LED pathways can reduce agricultural GHG emissions and contribute to food security; iii) explore how LED in crop and livestock sub-sectors provides farm- and landscape-level mitigation co-benefits; and iv) effectively support the development of an enabling environment and policies for undertaking LED at scale in public–

Linking adaptation and mitigation and capitalizing on their synergies in agriculture is vital in East Africa, and should form the core of national and regional climate policy planning and implementation.

Credit: Dawit Solomon (CCAFS).

private partnership schemes. The research will also benefit national LED efforts by developing and strengthening tools for better emissions measurement, to improve measurement, reporting and verification (MRV) systems that can feed into the countries' NDCs, and by building both technical and human capacities to implement LED at scale.

The primary beneficiaries of the program's LED research are the region's smallholder farmers, for whom LED practices can contribute to food security and climate resilience by increasing yields, reducing input use and improving natural capital. The research will also benefit the private sector and national LED efforts by providing better emissions estimates, improving technical capacities to implement and monitor LED, and supporting policy development.

Gender, youth and socially inclusive growth

Resource-poor women, youth and other already marginalized groups are particularly vulnerable to the impacts of climate change and often face higher risks.[9] These groups have inadequate access to and control over productive assets and can rarely participate in decision making and labor markets, making them unable to effectively contribute to climate-related planning, policy making and implementation of CSA initiatives. In addition, men and women often have different preferences and priorities, which need to be considered when piloting or scaling CSA. Women often play a critical role in addressing climate-related risks due to their local knowledge and leadership in sustainable natural resource management practices at household and community levels.[34] CCAFS EA recognizes that development and implementation of policies that do not take women's meaningful participation into account could further widen the gender gap. CCAFS EA will conduct research to inform, catalyze and target climate-smart solutions to women, youth and other vulnerable groups to increase their control over productive assets and resources as well as enhance their access to information and participation in decision making.

CCAFS EA will address gender, youth and social inclusion-related challenges and engage stakeholders to achieve these goals at multiple scales. The program's research and engagement

> Women often carry the brunt of the climate burden, but keeping their challenges in mind when designing research, technologies and policies can help create equitable opportunities and climate resilience.

efforts will focus on i) supporting the development of gender-sensitive and socially inclusive CSA policies; ii) developing strategies that encourage investments to increase access to and control over productive assets and resources by women, youth and other marginalized groups; iii) supporting gender-sensitive, socially inclusive community efforts that provide greater opportunity for women, youth and other vulnerable groups to adopt CSA technologies and practices; and iv) designing initiatives that increase access to CSA technologies and practices, information and decision making by women, youth and other marginalized groups.

The program will also prioritize building capacity of policy leaders to better integrate gender considerations into climate change policies and programs at national levels. Making CSA more attractive and accessible to youth will be another important focus, and potential strategies include improved linkages between education and business, inclusive financial services and business models, better access to markets and equitable transfers of technology and skills.

In addition to the strategic research pillars outlined above, the revised CCAFS EA strategy will explore and maximize the following emerging cross-cutting opportunities that can help transform the region's agriculture. In doing so, the program will seek to foster South–South partnerships among CCAFS' regional programs and seek out various bilateral opportunities to scale up the main research priorities outlined above.

5. Emerging cross-cutting opportunities in East Africa

Integrated ecological approaches for climate-smart and resilient landscapes and food security

East African countries, and their international development partners, have identified climate-smart, multifunctional landscapes as an important climate change adaptation and mitigation strategy. CCAFS EA recognizes that landscapes are multifunctional and provide benefits and services to a wide range of ecosystem processes and species as well as to the region's increasing population. The program seeks to support research on contextualized, integrated planning and management of landscapes that i) considers the interests of multiple stakeholders; ii) identifies synergies on productivity, food and nutrition security, income, adaptation and mitigation co-benefits; and iii) analyzes and negotiates the trade-offs among different uses. Identifying landscape approaches that integrate sustainable management of ecosystems with livelihood considerations, including crop–livestock management, agroforestry, sustainable fisheries, afforestation and reforestation, and improved rangeland management, will be an integral part of the regional program's priorities.

CCAFS EA will also work with relevant stakeholders and CGIAR partners to offer opportunities for reversing deforestation and land degradation as well as for creating synergies between climate change adaptation and mitigation. Such efforts will include quantifying carbon sequestration potentials and benefits of climate-smart and resilient landscapes as well as of large-scale land management and agro-ecosystem rehabilitation projects. The goal is to learn how to effectively use landscapes and agro-ecosystems to reduce GHG emissions, without compromising agricultural productivity or food and nutrition security.

Making such large-scale changes requires improving the enabling policy environment and setting priorities for targeted investments. The program will provide decision makers with evidence on the benefits of CSA at scale as well as trade-off analyses and foresight modeling to help inform policy decisions. CCAFS EA's research is also intended to help governments and the private sector prioritize CSA investments and to provide smallholders with access to climate finance. This can help overcome sustainability- and scaling-related constraints to achieving climate-smart and resilient landscapes.

Strengthening and climate-proofing value chains

Climate extremes and weather hazards could lead to severe economic and financial consequences for agricultural value chains and markets across East Africa, affecting both farmers and private sector actors.[22,35] Farmers' production is in many instances inextricably linked to agri-businesses, and a changing climate could likely jeopardize the relationship, putting businesses that depend on farmers at risk, and vice versa.

Recognizing the emerging challenges from climate variability and change, it is critical to include climate into vulnerability assessments across agricultural value chains. This will allow stakeholders, including smallholder farmers and agri-businesses, to identify the risks, develop and strengthen contingency plans, create possibilities for responding with climate-smart adaptation measures to minimize risks and climate-proof value chains, improve efficiency and reduce costs. At the same time, opportunities to reduce GHG emissions and capitalize on the ensuing new business opportunities can be created.

Strengthening agricultural value chains in support of CSA represents an opportunity to increase climate resilience in the region. Climate risks can be reduced by making inputs available and improving access to market information to incentivize smallholders to invest in CSA; developing and strengthening contingency plans for responding to climate risks; improving efficiencies and reducing costs along the value chain; and creating opportunities to reduce GHG emissions. CCAFS EA will work with countries, private sector partners and communities

It is time to look ahead for big opportunities: digital systems and technologies, climate financing and resilient value chains are some of the most promising.

Beneficiary of Takaful insurance payout in Wajir, northern Kenya. Credit: Riccardo Gangale (ILRI)

to i) identify key agricultural value chains in the region; ii) conduct socioeconomic and bio-physical feasibility and environmental benefit assessments with special focus on local smallholder farming communities and the natural environment, acknowledging their essential roles within business value chains; iii) ascertain drivers, such as shocks and disturbances, and hotspots for risks across value chains; and iv) evaluate key value chains' robustness, resilience, adaptability and capacity to withstand and absorb shocks.[36]

The program will aim to identify leverage points and opportunities for smallholder farmers, agri-businesses and other private sector stakeholders to develop and implement preventive actions that build robustness, address stressors and enhance reactive capacities of value chains. In this way, value chains can better respond to shocks and adapt to short- and long-term climate risks, thus creating benefits for private sector partners, communities and the environment.

To support such efforts, CCAFS EA has recently developed a large-scale climate and food security program focused on climate-proofing agricultural value chains for Kenya, Tanzania and Uganda in collaboration with the Netherlands Development Organization (SNV), Wageningen University and Research, Agriterra and Rabobank, and with support from the Government of the Netherlands.

Big data and climate-informed digital systems for improved agricultural advisory services

In the developed world, big data libraries, integrated digital technologies and advanced analytics are already transforming agriculture, making farm operations more insight driven and efficient. However, the application of digital technology in agriculture and other sectors remains limited in East Africa.

CCAFS EA will pursue the application of big data as well as digital systems and solutions to strengthen agricultural extension systems and advisories for smallholder farmers. Existing agricultural advisory systems are not designed to draw on location-

specific and accurate data, such as soil type and health, crop and livestock diseases and pests, and market prices. Instead, advisory services tend to be generic and centrally controlled, with limited options to engage with and respond to the needs of private sector actors, farming communities, women and youth. Opportunities for improving the use of digital solutions must be considered, including increasing 'last-mile connectivity'—as facilitated by the rapid expansion of mobile technology and large investments in telecom services, which makes it possible to reach even more smallholder farmers. Similarly, digital decision-support tools (DSTs) that benefit from big data have the potential to support policy makers, private sector investors and farmers to make better decisions.

CCAFS EA recognizes that increased use of digital technology and ICT has the potential to accelerate agricultural productivity, improve food security, and boost job opportunities and incomes across the region. Therefore, the program will work with smallholder farmers, national and regional partners, CGIAR centers and CGIAR research programs (CRPs), NGOs, women and youth groups, the private sector, and other relevant stakeholders to undertake strategic research in order to i) understand the priorities, policies and systemic bottlenecks for developing climate-informed digital advisories and solutions; ii) support the development of integrated national digital agricultural data hubs; iii) explore opportunities for developing digital, demand-driven and inclusive agricultural advisories, DSTs and services; and iv) test such digital systems at scale to help transform the region's agriculture.

These strategic efforts are expected to support the development of national agricultural digital hubs, which integrate climate, soil, crop, livestock and market information, as well as agricultural decision-support platforms that can engage women and youth. Through public–private partnerships, the program will strive to develop agro-ecosystem-specific, demand-driven, and climate-informed agricultural advisories, DSTs, climate and insurance services to be delivered through digital mechanisms (e.g. web-based services, smart phone-based apps, SMS, interactive voice response, video and radio) or through face-to-face interactions, particularly for climate services, agricultural advisories and insurance. These efforts are expected to make agriculture more attractive to the youth and have potential to enhance involvement of the youth in transforming East African agriculture.

Innovative financing mechanisms

Lack of vigorous and sustainable agricultural productivity and growth as well as prevalent unsustainable approaches are among the main causes of food insecurity in East Africa. On the other hand, robust growth in agricultural productivity, achieved through sustainable, demand-driven and market-oriented agricultural transformation, can drive the productivity increases crucial for food and nutrition security, poverty reduction and achievement of the SDGs under a changing climate. Clearly, there is need for scaled investment in agriculture to meet the existing challenges and support adaptation to climate change.

Accordingly, in 2003, the countries in East Africa agreed to dedicate 10% of their national budgets to agriculture in the Maputo Declaration on Agriculture and Food Security in Africa. Since then, agricultural investments in the region have been growing.[37] However, due to competing needs, pressure on public resources is increasing. Therefore, additional investments in agriculture, made possible through innovative financing mechanisms, will be critical to strengthen the sector's resilience and adaptation to climate variability and change.

CCAFS EA will work towards supporting private and public sector partners and other stakeholders in the region to identify and nurture innovative financing mechanisms that can generate positive returns on investment and synergies for sustainable development. Such mechanisms may provide incentives to scale up implementation of CSA and climate-smart landscapes, generating adaptation and mitigation co-benefits. Potential financing opportunities include i) private financing for climate adaptation, benefitting from the private sector's ability to mobilize finance for agriculture;[38] ii) impact investment in attractive agricultural projects with social, environmental and other development benefits; iii) blended finance where development finance and philanthropic funds are used to incentivize and leverage private sector capital for CSA, for example in the form of grants and loans to smallholder farmers and small agricultural

enterprises; and iv) funds from financial institutions that have mainstreamed climate resilience considerations into their operations.[38]

Private sector engagement

Engagement with the private sector is important for sustainable growth in agricultural productivity, which is a crucial factor for the region's food and nutrition security. Therefore, CCAFS EA will make concerted efforts towards engaging with the private sector to develop climate- and market-information services and insurance products to sustainably transform agriculture. In addition, by fostering effective strategic public–private partnerships, the program will seek to develop agro-ecosystem-specific, market-oriented, climate-informed agricultural advisories as well as decision support tools, climate and insurance services. In addition, CCAFS EA will work with national, regional and global partners, CGIAR centers and other relevant stakeholders to develop mechanisms that incentivize private sector investments in capacity development, agricultural extension, climate-proofing of crop and livestock value chains, and solar-powered irrigation to enhance efficiency and minimize vulnerability to climate extremes.

Integration of aquaculture into agriculture could lead to diversification of diets of resource-poor farming households and enhance livelihoods of rural women in East Africa. Credit: Cecilia Schubert (CCAFS).

6. Program structure

The focal region programs are on the ground, constantly evaluating which CSA solutions work and which ones are needed.

Beans on sale at a food market in central Kampala, Uganda. Credit: Neil Palmer (CIAT)

Globally, CCAFS maintains a matrix structure in which activities are carried out under four flagships and within five focal regions: Latin America, East Africa, West Africa, Southeast Asia and South Asia. The regional programs remain the central mechanism for CCAFS to connect research to national and regional policy and practice across the entire program. CCAFS EA will actively use a series of strategic research, engagement and communication activities to enhance its ability to generate knowledge, develop innovative technologies and practices, inform policy and deliver impact at scale.

The research, engagement and communication activities carried out under the East Africa program are mapped to one or more of the four flagships and their respective clusters of activities:

- **Flagship 1:** Priorities and policies for CSA – provides improved evidence and tools on enabling policy environments and priority setting for targeted investment to support the scaling of CSA
- **Flagship 2:** Climate-smart technologies and practices – provides evidence on

the synergies and trade-offs among CSA technologies and practices across a range of agro-ecologies and social contexts

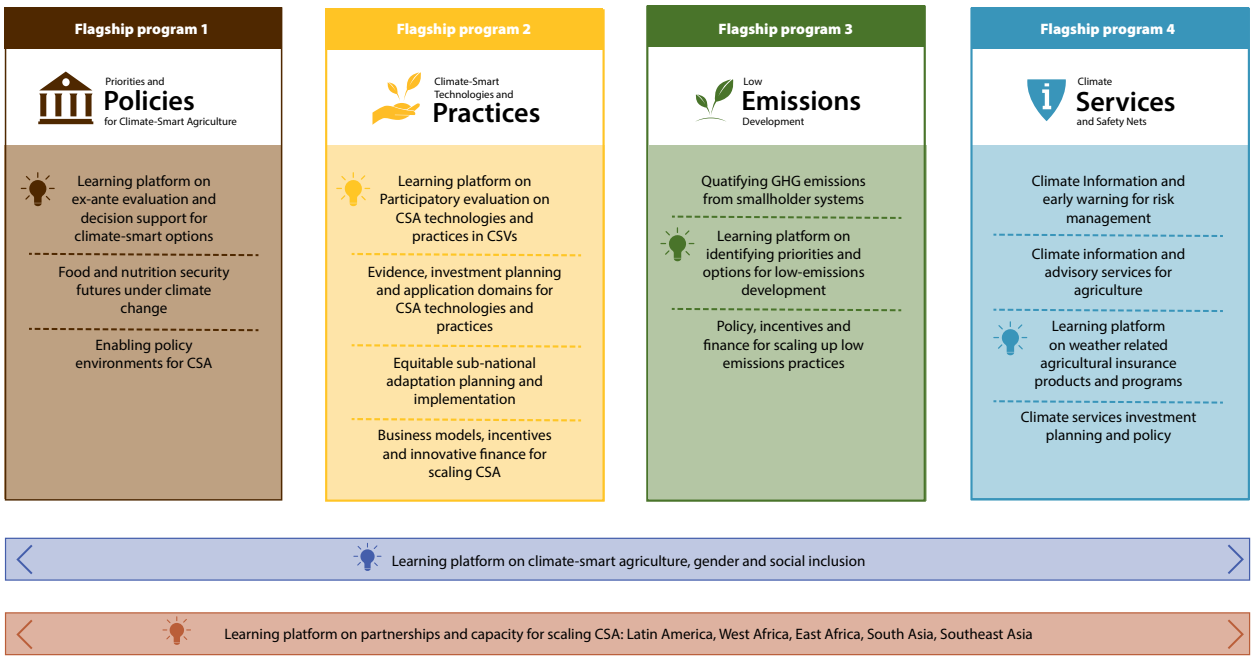
- **Flagship 3:** Low-emissions development – tests the feasibility of reducing agricultural GHG emissions at large scales, while ensuring rural food and nutrition security in low- and middle-income countries
- **Flagship 4:** Climate services and safety nets – addresses gaps in knowledge, methodology, evidence and capacity needed to effectively implement a set of scalable interventions that use climate-related information to manage climate-related risks

In addition, there are also six Learning Platforms (LPs) that link with other CGIAR research programs and across CGIAR centers, with two LPs cutting across the entire CCAFS program. The first cross-cutting LP, on CSA, gender and social inclusion, integrates gender and social analysis across the program's flagships and regions, and it provides support and knowledge on how to address gender and social inclusion in climate-related work. The second cross-cutting LP, on partnerships and capacity for scaling CSA, aims to manage national to global partnerships for climate change policy impact and scaling of CSA, ultimately seeking to position the CGIAR as the leading global research organization for developing country food systems and climate change (Figure 3).

Finally, CCAFS, led by the International Center for Tropical Agriculture (CIAT), is one of four integrating research programs within CGIAR. It ensures integration on climate change across the CGIAR portfolio by providing tools and advice on priorities in different contexts, making links to the climate science community and representing CGIAR in climate-related policy processes. CCAFS EA contributes to fulfilling this mandate through country collaborations with CGIAR centers and research programs.[32]

The CCAFS EA regional program is hosted by the International Livestock Research Institute (ILRI) in Addis Ababa, Ethiopia, with a satellite office in Nairobi, Kenya. The core regional team consists of a region program leader, who is responsible for delivering the regional portfolio, a science officer, a partnerships and policy specialist, a participatory action research specialist and a research assistant. The regional program collaborates closely with the other CCAFS flagships and regional programs as well as with the CCAFS Program Management Unit, based at Wageningen University and Research in Wageningen, the Netherlands, and at CIAT in Cali, Colombia.

Figure 3: CCAFS flagships and cross-cutting learning platforms



7. Delivering impact at scale

Strong partnerships with national governments, agricultural research centers and agricultural extension services are the best way to influence policies and practices in pursuit of CSA.

Checking for bean pests and diseases in Kawanda, Uganda.
Credit: Neil Palmer (CIAT)

Partnerships

Strong partnerships and engagements are critical to effectively address the seemingly intractable challenges at scale and achieving progress towards CSA as well as food and nutrition security in the region.

As an integrative CGIAR research program (CRP), collaboration with CGIAR centers and other CRPs is essential for CCAFS EA. The program's research and engagement portfolio is underpinned by close collaboration with the core CGIAR centers and CRPs that individually or through cross-center collaborations carry out the program's activities and climate-smart initiatives. The CGIAR partners include the International Center for Tropical Agriculture (CIAT), the International Livestock Research Institute (ILRI), Bioversity International, Center for International Forestry Research (CIFOR), International Center for Agricultural Research in the Dry Areas (ICARDA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Food Policy Research Institute (IFPRI), International Institute of Tropical Agriculture (IITA), International Maize and Wheat Improvement Center (CIMMYT), International Potato Center (CIP), International Water Management Institute (IWMI), and World Agroforestry Centre (ICRAF). CCAFS EA also plans to strengthen collaborations with CRPs such as Forests, Trees, and Agroforestry (FTA), Roots, Tubers and Bananas (RTB), Water, Land and Ecosystems (WLE), Agriculture for Nutrition and

Health (A4NH) and CGIAR platforms (Genebank and Big Data in Agriculture).

While the CGIAR centers and CRPs represent the key research partners, CCAFS EA also expands and enriches its portfolio through collaborations with a multitude of diverse national, regional and international partners, including knowledge, policy, financing and implementing partners, farmer organizations, NGOs, civil society and private sector stakeholders (Figure 4). Acknowledging that the primary pathway to uptake lies at the national level, the program places high priority on partnerships with national governments and other national stakeholders. These are agencies and bodies implementing CSA and other climate-related food security and agricultural initiatives. The program will strengthen engagement with the ministries of agriculture, environment and climate change to develop an enabling environment for CSA and influence policy; national agricultural research systems to develop and test CSA technologies and practices; national agricultural extension services to implement CSA as well as to pilot DSTs and digital agricultural advisories at scale; meteorological services to provide accurate and timely climate information services; and farmers and farmer organizations to co-design and implement demand-driven and market-oriented CSA and extension systems.

Establishing and maintaining partnerships with the private sector is a priority for developing and scaling innovative products such as climate and market information services and index-based agricultural insurance. The private sector also has important roles to play in optimizing climate information services, climate-informed agricultural advisories, DSTs and digital delivery mechanisms. Similarly, partnerships with civil

Figure 4: CCAFS East Africa partners

Key for partner organization acronyms: [ACMAD] African Centre of Meteorological Applications for Development; [ACPC] African Climate Policy Centre; [AfDB] African Development Bank; [AGN] African Group of Negotiators; [AGRA] Alliance for a Green Revolution in Africa; [ASARECA] Association for Strengthening Agricultural Research in Eastern and Central Africa; [AU] African Union; [EAC] East African Community; [EU] European Union; [FAO] Food and Agriculture Organization; [GRA] Global Research Alliance; [ICPAC] IGAD Climate Prediction and Application Centre; [IGAD] Intergovernmental Authority on Development; [NARS] National agricultural research systems; [NEPAD] New Partnership for Africa's Development; [NMA] National meteorological agencies; [UNFCCC] United Nations Framework Convention on Climate Change; [WB] The World Bank; [WFP] World Food Programme.

society organizations and NGOs underpin the above efforts at the national level and support implementation and scaling of CSA. CCAFS EA will work with these partners to implement evidence-based, contextualized, gender-sensitive CSA technologies and practices at scale to sustainably boost agricultural productivity as well as food and nutrition security.

To expand its reach and influence, CCAFS EA also engages with international development organizations working in East Africa. These include The World Bank, African Development Bank (AfDB), the European Union (EU), the UK's Department for International Development (DFID), the United States Agency for International Development (USAID), the Royal Netherlands Embassy, the Danish International Development Agency (DANIDA), Irish Aid, and the Australian Center for International Agricultural Research (ACIAR) . Conducting impact assessments and providing evidence for the efficacy of CSA to development organizations such as The World Bank, the International Fund for Agricultural Development (IFAD) and the German Society for International Cooperation (GIZ) is considered an important way to increase implementation and uptake of CSA.

Finally, CCAFS EA will place a particular focus on engaging in the processes surrounding the various regional and international organizations and alliances working on climate change, agriculture and food security. These include the United Nations Framework Convention on Climate Change (UNFCCC); the Food and Agricultural Organization of the UN (FAO); the World Food Programme (WFP); Global Alliance for Climate-Smart Agriculture (GASCA); UN Women for Eastern and Southern Africa; the Intergovernmental Authority on Development (IGAD); the East African Community (EAC); African Climate Policy Centre (ACPC); the Comprehensive Africa Agriculture Development Programme (CAADP); the Alliance for a Green Revolution in Africa (AGRA); the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA); and the New Partnership for African Development of the AU (NEPAD).

Communication

CCAFS EA will strategically position itself as a key point of reference in scientific knowledge and evidence generation, aiming to inform policy and deliver impact at scale. The program will continue

Trials of drought tolerant beans in Malawi -The pod from the drought tolerant variety is yellow, indicating early maturity, enabling the plant to escape the severity of the drought. Credit: Neil Palmer (CIAT)

to strengthen its communications and engagement with partners, and it will encourage national, regional, global and inter-organizational knowledge sharing, capacity building and collaborative research, including effective South–South joint initiatives to promote CSA and advance the SDGs. Strategic communication is a critical component of the regional program's strategy and serves as a bridge to inspire change, build support and leverage resources and impact. Communication plays a key role in strengthening CCAFS EA's support to East African countries' priorities, making its objectives, goals and knowledge products more visible and relevant to partners and other stakeholders. Therefore, the regional program will strategically use a combination of communication approaches and channels to disseminate CCAFS knowledge outputs and research results to enhance adoption and scaling of CSA, for example through print, and online media engagement, social media as well as cross-cutting science and policy meetings. The program will also develop and make available various forms of publications, such as blog posts, newsletters, info notes, working papers, policy briefs and peer-reviewed publications to disseminate CCAFS knowledge outputs and research results.

CCAFS EA will actively engage in dialogue and policy processes with relevant stakeholders to facilitate learning and enhance capacities. The program also synthesizes and disseminates science-based recommendations, solutions and tools to next users, and collaborates with local and global media to share information with policy makers and general interest groups in public, private and civil society sectors. CCAFS EA's engagement and communication approach is in line with CCAFS' overall engagement and communication strategy.[39]

Resource mobilization

CCAFS EA understands that the funding landscape for agriculture, food and nutrition security, and climate change research is becoming more complex, unpredictable and competitive. However, there is a need for sustained and secure investments in agriculture, food security and climate change for CCAFS EA to catalyze positive change towards climate-smart agriculture, food systems and landscapes. Only then can the program effectively contribute to a climate-resilient and food- and nutrition-secure East Africa that will overcome the existing environmental and socio-economic constraints and challenges related to emerging climate variability and change. Therefore, the program will continuously work towards mobilizing resources through a range of channels. For example, it will establish mechanisms for the provision of knowledge products and services and seek to unlock large sources of funding to scale up CSA and climate-smart landscapes. Public–private partnerships will be pursued for climate-proofing value chains. Climate and land use finance will be used to strengthen partnerships with international development partners (IFAD, DFID, IrishAid, DANIDA, the Government of the Netherlands, EU, AU, Bill and Melinda Gates Foundation), leading financial institutions (The World Bank, AfDB, etc.), and with non-traditional donors including private sector and philanthropic foundations. Likewise, the program will seek to establish partnerships with international climate funds, such as the Green Climate Fund, to finance the scaling of CSA solutions and support East African governments in their efforts to transform agriculture.

Monitoring and learning

CCAFS has adopted a results-based management approach to monitor, evaluate and internally learn from the program's portfolio of projects. Projects are designed to contribute to CCAFS' overall goals, and their performance and progress are evaluated against set targets. The program also identifies synergies within the projects and other ongoing related work and initiatives. Following adaptive management principles, the regional program is able to seize emerging opportunities with project researchers as well as with regional and global teams. The program continuously monitors project performance and progress towards outputs and outcomes to ensure that the program adds value and contributes to the identified development outcomes.

8. References

[1] [AGRA] Alliance for a Green Revolution in Africa. 2016. *The Africa Agriculture Status Report 2016: Progress towards agriculture transformation in sub-Saharan Africa. Nairobi: Alliance for a Green Revolution in Africa.* Available at: https://agra.org/aasr2016/ (accessed August 1, 2018).

[2] [CIAT] International Center for Tropical Agriculture, [BFS/USAID] Bureau for Food Security, United States Agency for International Development. 2017. *Climate-smart agriculture in Uganda.* CSA Country Profiles for Africa Series. Washington, D.C.: International Center for Tropical Agriculture; Bureau for Food Security, United States Agency for International Development.

[3] [CIAT] International Center for Tropical Agriculture, [BFS/USAID] Bureau for Food Security, United States Agency for International Development. 2017. *Climate-smart agriculture in Ethiopia.* CSA Country Profiles for Africa Series. Washington, D.C.: International Center for Tropical Agriculture; Bureau for Food Security, United States Agency for International Development.

[4] [CIAT] International Center for Tropical Agriculture, The World Bank. 2017. *Climate-smart agriculture in Tanzania.* CSA Country Profiles for Africa Series. Washington, D.C.: International Center for Tropical Agriculture; The World Bank.

[5] [NEPAD] New Partnership for Africa's Development. 2013. *Agriculture in Africa - transformation and outlook.* Midrand: New Partnership for Africa's Development. Available at: http://www.nepad.org/resource/agriculture-africa-transformation-and-outlook (accessed August 1, 2018).

[6] Republic of Kenya: Ministry of Agriculture, Livestock and Fisheries. 2017. *Kenya climate-smart agriculture strategy 2017-2026.* Nairobi: Ministry of Agriculture, Livestock and Fisheries.

[7] Awiti AO, Scott B. 2016. *The East Africa youth survey report.* Karachi: Aga Khan University. Available at: http://data.eadialogueseries.org/docs/The_East_Africa_Youth_Survey_report_executive_summary.pdf (accessed on August 1, 2018)

[8] [AfDB] African Development Bank. 2016. *Feed Africa: Strategy for agricultural transformation in Africa 2016–2025.* Abidjan: African Development Bank Group.

[9] Crumpler K, Laval E, Federici S, Eveille F, Bernoux M, Salvatore M, Di Stefano E, Darmaun M, Heureux A, Ramasamy S, Wolf J. 2017. *Regional analysis of the Nationally Determined Contributions of Eastern Africa: Gaps and opportunities in the agriculture sectors.* Working Paper 67. Rome: Food and Agriculture Organization of the UN.

[10] [IPCC] Intergovernmental Panel on Climate Change. 2018. *Summary for policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments.* Available at: https://www.ipcc.ch/news_and_events/pr_181008_P48_spm.shtml (accessed on October 22, 2018).

[11] Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach MJ, Plattner G-K, Allen SK, Tignor M, Midgley PM, eds. 2012. *Managing the risks of extreme events and disasters to advance climate change adaptation.* A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

[12] Thornton PK, Ericksen PJ, Herrero M, Challinor AJ. 2014. Climate variability and vulnerability to climate change: A review. *Global Change Biology* 20(11): 3313–3328.

[13] Waithaka M, Thomas TS, Kyotalimye M, Nelson GC, eds. 2013. *East African agriculture and climate change: A comprehensive analysis.* Washington DC: International Food Policy Research Institute.

[14] Ministry of Agriculture, Food Security and Cooperatives, Vice President's Office. 2015. *Tanzania climate-smart agriculture programme.* Dar Es Salaam: United Republic of Tanzania.

[15] Ministry of Agriculture, Animal Industry and Fisheries; Ministry of Water and Environment. *Uganda climate-smart agriculture programme 2015–2025.* Kampala: Ministry of Agriculture, Animal Industry and Fisheries; Ministry of Water and Environment.

[16] Njeru E, Grey S, Kilawe E. 2016. *Eastern Africa climate-smart agriculture scoping study: Ethiopia, Kenya and Uganda.* Addis Ababa: Food and Agriculture Organization of the UN.

[17] Schlenker W, Lobell DB. 2010. Robust negative impacts of climate change on African agriculture. *Environmental Research Letters* 5(1): 014010.

[18] [CCAFS] CGIAR Research Program on Climate Change, Agriculture and Food Security. 2018. *Setting an innovative vision for transforming agriculture and food security under climate variability and change.* Workshop concept note. Addis Ababa: CGIAR Research Program on Climate Change, Agriculture and Food Security.

[19] [IFAD] International Fund for Agricultural Development. 2017. *Looking ahead: IFAD in the context of the 2030 Agenda for Sustainable Development.* Rome: International Fund for Agricultural Development.

[20] Ahmed JS, Mengistu F, Getnet M. 2017. *Climate-smart agricultural strategy: For guiding agricultural research and development in Ethiopia.* Addis Abba: Ethiopian Institute of Agricultural Research.

[21] Jirata M, Grey S, Kilawe E. 2016. *Ethiopia climate-smart agriculture scoping study.* Rome: Food and Agriculture Organization of the UN.

[22] [UNDP] United Nations Development Programme, [GEF] Global Environment Facility. 2017. *Options and opportunities to make food value chains more environmentally sustainable and resilient in sub-Saharan Africa.* New York: United Nations Environment Programme.

[23] [FAO] Food and Agriculture Organization of the UN. 2017. *FAO strategy on climate change.* Rome: Food and Agriculture Organization of the UN.

[24] Federal Democratic Republic of Ethiopia. 2011. *Ethiopia's climate-resilient green economy strategy.* Addis Ababa: Federal Democratic Republic of Ethiopia: Environmental Protection Authority.

[25] [UNFCCC] United Nations Framework Convention on Climate Change. 2018. *UNFCCC list of parties.* Available at: https://unfccc.int/process/parties-non-party-stakeholders/parties-convention-and-observer-states (accessed on June 21, 2018).

[26] [UNFCCC] United Nations Framework Convention on Climate Change. 2018. *NDC registry.* Available at: http://www4.unfccc.int/ndcregistry/Pages/All.aspx (accessed on June 21, 2018).

[27] Climate and Development Knowledge Network. *African Group of Negotiators (AGN) support unit.* Available at: https://cdkn.org/project/african-group-of-negotiators-agn-support-unit/?loclang=en_gb (accessed on June 21, 2018).

[28] Division of Environment, United Republic of Tanzania. 2007. *Tanzania NAPA final report.* Available at: https://unfccc.int/resource/docs/napa/tza01.pdf (accessed on June 21, 2018).

[29] [EAC] East African Community. 2017. *EAC partner states.* Available at: https://www.eac.int/eac-partner-states (accessed on June 21, 2018).

[30] [AU] African Union. 2018. *The African Union to launch the Africa Agriculture Transformation Scorecard; towards achieving agricultural transformation.* Available at: https://au.int/en/pressreleases/20180125/african-union-launch-africa-agriculture-transformation-scorecard-towards (accessed on June 21, 2018).

[31] Recha J, Kimeli P, Atakos V, Radeny M, Mungai C. 2017. *Stories of success: Climate-smart villages in East Africa.* Wageningen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

[32] [CCAFS] CGIAR Research Program on Climate Change, Agriculture and Food Security. 2016. *Full proposal 2017–2022 for Phase II of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).* Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

[33] Richards M, Bruun TB, Campbell BM, Gregersen LE, Huyer S, Kuntze V, Madsen STN, Oldvig MB, Vasileiou I. 2016. *How countries plan to address agricultural adaptation and mitigation: An analysis of Intended Nationally Determined Contributions.* CCAFS dataset version 1.1. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

[34] [FAO] Food and Agriculture Organization of the UN, The World Bank. 2017. *How to integrate gender issues in climate-smart agriculture projects.* Training module. Rome: Food and Agriculture Organization of the UN.

[35] Vermeulen S, Dinesh D, Läderach P, Mwongera C. 2016. *How can we develop value chain programs that address climate risks?* Info note. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

[36] Tendall DM, Joerin J, Kopainsky B, Edwards P, Shreck A, Le QB, Kruetli P, Grant M, Six J. Food system resilience: Defining the concept. *Global Food Security* 7: 17–23.

[37] [AU] African Union. 2003. *Maputo Declaration on Agriculture and Food Security. Maputo: New Partnership for Africa's Development, African Union.* Available at: http://www.nepad.org/resource/au-2003-maputo-declaration-agriculture-and-food-security (accessed on August 4, 2018)

[38] Dinesh D, Cambell BM, Bonilla-Findji O, Richards M. 2017. *10 best bet innovations for adaptation in agriculture: A supplement to the UNFCCC NAP Technical Guidelines.* CCAFS Working Paper 215. Wageningen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

[39] [CCAFS] CGIAR Research Program on Climate Change, Agriculture and Food Security. 2013. *Engagement and communications strategy.* Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security.

Annex 1: CCAFS EA outcomes and targets

Priorities and
Policies
for Climate-Smart Agriculture

CCAFS flagship 2021 outcomes	CCAFS flagship targets	CCAFS EA 2021 outcomes	CCAFS EA 2021 targets
Number of organizations and institutions in selected countries/states adapting plans and directing investment to optimize consumption of diverse nutrient-rich foods, with all plans and investments examined for their gender implications.	14	National governments, development partners and private sector are using combined climate and food and nutrition security scenarios for multilevel policy development and implementation, with relevant policy change that includes consideration of gender issues being effected.	2
Number of countries/states where CCAFS priority setting is used to target and implement interventions to improve food and nutrition security under a changing climate.	20	National ministries of agriculture and livestock, environment, finance and relevant parliamentary committees, and regional and inter-governmental organizations are collaborating with research institutions (CCAFS, CGIAR and national agricultural research systems) and private sector to develop and implement evidence-informed gender-sensitive agriculture and food and nutrition security policies, strategies and initiatives for increased investments in climate-resilient food systems.	4
USD million of new investments by state, national, regional and global agencies, informed by CCAFS science and engagement.	450	Development agencies, international and regional organizations (including The World Bank and the Green Climate Fund) and national governments use evidence from CCAFS and CGIAR CSA research and CSVs to inform investments in CSA, including the National Agricultural Research Plans.	290
Number of national/state organizations and institutions adapting their plans and directing investment to increase women's access to, and control over, productive assets and resources.	20	National governments are integrating inclusive CSA into their strategies and investment plans to increase women's and youth's access to and control over productive assets and resources.	4
Number of policy decisions taken (in part) based on engagement and information dissemination by CCAFS.	11	AGN and UNFCCC focal points use CCAFS and CGIAR science and engagement to effectively articulate the African position on agriculture and climate change, including for the Koronivia Joint Work on Agriculture roadmap.	3

Climate-Smart
Technologies and
Practices

CCAFS flagship 2021 outcomes	CCAFS flagship targets	CCAFS EA 2021 outcomes	CCAFS EA 2021 targets
Number of millions of farm households receiving incentives (training, financial, programmatic, policy-related) for adopting CSA-related practices and technologies that potentially reduce production risks.	6	Farmers and stakeholders across scales receive incentives (contextualized training, financial, programmatic, policy) for adopting and scaling CSA practices and technologies to reduce production risks and enhance resilience and adaptive capacity.	2
Number of subnational public/private initiatives providing access to novel financial services and supporting innovative CSA business models.	15	CCAFS knowledge outputs and products stimulate public and private sector (small and medium enterprises and large financial institutions) investment and scaling of CSA using market-based approaches that promote inclusive business models, climate-proof value chains and innovative financing mechanisms in East Africa.	4
Number of site-specific targeted CSA technologies/practices tested, with all options examined for their gender implications.	50	National agricultural research institutions (Kenya Agricultural & Livestock Research Organization, National Agricultural Research Organisation of Uganda, Africa Research Institute and Ethiopian Institute of Agricultural Research), international agricultural research centres and ministries of agriculture are developing, testing and packaging gender-sensitive CSA technologies and practices for climate-smart multifunctional landscapes to increase agricultural productivity, food and nutrition security, incomes, and build resilience and where possible reduce GHG emissions.	10
Number of development organizations adapting their plans and directing investment to increase women's access to, and control over, productive assets and resources.	15	National governments, development partners and private sector are integrating inclusive CSA into their strategies and investment plans to increase women's and youth's access to and control over productive assets and resources.	3

Low Emissions Development

CCAFS flagship 2021 outcomes	CCAFS flagship targets	CCAFS EA 2021 outcomes	CCAFS EA 2021 targets
Number of agricultural development initiatives where CCAFS science is used to target and implement interventions to increase input efficiency.	20	Agricultural development initiatives by private sector, agricultural agencies and related national governments in East Africa use CCAFS science, including decision-support tools, to develop and implement interventions to increase input use efficiency.	3
Number of low-emissions plans developed that have significant mitigation potential for 2030, i.e., contribute to at least 5% GHG emissions reduction or reach at least 10,000 farmers, with all plans examined for their gender implications.	10	Regional and intergovernmental organizations, national governments and agencies (ministries of agriculture and livestock, environment and climate change and national environmental authorities) use improved GHG measurement informed by science (CCAFS, CGIAR, Global Research Alliance on Agricultural Greenhouse Gases and Food and Agriculture Organization of the UN) to design, develop and implement low-emissions strategies and policies for agriculture and livestock to support MRVs and NDCs.	2
Number of organizations adapting their plans or directing investment to increase women's participation in decision making about LED in agriculture.	15	National governments, private sector and non-governmental organizations are integrating gender inclusive approaches into their strategies and investment plans to increase women's and youth's participation in decision making about low-emissions development in agriculture.	2

Climate Services and Safety Nets

CCAFS flagship 2021 outcomes	CCAFS flagship targets	CCAFS EA 2021 outcomes	CCAFS EA 2021 targets
Number of institutions or major initiatives using CCAFS research outputs for services that support farm households' management of climatic risks.	40	Academic, national and regional meteorological agencies, the IGAD Climate Prediction and Applications Centre and development organizations closely collaborate and use CCAFS tools and support to improve governance of climate services, and develop and test climate applications for seasonal climate information services, incorporating user feedback, for agricultural management, early warning, decision making and management of climate risks.	4
Number of organizations adapting their plans and directing investment to increase women's access to gender-sensitive climate-based advisories and insurance.	20	Ministries of agriculture and livestock, regional and national meteorological agencies, private sector, NGOs, donors and relief agencies use CCAFS knowledge to develop and provide demand-driven gender-sensitive digital climate services and agricultural advisories for timely and efficient food security decision making, insurance for climate risk management and enhanced investment.	4

Kenya
innovative
resource
nutrition
agroproductivity
agroforestry
science-p
commun
resilience
gender
low
inclusivene
agricul
varial
landscap
resea
DS
MF
CGIAR
low
AGN
carbon
synergy
East
CSOs
business
adoption
knowledge
mitigation
adaptation
agreenhouse
transformation
ICT
Tanzania
Uganda
CRPs
enabling
CBOs
SDGs

NGOs
implementation
uptake
stakeholders
NDC
fisheries
information
agroadvisories
CCAFS
income
emissions
soil
UNFCCC
Rwanda
food
livelihood
partnership
livestock
extension
Ethiopia
capacity
climate
digital
index
CSA
CP

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), led by the International Center for Tropical Agriculture (CIAT), brings together some of the world's best researchers in agricultural science, development research, climate science and Earth System science, to identify and address the most important interactions, synergies and tradeoffs between climate change, agriculture and food security.
www.ccafs.cgiar.org

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), East Africa.
P.O. Box 5689. Addis Ababa, Ethiopia
Phone: +251-11 617 2000 Fax: +251-11 617 2001
Email: ccafsea@cgiar.org
Website: http://ccafs.cgiar.org/regions/east-africa

@cgiarclimate_EA

CGIARClimate

CGIAR Research Program on Climate Change, Agriculture & Food Security (CCAFS)

CCAFS East Africa is hosted by ILRI

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE