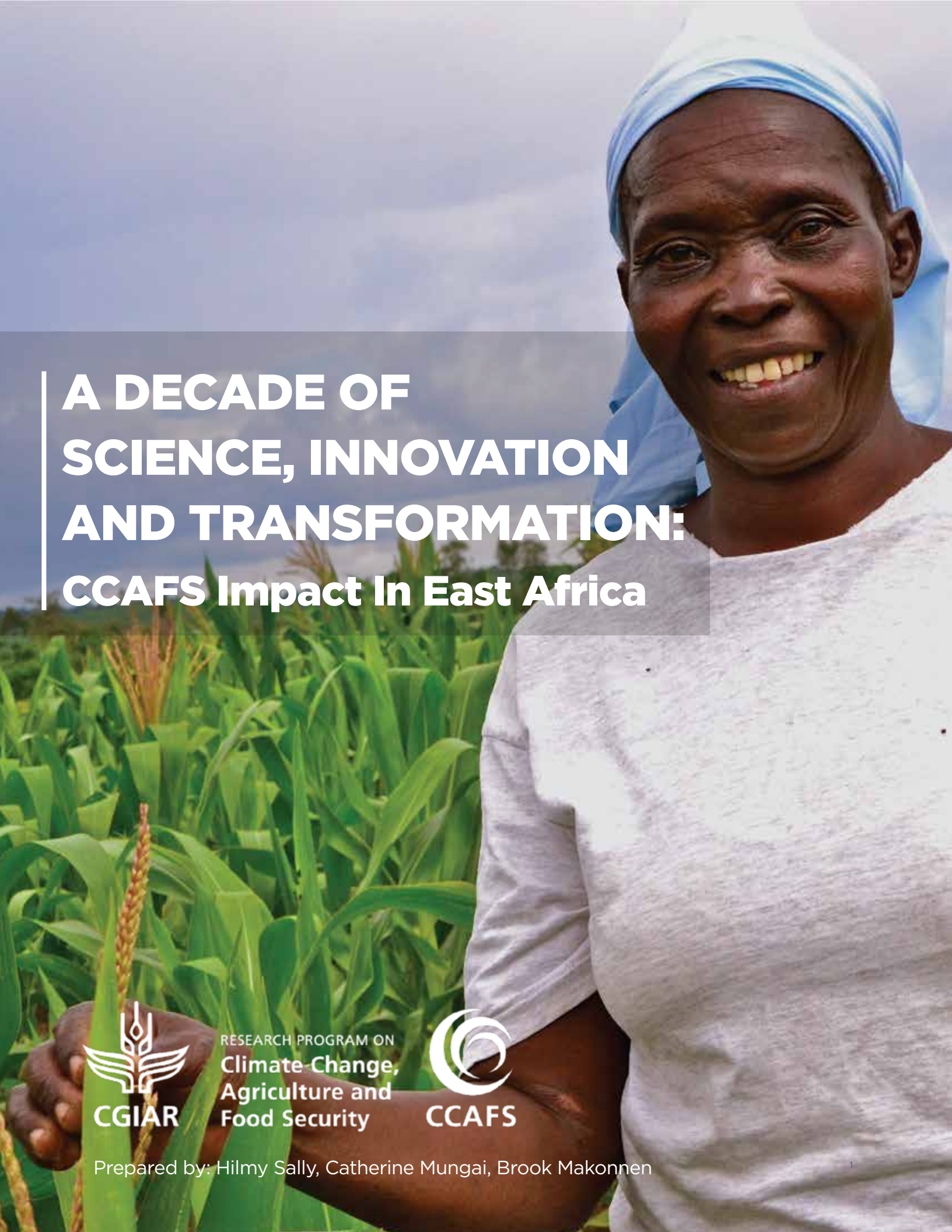

A DECADE OF SCIENCE, INNOVATION AND TRANSFORMATION:

CCAFS Impact In East Africa

CGIAR

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CCAFS

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Message from the Program Leader

We are pleased to share our CGIAR Climate Change, Agriculture, Food Security (CCAFS) East Africa legacy report, highlighting impacts and important milestones that we helped influence in policy engagement, research and partnership with various stakeholders across the greater Eastern Africa region. For centuries, agricultural systems in East Africa have been greatly dependent on rain and thus highly vulnerable to climate change and variability. In the current climate crisis age, climate-related risks such as prolonged dry seasons, droughts, and floods have become more frequent and severe in magnitude, with negative impacts on millions of agricultural livelihoods and food security. Furthermore, these challenges are compounded by high poverty rates, declining land sizes, poor market access, and high population growth rates with increasing demand for food.

CCAFS East Africa conducted its research and policy engagement activities mainly in four countries: Ethiopia, Kenya, Tanzania and Uganda. The program delivered transformative impact, from small-scale local community projects across East Africa to the highest level of government policymaking with Ethiopia's adoption of a CCAFS-informed national strategy on 'Climate-Smart Agriculture'. However, its impact and engagement spilled over to four additional countries in Eastern and Southern Africa, including Rwanda, Malawi, Mozambique, Zambia and Zimbabwe, with the same vigor and determination to foster climate-smart approaches and build resilience across millions of farmers.

The East African chapter of this global partnership research program supported ongoing regional and national efforts to transform agriculture sustainably and achieve food and nutrition security. The strategic research pillars include Climate-smart technologies, innovations and policies; Climate information, agro-advisory and insurance for climate risk management; Low-emissions development pathway for agriculture; and Gender, youth and socially inclusive growth. In addition, CCAFS catalyzed a suit of emerging cross-cutting opportunities in East Africa that look ahead for immense potential – from digital systems and technologies to climate financing and resilient value chains.

This legacy story document strives to showcase how this outcome-driven CGIAR research program, through never before seen engagement and partnership with continental, regional, national and subnational partners, developed an effective transfer system that made sure stakeholders and end-users benefit from CGIAR science, innovations, capacity building and facilitation of scaling to native impact at scale.

CCAFS catalyzed inspiring stories that have put climate-smart approaches, innovative partnerships, and smallholder farmers at their core in its near decade-long intervention. Smart farms, managed by young people and women's groups in a few villages, have acted as learning hubs for others in the community and incubators for tomorrow's lead farmers. Community seed banks have allowed farmers to access a wide range of diversity for climate change adaptation and help protect and conserve their biological diversity and improve seed storage. Furthermore, the power of private-sector partnerships has modernized the vital information channels that allow millions of farmers to prepare for the brunt of a changing climate. CCAFS and its range of partners – through the testimonies of the above stories – supported and improved the research and policy infrastructure of the region and will continue to do so to cater to lasting solutions. This legacy story reveals, in a much lesser way, this unprecedented success in the East African countries for posterity.

I would like to take this opportunity to thank the CCAFS East Africa team. Every individual's involvement has contributed significantly to the success evident in over a decade of science, innovation and transformation in the region. The CCAFS core team and the program management unit for developing and putting in place an inclusive management system that allows greater independence, flexibility, drive, collegiality, and focus toward outcomes on the ground to help smallholders farmers and livestock keepers and, where necessary, guidance to which I am deeply indebted and grateful as this was the essence of our success.

I hope you enjoy your read of the legacy document.

Dr. Dawit Solomon,
CCAFS East Africa Regional Program Leader

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

Contents

List of Tables

List of Figures

List of Boxes

Abbreviations & Acronyms

2DI	Two Degree Initiative for Food and Agriculture
AAU	Addis Ababa University, Ethiopia
ACPC	Africa Climate Policy Centre
ACToday	Adapting Agriculture to Climate Today, for Tomorrow
AfDB	African Development Bank
AGN	African Group of Negotiators
AGNES	Africa Group of Negotiators Expert Support
AGRA	Alliance for a Green Revolution in Africa
AICCRA	Accelerating the Impact of CGIAR Climate Research for Africa
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU	African Union
CAADP	Comprehensive Africa Agriculture Development Programme
CARE	Cooperative for Assistance and Relief Everywhere
CBBP	Community-based breeding program
CBO	Community based organization
CCAC	Climate and Clean Air Coalition
CCAFS	The CGIAR Research Program on Climate Change, Agriculture and Food Security
CDKN	Climate and Development Knowledge Network
CIAT	International Center for Tropical Agriculture (now part of the Alliance of Bioversity International and CIAT)
CIFOR	Center for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Center
CIS	Climate Information Services
COMESA	Common Market for Eastern and Southern Africa
COP	Conference of the Parties
CRAFT	Climate Resilient Agribusiness for Tomorrow
CRP	CGIAR Research Program
CSA	Climate-smart agriculture
CSA-FP	Climate-smart Agriculture Framework Program
CSAP	Climate-Smart Agriculture Partnership
CSA-RA	Climate-Smart Agriculture Rapid Appraisal
CSV	Climate-Smart Village
CTA	Technical Centre for Agricultural and Rural Cooperation
DFID	Department for International Development (UK)
EAC	East Africa Community
EDACaP	Ethiopian Digital Agro-Climate Advisory Platform
EFCCC	Environment, Forest and Climate Change Commission
EIAR	Ethiopian Institute of Agricultural Research
ENACTS	Enhancing National Climate Services
EU	European Union
FANA	State-owned mass media company in Ethiopia
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
FONERWA	Rwanda National Fund for Environment
FP	Flagship (Program)
GAP	Gender Action Plan
GCF	Green Climate Fund
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GRA	Global Research Alliance on Agricultural Greenhouse Gases
ICARDA	International Center for Agricultural Research in the Dry Areas
ICPAC	IGAD Climate Prediction and Applications Centre
ICRAF	World Agroforestry Centre
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communications Technology
IFAD	International Fund for Agricultural Development
IGAD	Intergovernmental Authority on Development
IITA	International Institute for Tropical Agriculture

ILRI	International Livestock Research Institute
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate and Society at Columbia University
IRR	Internal Rate of Return
IWMI	International Water Management Institute
KACCAL	Kenya Adaptation to Climate Change in Arid and Semi-Arid Lands project
KCSAIF	Kenya Climate Smart Agriculture Implementation Framework
KCSAP	Kenya Climate-Smart Agriculture Project
KJWA	Koronivia Joint Work on Agriculture
LED	Low-Emission Development
MALF	Ministry of Agriculture, Livestock and Fisheries, Kenya
Meteo-Rwanda	Rwanda Meteorological Agency
MoALFI	Kenya Ministry of Agriculture, Livestock, Fisheries and Irrigation
MINAGRI	Ministry of Agriculture and Animal Resources, Rwanda
MRV	Measuring, Reporting and Verification
MSP	Multi-stakeholder Platform
NAMA	Nationally Appropriate Mitigation Actions
NAP	National Adaptation Plan
NARO	National Agricultural Research Organization (Uganda)
NARS	National Agricultural Research Systems
NDC	Nationally Determined Contribution
NEPAD	New Partnership for Africa's Development
NFCS	National Framework for Climate Services
NGO	Non-governmental organization
NMA	National Meteorological Agency, Ethiopia
NMS	National Meteorological Services
PCSLS	Programme for Climate-Smart Livestock systems
PICSA	Participatory Integrated Climate Services for Agriculture
R4D	Research for Development
RAB	Rwanda Agriculture and Animal Resources Development Board
RCSA	Rwanda Climate Services for Agriculture
RLC	Radio Listeners Club
RYAF	Rwanda Youth in Agriculture Forum
SADC	Southern Africa Development Community
SALM	Sustainable Agricultural Land Management
SBI	Subsidiary Body for Implementation
SCCF	Special Climate Change Fund
SDL	State Department for Livestock, Kenya
SHAMBA	Small-Holder Agriculture Monitoring and Baseline Assessment
SMA	Small and Medium Enterprise
SMS	Short Text Message System
SNV	Netherlands Development Organization
SPI	Standardized Precipitation Index
SRP	Strategic Research Pillar
SSIMIS	Small-Scale Irrigation Management Information System
SUA	Sokoine University of Agriculture, Tanzania
ToC	Theory of Change
TMA	Tanzania Meteorological Agency
UNECA	United Nations Economic Commission for Africa
UNFCCC	United Nations Framework Convention on Climate Change
UNIQUE	Unique Forestry and Land Use GmbH
USAID	United States Agency for International Development
WB	The World Bank
WBCSD	World Business Council for Sustainable Development
WISER	Weather and Climate Information and Services for Africa
WUR	Wageningen University and Research

1 PURPOSE AND SCOPE OF THIS DOCUMENT

Photo: Sebastian Liste

1.1 Purpose and Scope

This legacy document is intended to capture the key outcomes and highlight the impact of the CCAFS East Africa regional program over the past decade. The reporting is structured around the Strategic Research Pillars detailed in the CCAFS-EA Strategy 2019–2021, apart from the fact that aspects related to Gender, Youth and Socially Inclusive Growth (Pillar 4) are not treated separately but integrated into the other three pillars.The report also highlights the influence and likely contributions of CCAFS East Africa to upcoming endeavors such as OneCGIAR, Accelerating the Impact of CGIAR Climate Research for Africa (AICCRA), and the Two Degree Initiative for Food and Agriculture (2DI).

1.2 Structure of the Report

Chapter 2 presents an overview of the global CCAFS program and the salient features of the CCAFS-EA regional program, highlighting its goals, expected outcomes, its Theory of Change, its structure, operations, and geographical coverage.

Chapters 3 to 5 describe the main achievements(what, who, where, when, how) realized under three of the four Strategic Research Pillars (SRPs) around which CCAFS-EA's work is organized, namely: (a) Climate-smart technologies, innovations and policies; (b) Climate information and agro-advisory services for climate risk management; and (c) Low-emissions development pathways for agriculture. Gender, youth and social inclusion have been intrinsic to all the work of CCAFS-EA. Hence, the achievements in respect of the fourth SRP, Gender, youth and socially inclusive growth, are not reported separately as they cut across and are seamlessly integrated into all facets of the CCAFS-EA program. Quotes, testimonials, and photo evidence featuring beneficiaries, participants and other stakeholders are included. The ways in which CCAFS-EA science has informed policy formulation are highlighted.

Chapter 6 presents the key messages that have emerged from the work of CCAFS-EA.

Possible CCAFS-EA contributions to upcoming research for development initiatives, drawing on the lessons learned over the past decade of CCAFS endeavors, are presented in Chapter 7.

2 BACKGROUND

Photo: Sebastian Liste

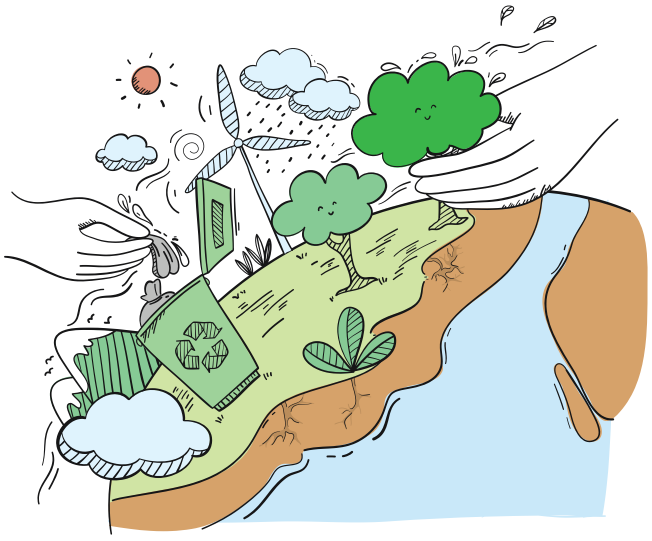
2.1

Agriculture and Climate Change Challenges in East Africa

The agriculture sector plays a pre-eminent role in food and nutrition security, sustainable natural resources management, and economic diversification in East Africa. East African countries derive around a third of their Gross Domestic Product (GDP) from agriculture. However, agricultural sector growth has primarily been achieved through unsustainable approaches, such as increasing the total land area under cultivation or mobilizing large agricultural labor forces, without much improvement in yield and productivity. Moreover, the sector is dominated by smallholder subsistence farmers, who are struggling with deep-rooted poverty and have few productive assets.

Agriculture in East Africa also faces enormous challenges in striving to attain food and nutrition security, adapting to climate change and, where possible, reducing GHG emissions. In effect, increased climate variability and climate change give rise to significant direct and indirect impacts on agricultural production and the sustainable growth of the sector in East Africa. East African countries are especially vulnerable to the effects of climate change due to their reliance on subsistence, rain-fed agriculture, responsible for producing approximately 95% of the region's food. More variable weather patterns as well as extreme climate events -- droughts, floods, and extreme temperatures -- represent an additional source of risk and uncertainty to the region's smallholder farmers and are likely to severely disrupt rain-fed agriculture.

National governments in East Africa have therefore accorded high priority to achieving sustainable transformation of agriculture in parallel with climate change adaptation and mitigation. Ethiopia[1], Kenya[2], Tanzania[3] and Uganda[4] have adopted national policies, strategies and programs designed to achieve climate-resilient and low-carbon agriculture and food systems. These climate-smart agriculture strategies and programs are expected to deliver food and nutrition security while adapting to climate variability and climate change and reducing GHG emissions.



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

2 Republic of Kenya: Ministry of Agriculture, Livestock and Fisheries. 2017. Kenya climate-smart agriculture strategy 2017-2026. Nairobi: Ministry of Agriculture, Livestock and Fisheries.

3 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

4 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.

2.2

Overview of CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) was launched in 2010 to identify and promote agricultural practices, policies and institutions to effectively confront the challenges posed by climate variability and change, global warming, and declining food security. CCAFS was conceived and operated as a strategic global partnership between the world's leading research institutions on agriculture, climate change, and food security. This consortium of CGIAR Centers and Advanced Research Institutions was led by the International Center for Tropical Agriculture (CIAT), now part of the Alliance of Bioversity International and CIAT. CCAFS brought together leading researchers in multiple disciplines, including agricultural science, climate science, earth systems, policy and institutional analyses, and gender studies to catalyze transformation towards climate-smart agriculture, food systems and landscapes. The initiative also helped position the CGIAR as a major role-player in bringing associated practices, technologies, and institutions to scale.

Broad-based partnerships were established with a wide range of partners, enabling the CCAFS consortium to conduct research and share knowledge collaboratively to identify, test and scale innovative technological, policy and institutional solutions and deliver results when and where it mattered[5]. The CCAFS global program management unit was based at the Wageningen University and Research in the Netherlands while CCAFS research was conducted in five focal regions throughout the global south: East Africa, West Africa, Latin America, Southeast Asia, and South Asia.

2.3

The CCAFS Program in East Africa, CCAFS-EA

2.3.1 Goals and outcomes

The CCAFS East Africa regional program (CCAFS-EA) was hosted by the International Livestock Research Institute (ILRI) in Addis Ababa, Ethiopia, with a satellite office in Nairobi, Kenya. The overarching goal of CCAFS- EA, which is consistent with the national policies and priority actions of East African countries, is a climate-resilient, food- and nutrition-secure East Africa providing equitable access to livelihood opportunities for all with a special focus on smallholder farmers. The persistent constraints and challenges in East African agriculture are addressed by implementing innovative, climate-smart, agriculture technologies and practices at scale accompanied by policies, enabling environments and conducive investments. The assumptions, approaches and the pursued outcomes are illustrated in the CCAFS-EA theory of change shown in Figure 1.

5 Fuller details regarding the CCAFS partnership strategy are found at: https://cgspace.cgiar.org/bitstream/handle/10568/83236/CCAFS_PII_PartnershipStrategy.pdf

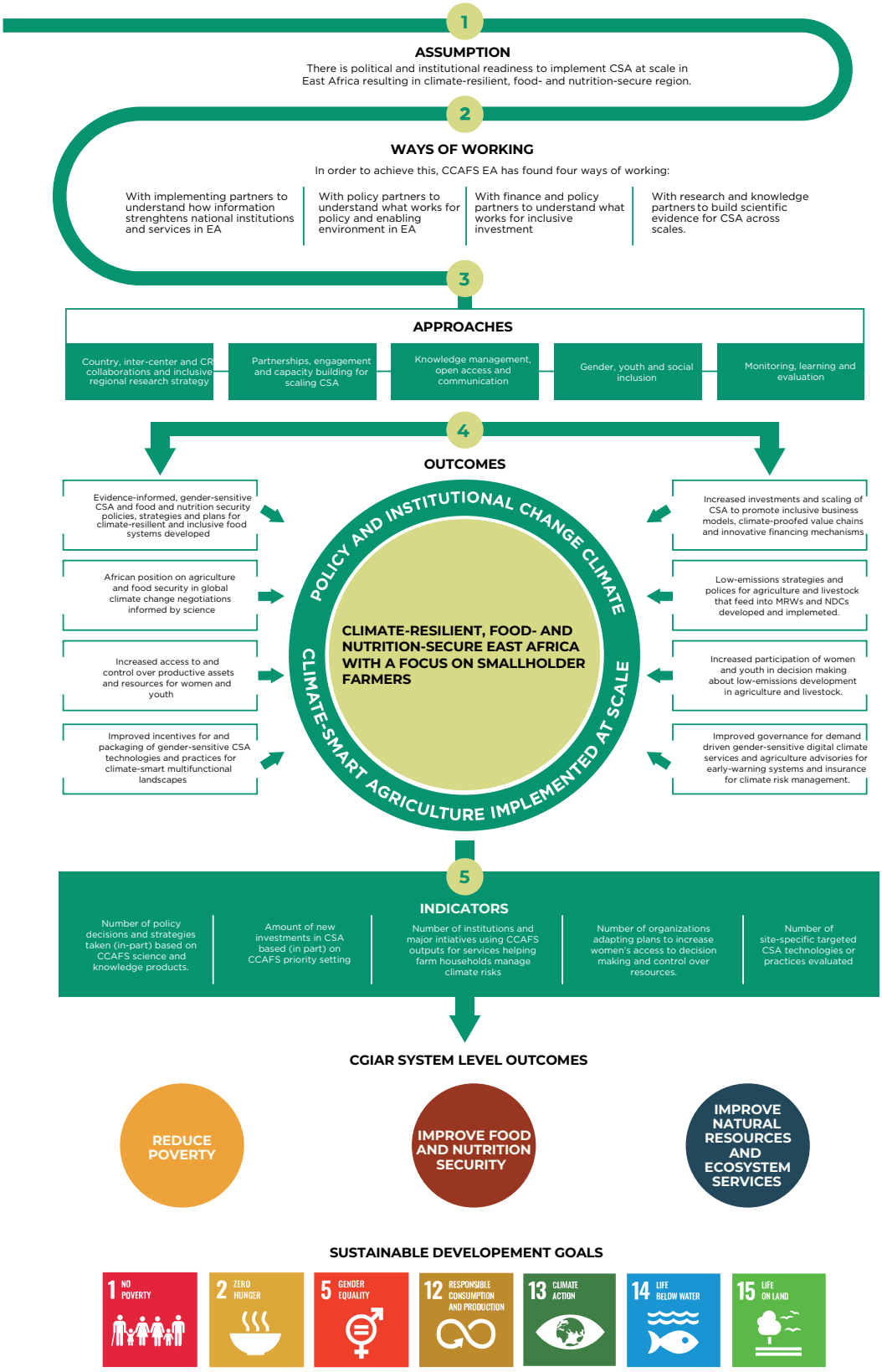


Figure 1. The CCAFS East Africa Theory of Change

2.3.2 Focus countries and research sites

CCAFS-EA carried out its research and engagement activities in four focus countries: Ethiopia, Kenya, Tanzania and Uganda. These countries were selected because their farming systems are confronted with a wide range of climatic, agro-ecological, environmental, and socioeconomic challenges. Furthermore, the agricultural communities in these countries are highly vulnerable to climate risks and have very low adaptive capacities, resulting in a very fragile existence.
CCAFS-EA established six research sites within these focus countries to introduce, test, evaluate and promote technological and institutional CSA options for addressing climate variability and change in agriculture (Figure 2).

The six research sites cut across the main agro-ecological zones and farming systems in East Africa: Nyando (Kenya), Lushoto (Tanzania), Hoima (Uganda) and Borana, Doyogena and Basona Werana (Ethiopia). Outside the four primary focus countries, the program worked in Rwanda to build capacity in the national climate services and to improve climate risk management for agriculture. In Southern Africa, the program worked in Malawi, Mozambique, Zambia, and Zimbabwe to make value chains and business models more inclusive and provide incentives and innovative finance for scaling CSA.

PHASE 1		PHASE 2	
2011	2016	2017	2021

FOCUS COUNTRIES: ETHIOPIA KENYA TANZANIA UGANDA

CLIMATE-SMART VILLAGES

PHASE 1 -	Wote and Nyando (Kenya), Lushoto (Tanzania), Hoima and Rakai (Uganda), and Borana (Ethiopia)
PHASE 2-	Nyando (Kenya), Lushoto (Tanzania), Hoima (Uganda), and Borana, Doyogena and Basona Werana (Ethiopia)

OTHER COUNTRIES WHERE PROJECTS WERE IMPLEMENTED

- MALAWI
- MOZAMBIQUE
- ZAMBIA
- ZIMBABWE

Table 1. CCAFS-EA Program Snapshot

Figure 2. The CCAFS East Africa focus countries and research sites

3 CLIMATE-SMART AGRICULTURE TECHNOLOGIES, INNOVATIONS AND POLICIES

Photo: Annie Spratt

3.1
Climate-Smart Agriculture (CSA) and Climate-Smart Villages (CSV)

CCAFS-EA successfully developed, tested and rolled out a range of climate-smart agriculture (CSA) technological and institutional innovations. The adoption of context-appropriate CSA technologies, policies and practices has contributed to transforming agriculture in the region through the sustainable improvement of agricultural productivity, incomes, and climate resilience of East African smallholders.

Researchers, practitioners and communities conducted participatory development and testing of integrated portfolios of CSA practices at Climate-Smart Villages (CSVs) established at the CCAFS-EA research sites across its four focus countries. CCAFS-EA started piloting the CSV approach in East Africa in 2010. In each CSV, CCAFS-EA scientists collaborated with colleagues in national agricultural research and extension systems and the rural communities to assess the performance of climate-smart intervention packages. By facilitating partnerships and applying the principles of participatory action research around collective initiatives within the CSVs, CCAFS-EA fostered a scientific approach to delivering proven and effective development outcomes.

A CSV typically sees the convergence of several components:

a. CSA practices and technologies;
b. Farmers' knowledge;
c. Local and national public and private institutions;
d. National and sub-national plans and policies;
e. Climate ag-development finance;
f. Climate information services and insurance.

This interplay leads to the emergence of an Empowered Community as illustrated in the Figure 3.

The CSVs served as 'lighthouses', allowing CCAFS-EA and the communities to collaboratively test, co-develop and adopt combinations of CSA technological and institutional options, fill knowledge gaps and build the evidence base to stimulate scaling-up and scaling-out of proven CSA portfolios. CCAFS-EA facilitated partnerships among researchers, policy makers, development partners, national agricultural research and extension systems, and the rural communities around collective action initiatives to promote climate-smart technologies and bring a scientific approach to delivering development outcomes in the CSVs.

Recognizing the importance of collective action in dealing with climate-related risks and adapting to climate change, farmers across the CSVs came together within collective action groups[6]. Existing and emerging collective action groups served as innovative platforms for (a) disseminating new knowledge and skills, (b) building farmers' capacity to adopt climate-smart crop and livestock interventions, and (c) transforming their farming practices. farming practices.

CCAFS EA recognized that developing and implementing policies that do not meaningfully consider the needs, priorities and participation of resource-poor women and youth and similar disadvantaged groups could exacerbate gender and social inclusion gaps. Therefore, the climate-smart solutions developed by CCAFS EA research sought to increase the control exercised by women, youth, and other vulnerable groups over productive assets and resources.

6 A notable feature of the collective action groups in the CSVs was the high proportion of women members, accounting for more than 50% of the membership.

Figure 3. Components of a Climate-Smart Village
[source: "Stories of Success: Climate-Smart Villages in East Africa"]

3.2
Improved Delivery of Seed through Community Seedbanks

CCAFS-EA research established that farmers needed more resilient, faster-maturing varieties of sorghum, millet, and beans to overcome the climate-induced loss in the genetic diversity of planting material[7]. It was observed that over 65 percent of the seed used by farmers were derived from their own stocks due to the highly fragmented nature of social seed networks.

Community seedbanks were therefore identified as a mechanism to help manage, conserve and introduce new varieties as well as already available local diversity. Such seedbanks served as a convenient platform for farmers to share and exchange seed genetic resources that are more resilient and better adapted to the local climatic conditions.

Figure 4. Farmer exchange visit in Nyando CSVs, Western Kenya
Photo: P. Kimeli (CCAFS)

7 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3125&cycle=Reporting&year=2019

In 2018, Uganda revised its National Seed Policy, giving explicit recognition to community seedbanks and providing for the regulation, production, and sale of quality declared seeds in favor of smallholder farmers, including the national listing of traditional varieties[7]. By 2019, multifunctional community seedbanks had reached 189,000 farmers in East Africa[8]: 107,000 farmers in Kenya and Uganda enjoyed enhanced access to seeds through the seedbanks while another 82,000 potato farmers in Kenya were using a web-based SMS platform for disseminating information on resilient seeds

District agronomists in Rwanda, trained to access, understand and use the advanced suite of online climate information products and tools available through the national meteorological agency, Meteo Rwanda, are now using this information to improve the services they provide to farmers. From an analysis of local historical climate information, District Agronomists in the highlands of Western Province realized that the crop seed varieties that had been distributed to farmers were not well adapted to local conditions. They identified maize hybrids that better matched the local climate and distributed the improved seed to 87,872 farmers[9].

CCAFS-EA's support to establish climate-resilient and biodiversity-rich seed systems (including conservation, crop improvement, seed production and distribution, climate and crop modeling, policies, and laws) also led to the publication of the 2nd edition of the resilient seed systems handbook in 2019 (Vernooy et al. 2019). This second edition includes a new module on seed production and distribution and incorporates recent ideas and examples of good practices.

3.3 Developing and Promoting Climate-Smart Tubers

3.3.1 Better potatoes

Potatoes form an important part of the diet in East Africa. In Lushoto, Tanzania, potatoes are also grown as a cash crop. Farmers mostly grow local varieties, such as Kidinya. But this dominant variety is highly susceptible to late blight so farmers can only plant it once a year to avoid the months when disease pressure is high. As a result, production is limited to one harvest per year.

> The most important way of controlling late blight is to prevent its onset in the field—its control being very costly and thus, less accessible to small-scale farmers when symptoms are already visible. Coming up with resistant potato varieties is, therefore, a game-changer,
>
> **Dieudonné Harahagazwe, Researcher, CIP**

7 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3125&cycle=Reporting&year=2019
8 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3189&cycle=Reporting&year=2019
9 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3199&cycle=Reporting&year=2019

Beginning in 2013, CCAFS-EA along with smallholder farmers, extension agents, and NGO officials in Lushoto, undertook the participatory evaluation of improved potato varieties (Recha et al. 2017) to help farmers select and access potato varieties that can be grown all year round and produce higher yields and overall production. Participants tested advanced potato materials (clones, yet to be formally released) and improved varieties (Asante, Shangii and Obama) against the local variety, Kidinya, as a control. With guidance from the International Potato Center (CIP) and SARI, participants grew the varieties on a demonstration farm at the Lushoto Resource Center and also tested them in their own fields. Both the advanced clones and improved varieties outperformed the local Kidinya in terms of yield and resistance to late blight and high temperatures.

Within three years, farmers who participated in the trials succeeded in doubling their yields, bringing about changes to their livelihoods. During 2015, champion farmers who had completed the training sessions spearheaded village learning events to share their agronomic knowledge and promote the wider planting of improved varieties. A total of 135 farmers in neighboring villages planted the high-quality Asante potato seed in 2015, which they sold locally to another 450 farmers for consumption and seed. In the first rainy season of 2016, it was estimated that more than 1000 farmers were planting the Asante potato variety in Lushoto.

Figure 5. Farmer Samuel Tendwa and his wife
Photo: D. Harahagazwe (CIP)

Box 1. Upgrading potato production in Lushoto

Samuel Tendwa was among 70 farmers from three villages in Lushoto who worked with research and extension partners over four consecutive growing seasons, starting in 2014. During the short rainy season of 2014, Samuel and nine other champion farmers from his village received one 80 kg bag of clean Asante potato seed each. Making use of the knowledge and skills acquired from the training, they planted the seed during the first season. Samuel harvested 1000 kg from his 0.2 ha farm, which was near the optimum yield, and double his previous harvests. Samuel and other champion farmers sold three-quarters of their potato seed. The price they received of USD 70 per bag was double the normal price of potatoes for consumption because they were selling a higher value seed product. The remainder was stored as seed for the subsequent planting season.

"Asante is a completely new potato variety in our area, and with the help of these researchers, I have learned to produce high-quality potato for seed and consumption," says Samuel.

A total of 135 farmers in neighboring villages planted the high-quality Asante potato seed in 2015

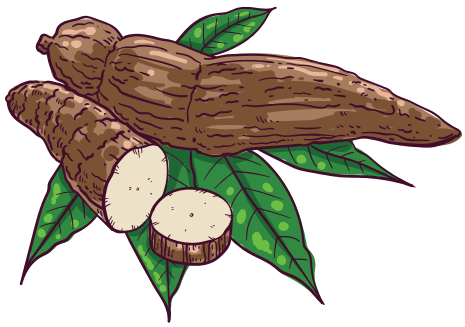
Which in turn was sold locally to another 450 farmers for consumption and seed.

In the first rainy season of 2016, it was estimated that more than 1000 farmers were planting the Asante potato variety in Lushoto.

As two of the high-yielding trial materials moved towards formal release, the farmers who participated in the participatory varietal selection processes proposed formal names for them to reflect their qualities. Mvono, named for its high number and size of tubers, and Mkanano, meaning highly competitive, were formally released in Tanzania in 2016. The availability of improved potato varieties that are higher-yielding and disease-resistant opened new, more valuable seed markets[10]. When combined with improved agricultural practices, the use of these varieties has enabled farmers to improve their incomes as well as their capacity to adapt to the impacts of climate change.

3.3.2 Better root crops

Cassava and sweet potato are the two most important starchy root crops for communities in Uganda. Farmers mainly grow low-yielding cassava and sweet potato varieties with average national yields of about 5 tons per ha. The crops are grown in mixtures with legumes and cereals on small plots of land, generally with no inputs other than labor. Moreover, pests and diseases represent a major threat. African cassava mosaic virus and bacterial blight, mealybug and green spider mite have decimated cassava production. Likewise, sweet potatoes are plagued by weevils, nematodes, and insect pests.



Farmers in the Hoima CSV began working with CCAFS-EA and partners in 2013 to test new, resilient, high-yielding cassava and sweet potato varieties (Recha et al. 2017). Local community-based organizations were instrumental in promoting the uptake of the new varieties to individual farmers through village demonstrations, field days, and the multiplication of planting material. Within three years, more than 750 households planted a new cassava variety (NASE-14) and two new varieties of sweet potatoes (NASPOT-11 and NASPOT-8).

The participatory approach ensured that the traits of importance to the farmers are considered. Women's groups were actively involved in the field trials to ensure that the varietal choices were also attuned to their needs. Indeed, experienced cassava and sweet potato - who are mainly women - bring to the evaluation detailed knowledge about traits that researchers might not consider important or may not be able to measure satisfactorily. This approach also accelerates the rate at which new varieties reach farmers' hands and hastens their adoption and use.

Box 2. Voices from the field

"I have observed higher pest tolerance and disease resistance capabilities, and shorter maturity period of four months for the new varieties."

Alice Nyangoma, a farmer in Kasinina village in Hoima attests to a good sweet potato harvest with the newly introduced varieties

"The new improved sweet potato varieties yield about 30 tons per ha per season compared to the 5 tons produced by the local varieties. The new NASE-14 cassava variety matures in seven months while the local cassava takes about a year to mature."

Fred Sekiwoko, NARO scientist

"I have been harvesting the improved cassava variety for three years now, while the local type lasts for less than two years on the farms."

Farmer Godfrey Kairagura, member of Kyabigambire Farmers Organization.

10 https://ccafs.cgiar.org/news/addressing-climate-risks-through-improved-potato-production-lushoto-climate-smart-villages-tanzania

3.4 Breeding Resilient Ruminants

3.4.1 Breeding improved sheep and goats

In Nyando, Kenya, almost 90% of the farmers keep small ruminants - mainly local breeds of East African goats and fat-tailed sheep. However, small ruminant production in this area is characterized by low productivity and poor recovery from drought and disease. Poultry, goats and sheep are the only livestock assets over which women and young people tend to have control, being less labor-intensive than larger livestock such as cattle. Therefore, promoting improved breeds of small ruminants, coupled with better livestock management practices, can not only transform productivity but also provide a pathway to better livelihoods, notably for women and young people.

Since 2011, CCAFS-EA and its partners have been working to help livestock farmers in Nyando improve the productivity of their sheep and goats (Recha et al. 2017). From 2012 to mid-2013, improved breeds of Galla goats[11] and Red Maasai sheep[12] were introduced to farmers in Nyando to be crossed with local breeds to increase productivity. Farmers in three local community-based organizations -- FOKO, Kapsokale and NECODEP -- established about 70 breeding units of Galla goats and 30 breeding units of Red Maasai sheep. Each breeding unit comprises a single goat buck, which can service about 30 does per month, or a Red Maasai sheep ram, serving around 12 ewes a month.

Thanks to the cross-breeding initiative, an average of 2,500 cross-bred sheep and 15,000 goats are added to the Nyando flock every year. ILRI has initiated a monitoring and management system to control in-breeding and maintain high-quality breeds while extension staff from MALF train farmers on improved housing, feed development, and animal healthcare. Through the partnership, 16 community- based animal health workers (paravets), have been trained across the three CBOs to support veterinary officers in managing the livestock's health.

Figure 6. Improved species of goats and sheep in Nyando, Western Kenya

11 Compared to local East African goats, Galla goats mature up to six months faster, have higher milk production, and high twinning rates. They can also fetch up to three times the price of local breeds

12 Red Maasai sheep can withstand heat stress and are more resistant to diseases and parasites, more prevalent in the warmer climate, than local fat-tailed sheep

The pure and cross-breeds of Galla goats are in high demand and CBOs are passing on offspring to other community members so they also benefit from the initiative. As the uptake of the Galla cross-breeds increases, farmers are devising innovative ways to market their livestock. An annual goat auction is emerging in the upper parts of Nyando, where there is a relatively high population of goats. The first auction was held in 2014 in Barng'oror village, at which about 1,500 goats were auctioned. The second annual goat auction in December 2015 was graced by the Kenyan Deputy President who was impressed by the CSVs, particularly by the promotion of livestock as a way of addressing climate change and food insecurity and improving incomes. He urged the champion farmers to continue to share their knowledge with their neighbors to promote learning and wider adoption of new technologies.

3.4.2 Women's voices from the field: Dorothy Achieng – Small ruminants livestock keeper

Nyando is a rich agricultural flood plain around Lake Victoria in Western Kenya. About 120 households here, 70% of whom are headed by women, benefited from CCAFS-EA interventions on small ruminants.

Dorothy Achieng started keeping goats and sheep in 2015. Not being too labor-intensive, Dorothy can take care of the livestock as well as manage other household responsibilities. The improved breed of sheep and goats grows very fast and fetches attractive market prices. Women have full control over the small ruminants they can sell without seeking authority from their husbands, unlike cows that men can only sell. Dorothy encourages fellow women to take to small ruminant livestock production as it is not labor-intensive and has low production costs[13].

Farmer Dorthy Achieng tending to her livestock
T. Muchaba (CCAFS)

"I sell the sheep and goats to local farmers in Nyando. I also sell goat milk, which is very nutritious, and I can now easily pay school fees for my children."

"I am a happy woman. My life changed since I started keeping sheep and goats"

Dorthy Achieng

13 Celebrating women farmers in Nyando: transforming lives through climate-smart agriculture (cgiar.org)

3.4.3 Farmer to farmer knowledge transfer on community-based sheep breeding[14]

Sheep production is an integral part of Southern Ethiopia's production system. CCAFS-EA, in collaboration with the International Center for Agriculture Research in the Dry Areas (ICARDA), established an all-women community-based breeding program (CBBP) in the Doyogena climate-smart landscape that allows for community ownership and participatory design and implementation of breeding techniques and genetic improvement.

Farmers share insights during the learning exchange about small ruminant breeding and management in Ethiopia's SNNPR. Photo: G Ambaw (CCAFS)

The Boqa-Shuta CBBP had grown from 67 male members, two female members and a budget of ETB 34,600 (about USD 1,200) at its inception to a membership of 334 farmers, 32 of whom are women, and a capital of ETB 1,100,100 (about USD 38,250) in 2019.

CBBPs serve as learning platforms to enhance the adaptive capacity of livestock-based livelihoods in agro-pastoralist societies. Exchange visits with members of the decade-old Boqa-Shuta CBBP provided inspiring learning opportunities for Doyogena's female farmers to emulate their visitors' experiences in small ruminant breeding and management.

A farmer in Boqa-Shuta's CBBP in Southern Ethiopia. Photo: G Ambaw (CCAFS)

The CBBP members possess breeding rams in their flock, sell surplus livestock to surrounding communities, purchase educational supplies, and housing materials for their families with the additional income. Members can also buy larger livestock such as oxen from the sheep sales.

Farmers learn from best practices for community-based breeding in Southern Ethiopia. Photo: G Ambaw (CCAFS)

14 https://ccafs.cgiar.org/news/farmers-share-experiences-community-based-sheep-breeding-southern-ethiopia

3.5 Integrated Land, Water, Soil Fertility and Crop Nutrient Management Boosts Productivity

3.5.1 Terraces and check dams

In Lushoto, Tanzania, farmers have constructed about 100 km of terraces, in an area supporting more than 1000 farming households (Recha et al. 2017)[15]. CCAFS partners Lushoto District Council and the Tanzania Agricultural Research Institute (TARI) have trained 1980 households that are members of three village Savings and Credit Cooperative Societies (SACCOs) on techniques to help prevent erosion and enhance water retention (Bonilla-Findji et al. 2018). This involves constructing and integrating terraces with contoured grass strips to prevent massive loss of rich topsoil, enhance water retention, and provide fodder for livestock. These techniques have helped farmers in villages like Mbuzii where the light-textured soils are low in organic matter and characterized by depleted fertility for crop production.

"We now see the difference that the improved terraces are bringing to the landscape, through water flow control and retention," says farmer Swadakati of Mbuzii village

3.5.2 On-farm tree cover

Increased tree cover controls soil erosion as it reduces the impact of raindrops on bare soils and prevents the wind from removing soil particles. Moreover, the ground cover and litter layer beneath the trees reduce the speed of water flowing over the land and help control soil erosion. CCAFS-EA, therefore, encouraged and trained farmers to establish tree nurseries and plant trees on their farms. The tree-planting campaign was initiated in 2013 with the Tanzania Forestry Research Institute (TAFORI) providing 17,000 seedlings to 100 households. To meet the growing demand for tree seedlings, farmers established tree nurseries within their villages (see Box 3).

Box 3. Multiplication of tree seedlings for soil and water conservation

The three village SACCOs established 20 nurseries having a capacity to produce a total of 200,000 tree seedlings every season. In Milungui village, for example, in 2016 the farmers' group established a tree nursery and produced some 20,000 seedlings. Besides providing seedlings for its members, tree nurseries also generate income for the group. Around 25% of the seedlings are sold and the proceeds used to sustain the nursery. Members take the remaining 75% for planting on their farms. Each member of the group is entitled to a certain number of tree seedlings from the nursery, depending on their level of involvement in the group's activities.

Priority areas requiring urgent tree cover were identified -- open areas, farmland and roadsides -- and tree species were selected according to the needs of farmers in the village. Preferred tree species included Pinus patula and Eucalyptus grandis for wood; Grevillea robusta for farm boundaries and contours; Casuarina cuninghamiana for windbreaks and roadsides; and avocadoes, plums and apples for fruit (Recha et al. 2017).

Interventions were scaled-up thanks to local policy engagement processes with 100,000 farmers achieving on-farm tree cover of 10% , in line with the Lushoto District Council's policy.

15 https://hdl.handle.net/10568/81030

In Nyando, Kenya, soil erosion is a recurrent phenomenon every rainy season, with runoff forming deep gullies that affect about 40% of the landscape. To combat this problem, farmers in Nyando organized themselves into community-based organizations involving more than 10,000 households. The members, 60% of whom are women and young people below the age of 25, worked with CCAFS and other partners to increase on-farm tree cover.

Through this partnership, more than 40 tree nurseries have been established, with a capacity to produce 140,000 high-quality seedlings per season. Tree species are selected in response to farmers' needs and technical advice from Vi Agroforestry extension staff. The sale of seedlings generates income for the group besides supplying the local community with high-quality tree seedlings for agroforestry and woodlots.

CCAFS Nyando site located in western Kenya near Lake Victoria. Photo: A. Eitzinger (CIAT)

3.5.3 Intercropping

In Hoima, Uganda, farmers intercropped fruit trees (grafted mangoes and pawpaws) with food crops such as maize, sorghum, cassava, sweet potato, nitrogen-fixing legumes (beans and groundnuts), and indigenous vegetables. Planting the fruit trees across contours and on terraces helped to reduce erosion. Farmers also dug water retention ditches and trenches to further enhance soil and water conservation.

The improved mangoes produce their first yield in three years compared to local varieties that take up to six years. Improved mangoes are also higher-yielding with better-tasting fruit that command higher market prices. An improved mango tree produces up to 1500 fruits a year, compared to about 250 mangoes produced by the local varieties. Farmers can thereby earn additional income from intercropping while simultaneously conserving soil and water.

Figure 7. Intercropping of fruit trees in Hoima, Uganda

3.6
Improving the Performance of Smallholder Irrigation

3.6.1 Small-scale irrigation in Ethiopia

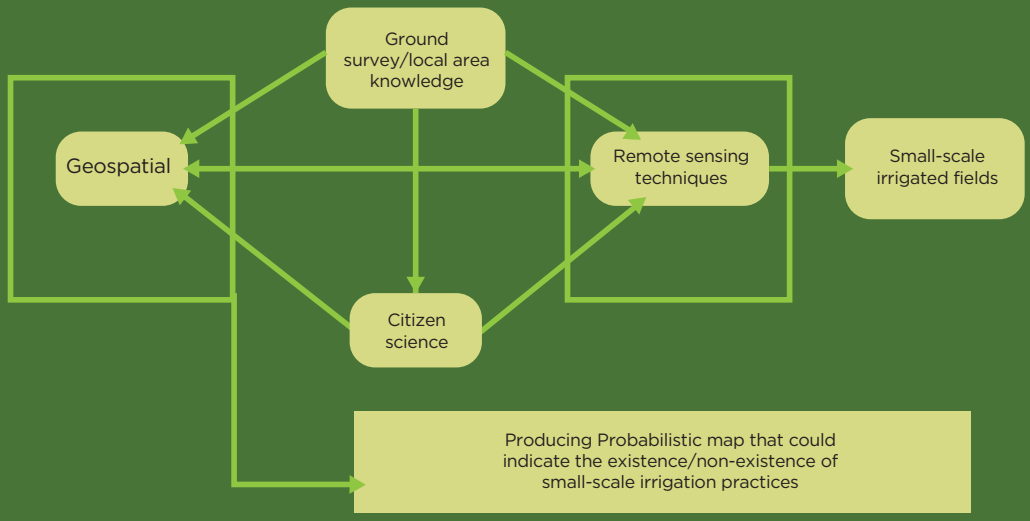
In Ethiopia, the National Smallholder Irrigation and Drainage Strategy of 2011 underlined the government's commitment to scale up smallholder irrigated agriculture in the country, recognizing its vital role in meeting the food, nutrition and income needs of rural communities. But knowledge about the scale, potential and challenges related to this subsector is limited. Moreover, being outside the formal extension system, smallholder irrigators are unable to benefit from an effective support system.

It, therefore, became imperative to identify, map and characterize the conditions, production systems, and value chains associated with this sector to provide a basis for informed decision-making for its development. The collaborative initiative between the Amhara Region, the International Water Management Institute (IWMI) and the MoA led to the creation of an inventory of smallholder-irrigated areas in some parts of the region (Tamene et al. 2021). More recently, the Alliance of Bioversity and CIAT (The Alliance), in collaboration with CCAFS-EA and the MoA, has developed a web-based Small-Scale Irrigation Management Information System (SSIMIS) – see figure 8.

Figure 8 . The Small-Scale Irrigation Management Information System (SSIMIS)

SSIMIS employs a combination of earth observation, citizen science and geospatial techniques as shown in figure 9 below.

The overall methodological framework developed to map small-scale irrigated fields



Geospatial mapping approach

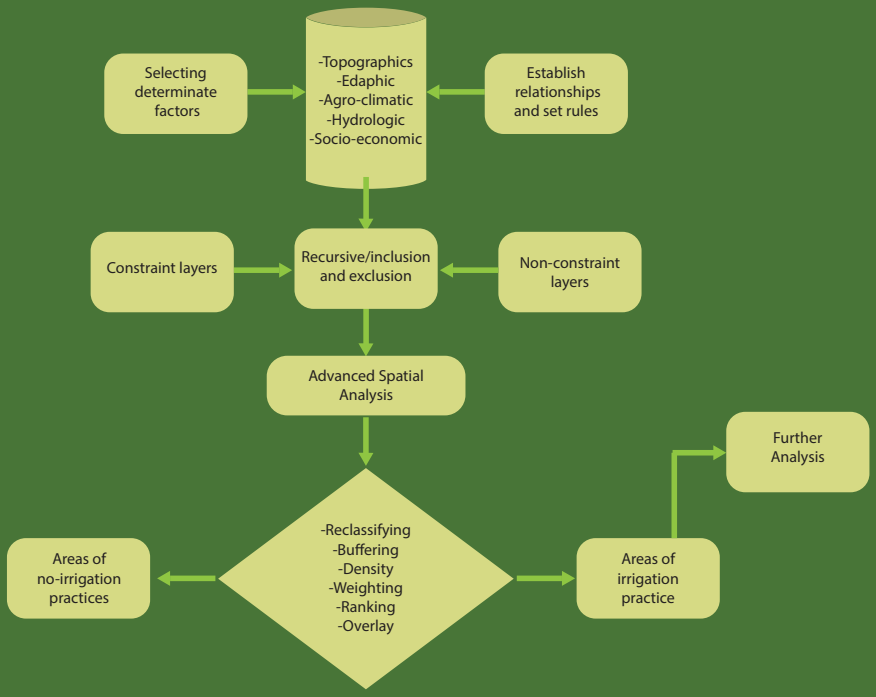


Figure 9. Schematic overview of SSIMIS

SSIMIS provides a timely, accurate and readily available database related to small-scale irrigation schemes and offers a platform for developing tailored advisories to irrigation farmers to achieve higher agricultural productivity, enhanced climate resilience, and improved livelihoods (Tamene et al. 2021). The web-based dashboard, linked with relevant geospatial datasets and the system, will be updated in near real-time.

It is being pilot-tested in Ethiopia's Amhara region (figures 10 and 11). An app is under development to disseminate advisories related to crop choice, input use, and market information. Feedback from the farmers and extension workers is used to fine-tune the system through adaptive learning. The deployment of this type of interactive data visualization platform on small-scale Irrigation aligns with Ethiopia's digitalization efforts under its Digital Ethiopia 2025 Strategy.

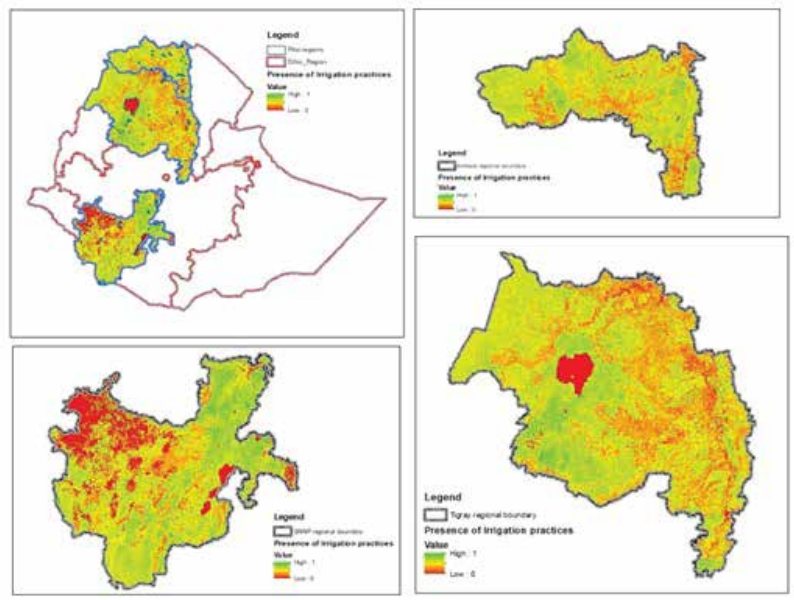


Figure 10. Probabilistic map of small-holders based irrigation practices

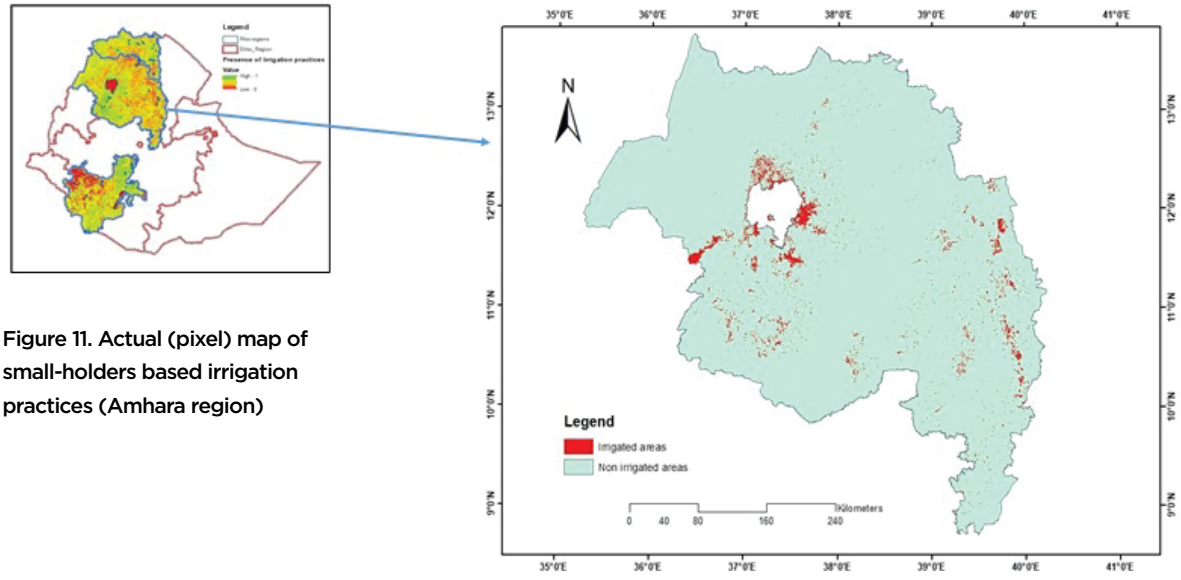


Figure 11. Actual (pixel) map of small-holders based irrigation practices (Amhara region)

3.6.2 Women's voices from the field: Pauline Omondi – Water harvesting warrior

Pauline Omondi, a farmer from the Nyando agricultural flood plain around Lake Victoria in Western Kenya, has four water pans with a capacity of more than 84,000 liters that meet her water needs during the dry season. Pauline also practices soil conservation - she has constructed terraces to control soil and water movement on her farm. On the terraces, she has planted fruit trees which have increased her annual income. She also keeps and sells mad fish every three months.

"The water pans are everything, I irrigate my farm and use it for my household's chores. I can do everything I want to do on the farm."

"I am not scared as my family will never lack food. Most women in the area give up after the water pan has dried. During droughts and dry season, I divert water from the river to the water pans."

Pauline advises that women should be trained on how to use and maintain water pans.

. "Despite the challenges, I have persisted in farming and increased my harvest every year."

Pauline Omondi

Pauline Omondi Water Pan Photo: T.Muchaba (CCAFS)

3.7

Scaling-up Smart Farms

Smart farms offer the possibility of 'climate proofing' crop production. That is, securing higher yields while being insulated from seasonal rainfall variability and climate change-induced extreme events like prolonged dry spells and intense flooding. Smart farms also save water, offer better control of pests and diseases and, thanks to their dependable production cycle, can produce reliable harvests, timed to suit market needs. Although it has many advantages, smart farm technology requires a high level of skills and knowledge for successful operation. To address this, CCAFS-EA, in collaboration with government agencies, NGOs, and the private sector, trained and equipped farmers, particularly young people, and women's groups, to take full advantage of the possibilities offered by smart farms.

By the end of 2015, smart farms had been established in four villages in the Nyando CSV in Kenya: Kamula, Kapsorok, Obinju, and Onyuongo (Recha et al. 2017). These smart farms are managed by young people and women's groups and serve as demonstration sites for other groups, as well as the wider community. The initial investment cost of a smart farm is about USD 3000, with the potential to yield four times this sum over two or three production cycles.

3.7.1 Kamula Smart Farm

The Kamula Village Youth Group's smart farm has been in existence since 2013 and has emerged as a learning hub for the entire village, attracting visits from residents and school groups who then share their experiences with the wider community and contribute to transforming rural agriculture.

Figure 12. Kamula Smart Farm

Box 4. Kamula Smart Farm in Nyando

The Kamula Youth Group's smart farm incorporates improved crop varieties of tomatoes, cow pea, climbing beans and indigenous crotalaria. The group created a small earth dam with a capacity of 300,000 liters of water, which is stocked with 1000 fingerlings per season. They also manage five colonized bee hives, as well as fodder crops such as Boma Rhodes and Napier grass.

According to Jackson Onyango, the group leader: "In 2013, when we started, people in the village were not sure what the group aimed to achieve. However, after one year, good results began to emerge."

During the first year, the three main enterprises - fish farming, tomatoes and vegetable production - earned approximately USD 5000. Using proceeds from the smart farm, Kamula Youth Group opened a bank account to save money for future projects that include a solar power system to drive operations like pumping water from the adjacent river into tanks and earth dams.

3.7.2 Women's voices from the field: Catherine Akinyi – Obinju Smart Farm

Catherine is the chairperson of the Obinju Smart Farm Group in Nyando. The smart farm's greenhouse, which is free from flooding and drought, is used for seed bulking of fodder for livestock, and growing horticultural crops. The smart farm has two water pans with a total capacity of over 250,000 liters having over 1,000 tilapia fish. The group is also involved in producing sorghum and maize, and beekeeping. The farm serves as a demonstration site for women groups to engage in climate-smart agriculture.

> "Since we started this smart farm, we have never lacked food. We always have vegetables to sell and food to eat in our homes."
>
> **Catherine Akinyi**

Farmer Catherine Akinyi proudly displays produce from the Obinju Smart Farm: T. Muchaba (CCAFS)

The group started operations around 2012 as a women's group and used to plant trees. With the help of CCAFS, they now grow improved varieties of crops. After men saw how successful the women were, they joined the group. The women save the profits from selling their produce in a group bank, locally known as 'table banking'. At the end of each month, they divide the profit among themselves, each member can get up to KES 25,000 (USD 250).

> "I used to find it very hard to ask for money from my husband before, but I now have money. I can now convince my husband to do farming as he can also see the good returns."
>
> **Catherine Akinyi**

The experience of the Kamula and Obinju demonstrates that smart farms managed by young people and women's groups in a small number of villages can serve as incubators for tomorrow's lead farmers to acquire the knowledge and skills necessary for the successful operation of smart farms having the potential to boost food production, improve food security and increase incomes.

3.7.3 Multiplying gender-responsive climate-smart agriculture [16]

Bekelech Belachew, a model female farmer in Southern Ethiopia, uses her climate-smart farm to educate other community members. The farm is highly biodiverse, with fruits, cereals, legumes, vegetables, enset, coffee, khat and different varieties of fodder grass. Bekelech has also designed a water harvesting structure to collect rainwater during the rainy season and uses the stored water to irrigate her farm during the dry seasons. In addition, she produces her own compost and applies it as fertilizer on her farm. Bekelech has gone beyond the point of simple subsistence; she has accumulated cash savings from her farm product sales.

Bekelech Belachew, a model farmer showcasing her climate-smart onset crops in Doyogena, Ethiopia. Photo: J Recha (CCAFS)

16 https://ccafs.cgiar.org/fr/node/56546

Model farmer Bekelech Belachew harvesting her climate-smart collard greens. Photo G. Ambaw (CCAFS)

> "I'm doing this to get out of poverty, not to make my husband happy,"
>
> **Bekelech Belachew**

3.8 Informing Climate-Smart Agriculture Policy and Investment in East African Countries

3.8.1 Supporting Kenya's climate-smart agriculture strategies

CCAFS-EA, ICRAF, CIAT, CIFOR and ILRI have been working since 2012 with policymakers from Kenya's Ministry of Agriculture, Livestock, Fisheries and Irrigation (MoALFI) and the Directorate of Climate Change (Ministry of Environment and Forestry) contributing a science-based platform to support the development of the Climate-smart Agriculture Framework Program 2015 (CSA-FP). The CSA-FP was integrated into Kenya's Intended Nationally Determined Contribution (INDC) 2015 submission to the United Nations Framework Convention on Climate Change (UNFCCC)[17,18].

17 https://ccafs.cgiar.org/outcomes/kenya-integrates-climate-smart-agriculture-its-intended-nationally-determined
18 https://cgspace.cgiar.org/bitstream/handle/10568/67906/07outcomecase.pdf?sequence=6

The CSA-FP catalyzed the development of a comprehensive CSA Strategy and a CSA Implementation Framework. On 31 October 2018, the MoALFI launched the Kenya Climate Smart Agriculture Implementation Framework: 2018-2027 (KCSAIF) in Nairobi (CCAFS, 2018)[19]. This followed the launch of the Kenya Climate-Smart Agriculture Strategy (KCSAS) 2017-2026 in March 2017, which marked a significant milestone in CCAFS' long-standing engagement with Kenyan policymakers.

The KCSAIF now stands as the guiding policy document for CSA implementation and achieving climate-resilient and low-carbon sustainable agriculture that ensures food security and contributes to national development goals. CCAFS continues to support the implementation of the KCSAIF through the CSA Multi-Stakeholder Platform (MSP)[20]. The MSP is a network of organizations steered by the climate change unit at MoALFI and working to realize CSA at national and county levels, from on-farm practices to policy and programs.

As Ethiopia has many different agro-ecologies and farming systems that vary within short distances (CCAFS, 2013[21]), the government called upon the EIAR-CIMMYT-CCAFS partnership to produce the site-specific research results needed to plan and develop sustainable agricultural production at the smallest administrative units. The research analyzed past and future climate risks in almost all agro-ecologies with a particular focus on wheat- and maize-based production systems to improve the resilience of crops to climate variability and climate change.

Furthermore, Ethiopia's regional governments have incorporated the research findings in their regional climate change policy and adaptation strategies. NGOs, who were keen participants in the EIAR-CIMMYT-CCAFS climate change workshop, are now putting more emphasis on climate and environmental issues in their interventions.

3.8.2 Supporting the development of Ethiopia's climate change adaptation strategy

The EIAR-CIMMYT-CCAFS partnership on climate change research in Ethiopia is a good illustration of how scientific collaboration at the national and local level helped to build national climate research capacity as well as influence national and regional climate change policy and development initiatives (Georgis, 2015). EIAR-CIMMYT-CCAFS provided continuous science-based input to the development of the National Climate Change Adaptation Strategy (CCAS) and other climate change initiatives in the country.

19 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=2122&cycle=Reporting&year=2018
20 https://csa-msp.kilimo.go.ke/
21 https://ccafs.cgiar.org/outcomes/planning-national-adaptation-responses-climate-change

3.8.3 Informing sub-national climate-smart agriculture investments in Kenya

CCAFS partner CIAT led the development of 31 county climate risk profiles to guide climate-smart agriculture (CSA) investments and priorities at the sub-national level in Kenya[22]. As the climates and farming situations vary greatly across the country, county-level climate risk profiles were developed to help tailor interventions for a given context. The profiles also contributed to shaping the World Bank investment of US$ 250 million in the Kenya Climate-Smart Agriculture (KCSA) project[23]. See also CCAFS (2016).

In every county, the main value chain commodities were identified, the most problematic climatic hazards outlined, and the vulnerabilities and risks posed by these hazards across the value chain were mapped. The profiles provide an analysis of the underlying causes of vulnerability, ongoing adaptation strategies, and existing off-farm services available for combating the risks associated with the hazards, with recommendations for potential adaptation options. The profiles also offer snapshots of the enabling environment for building resilience in terms of the policy, institutional, and governance contexts, and possible pathways to be pursued to build institutional capacities for effective redress of potential future climate risks.

3.8.4 Capacitating and promoting regional climate-resilient agribusiness

CCAFS is actively engaged in the innovative Climate Resilient Agribusiness for Tomorrow (CRAFT) project in East Africa, a five-year undertaking (2018-2023) funded by the Netherlands Ministry of Foreign Affairs[24] aiming to improve agribusiness resilience and increase agricultural productivity by creating an enabling environment that can foster large-scale roll-out of CSA. Partnerships were developed with national business champions in Kenya, Tanzania and Uganda to facilitate market linkages for CSA products and services and accelerate the adoption of CSA technologies and practices.

CRAFT leveraged 34 million euros of co-investments with the private sector and deployed financial services to support 36 innovative climate-informed business initiatives targeting 237,250 smallholder farmers in seven priority agriculture value-chains in these three countries[25]. Conscious of the gender differences that affect the uptake of innovations, CRAFT placed special emphasis on increasing the involvement of women in agribusiness development. It also worked to make CSA more attractive and accessible to youth. Gender equality and opportunities for youth employment were therefore fully integrated into the program's implementation. CRAFT developed and applied tools to map youth and gender dynamics within selected value chains and business cases and promoted inclusive financial services and business models and equitable transfers of technology and skills. Specific selection criteria were set to attract businesses led or managed by women and youth. Fifteen women and youth-led businesses thereby got the opportunity to work with CRAFT in the three countries.

22 https://ccafs.cgiar.org/resources/publications/kenya-county-climate-risk-profiles
23 https://projects.worldbank.org/en/projects-operations/project-detail/P154784?lang=en
24 The project is implemented by SNV (lead) in partnership with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Wageningen University and Research (WUR), Agriterra and Rabo Partnerships
25 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3857&cycle=Reporting&year=2020

The CRAFT project activities supported CCAFS-EA's CSA capacity strengthening initiatives targeted at farmers and SMEs to adopt and apply climate-smart technologies, practices, products, and services. CCAFS-EA worked with SNV country implementation teams and other consortium partners to assess the capacity-building needs of CRAFT's stakeholders. Based on the identified gaps, CCAFS-EA and its partners prepared relevant CSA training materials and led the hands-on capacity-building training sessions for agribusiness value chain actors in Kenya, Tanzania and Uganda.

CRAFT also developed a Climate Resilient Farmer Field School (CR-FFS) methodology and handbook (p'Rajom et al. 2020), drawing on experiences from the field in Kenya, Tanzania and Uganda to serve as a training module for climate-resilient farming. partners prepared relevant CSA training materials and led the hands-on capacity-building training sessions for agribusiness value chain actors in Kenya, Tanzania and Uganda. CRAFT also developed a Climate Resilient Farmer Field School (CR-FFS) methodology and handbook (p'Rajom et al. 2020), drawing on experiences from the field in Kenya, Tanzania and Uganda to serve as a training module for climate-resilient farming.

3.9 International Outreach

CCAFS EA has built strong partnerships around agriculture and climate change with government ministries in East Africa. Such partnerships and collaborative initiatives played an essential role in scaling climate-smart agriculture innovations[26]. CCAFS researchers regularly provided inputs to the Africa Group of Negotiators Expert Support (AGNES) strategy meetings, contributing knowledge on climate and food security scenarios and their gender implications within African agriculture at a continental scale. CCAFS research also informed several gender, agriculture and climate change submissions of the Africa Group of Negotiators (AGN) to the UNFCCC.

a. At the 3rd UNFCCC Conference of the Parties (COP23) in 2017, CCAFS played a crucial role in brokering consensus on a new work plan concerning agriculture: the Koronivia Joint Work on Agriculture (KJWA)[27].
b. CCAFS contributed text to the AGN submission on the UNFCCC's Gender Action Plan (GAP)[28] at the 46th Subsidiary Body for Implementation (SBI46) in May 2017.
c. CCAFS support was instrumental in finalizing the 5-Year GAP adopted at COP25[29]. This support includeding paper "Gender Implications of the Gender Action Plan and Koronivia Joint Work on Agriculture" (Masiko et al. 2019).
d. CCAFS actively collaborated with the AGNES gender facilitator at the GAP negotiations at COP25, particularly the AGNES submission on Good Practices in Gender Mainstreaming of National Adaptation Plans and NDCs.

AGNES has now designed a formal training program on climate governance, diplomacy and negotiations leadership[30] to enhance the capacity of African negotiators to effectively contribute to the, often technical and complex, international climate change policy discourse.

26 https://ccafs.cgiar.org/news/how-inclusive-partnerships-tackle-climates-challenges-east-west-africa
27 https://ccafs.cgiar.org/outcomes/informing-unfccc-decision-agriculture-cop23
28 The GAP, which sets out plans for gender-responsive climate action, is an essential component of ensuring inclusive and meaningful participation for all genders in the UNFCCC process.
29 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=2042&cycle=Reporting&year=2019
30 https://training.agnes-africa.org/programs/climate-governance-diplomacy-and-negotiations-leadership-program/

On another front, CCAFS partnered with the University of Oxford's Environmental Change Institute[31] to work closely with stakeholders from governments, the private sector and researchers across six global regions to develop credible "what if" future climate change scenarios. The inclusion of stakeholders from diverse backgrounds accounted for different perspectives and strategies, and avoided blind spots arising from a single vision of the future. CCAFS scenario-based recommendations thereby created a sound enabling environment for climate resilience and informed climate, agriculture and socio-economic development policies in seven countries, including two in East Africa: Tanzania's New Environmental Policy and Uganda's Agricultural Sector Plan (CCAFS, 2015)[32]. Close collaboration with government teams in each case led to timely applications and ownership of the process by policymakers.

31 http://www.eci.ox.ac.uk/

32 https://cgspace.cgiar.org/bitstream/handle/10568/67900/01outcomecase.pdf?sequence=3

4 CLIMATE INFORMATION AND AGRO-ADVISORY SERVICES FOR CLIMATE RISK MANAGEMENT

Photo: Blue Ox Studio

4.1
The Issues

What to plant and when is a question confronting smallholder farmers everywhere. Traditionally, such decisions are made based on indigenous knowledge, accumulated over the years and passed on from generation to generation. But the reliability of traditional knowledge systems alone to inform farm decision-making in the rainfed agriculture-dependent economies of East Africa is challenged by climate variability and aggravated by the effects of climate change. So, what if these local-level knowledge systems were coupled with the tools and methods of modern technology to provide timely and reliable climate-related information to support farmers in their crop management decisions? Wouldn't the chances of success of their cultivation season be enhanced and their livelihoods improved? Wouldn't this also help farmers to adapt to climate change and improve their resilience to climate shocks? It is precisely these sorts of considerations that motivated CCAFS-EA, over the past decade, to develop and disseminate effective climate services to help farmers better manage climate-related risk.

4.2
Agroclimatic Advisory Platforms in Ethiopia

The Ethiopian Digital Agro-Climate Advisory Platform (EDACaP)[33,34] launched in 2019[35,36], represents a breakthrough in providing reliable and timely climate information and decision-support tools to strengthen the adaptive capacity and resilience of smallholder farmers. EDACaP provides interactive agroclimatic information and advisories to assist Ethiopia's smallholder farmers to make improved crop management decisions and reduce their climate-related production risks. EDACaP was developed as a collaborative effort between CCAFS-EA, its international partners, and relevant national institutions like the Ethiopian Institute of Agricultural Research (EIAR), the Ministry of Agriculture (MoA), the National Meteorological Agency (NMA), and FANA Broadcasting Corporate.

EDACaP links four components:

a. The national agro-climatic database infrastructure;
b. Climate modeling to improve the spatial and temporal resolution of seasonal and sub-seasonal weather forecasts;
c. Crop modeling simulation outputs in the form of district-specific agro-weather advisories and best-bet agronomic management recommendations;
d. Dissemination of agro-advisories to farmers, extension officers, researchers, and policymakers in local languages through mobile phones, radio, and a web platform.

33 EDACaP-AgroClimate Advisory – Ethiopian Digital AgroClimate Advisory Platform (ethioagroclimate.net)
34 Seid et al. 2020
35 AllAfrica.com. 2019
36 https://marlo.cgiar.org/summaries/CCAFS/projectInnovationSummary.do?innovationID=440&phaseID=56

The overall architecture of the EDACaP platform is shown in the following figure:

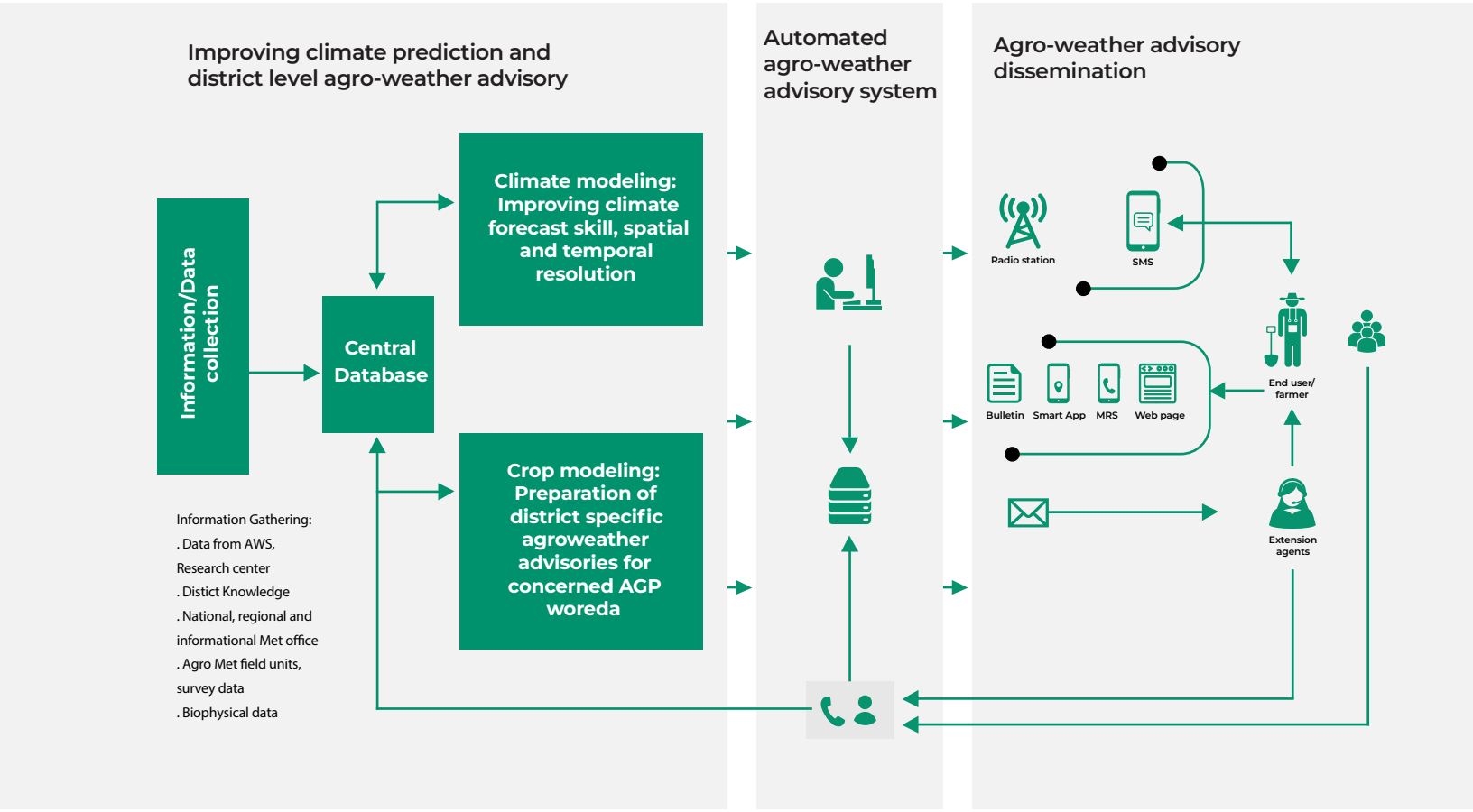


Figure 13. General framework of the EDACaP Platform
[source: Seid et al. 2020]

By translating the results of complex science to actionable decisions, EDACaP[37] has helped smallholder farmers to make better-informed decisions in respect of selection of crops and varieties, the timing of operations such as planting and harvesting, irrigation scheduling, and prevention of pests and diseases.

Farmers in the pilot sites have reported less expenditure on inputs and higher yields when they can plan their farming activities and make timely decisions at different stages of crop production thanks to the availability of timely and reliable weather information. The partnership between the EDACaP team with Ethiopia's FANA Broadcasting Corporate enables the dissemination of agro-climate messages to almost 15 million smallholder farmers across FANA's 11 regional broadcasting centers in Ethiopia.

4.3
Climate Information in Support of Local and National Decision-Making in Rwanda

4.3.1 Rwanda Climate Services for Agriculture (RCSA)

The Rwanda Climate Services for Agriculture (RCSA) project achieved many firsts:

- Rwanda became the **first** country in the world to train agency staff and farmers in climate services in all of its 30 districts, with special attention paid to the youth, considered as future farmers and agribusiness leaders. The participatory process was implemented at an unprecedented scale by training 2,111 local agricultural extension staff and volunteer Farmer Promoters within the Twigire Muhinzi[38] agricultural extension system[39].

- Rwanda was the **first** country in Africa to adopt innovative approaches to deliver seasonal climate forecasts in support of local agricultural decision-making, overcoming the limitations of traditional methods. Climate services were disseminated directly to nearly 112,000 farmers across all 30 of Rwanda's districts through Participatory Integrated Climate Services for Agriculture (PICSA), Radio Listeners Clubs (RLCs), and cell phones, besides radio broadcasts accessible to practically the entire population[40]. Project interventions notably increased women's participation in household decision-making and enhanced their social standing within their communities.

- The RCSA project got international recognition as the **first** recipient of the Climate Smart Agriculture Project of the Year Award at the inaugural Africa Climate Smart Agriculture Summit in May 2018[41].

37 EDACaP-AgroClimate Advisory – Ethiopian Digital AgroClimate Advisory Platform (ethioagroclimate.net)

38 Twigire Muhinzi is a 'home-grown solution' extension model to ensure that all farmers in Rwanda have access to advisory services. The model is based on two farmer-to-farmer extension approaches: the Farmer Promoter approach and the Farmer Field School approach.

39 https://ccafs.cgiar.org/news/trainings-climate-services-agriculture-reach-all-rwanda-0

40 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3904&cycle=Reporting&year=2020

41 Rwanda Climate Services for Agriculture project awarded the first ever Climate Smart Agriculture Project of the Year 2018 (cgiar.org)

The RCSA project was a four-year initiative that ran from 2016 to 2019 that sought to transform Rwanda's rural farming communities and national economy through improved climate risk management and adaptive capacity. It aims to improve the supply, exchange and use of climate-related information in a balanced manner using products co-developed by both providers and users. The project was funded by USAID and implemented by a consortium of national and international partners with CCAFS as the principal coordinating agency.

Box 5. RCSA project interventions in a nutshell

The main thrust of the RCSA project was to build the capacity of the national systems to generate and provide climate services to farmers and extension staff across Rwanda. The project interventions therefore took place in all its 30 districts and followed a **four-pronged approach**:

1. Climate services for farmers: Agricultural extension and other relevant intermediary organizations and communicators (e.g., farmer cooperatives, rural radio networks, ICT providers, NGOs) delivered decision-relevant and operational climate information and advisory services to farmers across Rwanda's 30 districts and trained them to use the information to better manage risk.

2.Climate services for government and institutions: Agricultural and food security decision-makers in the Ministry of Agriculture (MINAGRI), and in other national and local government agencies and institutions, used climate information to respond more effectively to climate-related risks and to inform decisions that build the resilience of farmers.

3.Climate information provision: Meteo-Rwanda designed, delivered, and incorporated user feedback into a growing suite of weather and climate information products (historic, monitored and forecast) and services tailored to the needs of agricultural and food security decision makers.

4.Climate services governance: A national climate services governance process—involving joint decision making among relevant national stakeholders—oversaw and fostered sustained coproduction, assessment and improvement of climate services for agriculture and food security; and facilitated a formal interface and effective dialogue between the key agencies involved.

Project interventions were conducted through the Participatory Integrated Climate Services for Agriculture (PICSA) approach[42] to provide timely and location-specific agroclimatic information to rural communities throughout the country and facilitate informed decision-making by farmers. The PICSA training process specifically targeted female and youth[43] participation, resulting in nearly equal participation by gender. Young farmers gained exposure to PICSA through the Rwanda Youth in Agriculture Forum (RYAF) – a platform that brings together young entrepreneurs in agribusiness.

42 The Participatory Integrated Climate Services for Agriculture (PICSA) approach was developed by the University of Reading to support farmers' use of historical and forecast seasonal climate information

43 https://ccafs.cgiar.org/fr/node/56392

Figure 14. Farmers and extension workers at a PICSA training session in Kigali, Rwanda, Feb 2019
(Source: https://www.flickr.com/photos/cgiarclimate/albums/72157706816867825/with/33278779168/)
Photo: S Samuel (CCAFS)

4.3.2 What information and who benefited?

Meteorological tools developed under the RCSA project now allow better climate forecasting for the benefit of farmers. Reliable and timely climate information enables farmers to decide which crops to grow, what crop varieties to plant, when to plant, and when and how to prepare the land. In effect, such information improves farmers' resilience to climate shocks and encourages a transition to climate-smart practices.

Knowledge of the starting date of the rainy season has a huge influence on the cropping calendar and farming practices. Athanase Mudenge, a farmer promoter from Ruhuha, Bugesera District aptly sums up the situation[44] **: "Planting on time is the best starting point in the use of improved agronomic practices. To achieve this, you need to prepare the land early, look for all inputs and get ready for the season to start."**

At the national and institutional level, the CCAFS collaboration with Rwanda's National Meteorological Agency (Meteo Rwanda) since 2016 has contributed to rebuilding Meteo Rwanda's database and lost climate history and to filling gaps in historical records through the Enhancing National Climate Services (ENACTS) initiative hosted by the International Research Institute for Climate and Society (IRI) at Columbia University's Earth Institute[45,46].

Meteo-Rwanda has been able to merge satellite data with its station observations to fill gaps in both space and time and can now provide a range of high-resolution climate information products tailored to agricultural user needs through a suite of web-based "Climate Maprooms"[47], which compile historical and present-day climate data as well as seasonal climate forecasts.

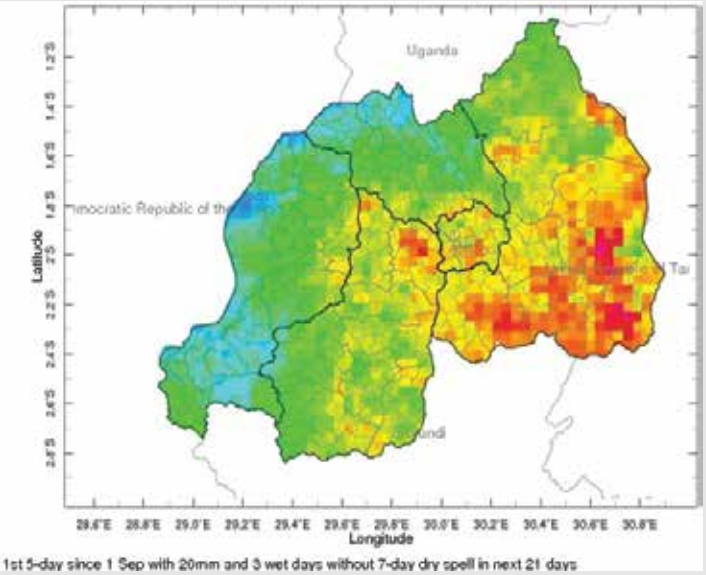
Box 6. Types of climate information

1. **Seasonal forecasts:** Seasonal forecasts give the overall configuration of the rainy season, including including total amount and dates of onset and cessation of rainfall
2. **10-day forecasts:** Ten-day forecasts help to detect dry spells and other anomalies in rainfall distribution; identifying trends could provide appropriate guidance to farmers
3. **Daily forecasts:** Climate information can become quickly obsolete with time, so daily weather reports are especially useful during the rainy season
4. **Instant forecasts:** Instant information concerns extreme events and forms the basis for early warning systems in advance of the event itself

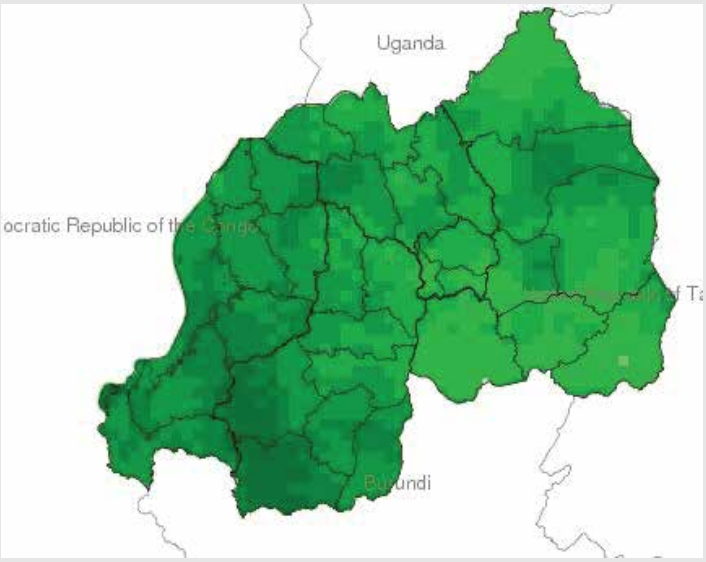
Figure 15. View of the Maproom during the launch of the Rwanda National Framework for Climate Services, December 2017
[Source: https://www.flickr.com/photos/cgiarclimate/albums/72157690511552774/with/39128402582/]
Photo: T Muchaba (CCAFS)

The following figures show examples of Maproom products from Meteo Rwanda. [Source: http://maproom.-meteorwanda.gov.rw/maproom/Agriculture/index.html]

44 https://ccafs.cgiar.org/news/rwandan-farmers-share-how-climate-information-helps-them-improve-food-security
45 https://iri.columbia.edu/wp-content/uploads/2013/07/ENACTS7_10v2.pdf
46 https://iri.columbia.edu/resources/enacts/
47 http://maproom.meteorwanda.gov.rw/maproom/Climatology/index.html



Rwanda: Historic Seasonal Rainfall Totals *[The Maproom explores historical rainy season length and total rainfall amount based on a user-defined definition of onset. The date when the rainy season starts is critical to agriculture planning, in particular for planting]*



Rwanda: Precipitation Forecasts in September-December season

Figure 16. Sample Maproom products from Meteo Rwanda [Source: http://maproom.meteorwanda.gov.rw/maproom/Agriculture/index.html]

4.3.3 Delivering climate information: How does it get to where it should?

In addition to participating in the development of these tools, CCAFS-EA supported their dissemination and implementation. Practical training sessions were conducted where stakeholders, including a cadre of around 150 national and local agricultural professionals, learned to analyze, interpret and use Meteo-Rwanda's Maproom products in support of agricultural planning and decision-making to suit their needs and priorities. Special efforts were deployed on building capacity to understand the climate information needs of women farmers and to deliver services that meet their needs effectively.

By enabling agriculture professionals and farmers to access locally relevant climate data tailored to their specific needs, the project has empowered communities to make informed farm-based decisions, which is critical in the face of a changing climate. District agronomists trained in the use of Meteo Rwanda's online Maprooms[48,49], have used climate information to improve their services to farmers. For instance, in the western highlands, the analysis of historical climate information allowed agronomists to better match crop varieties to local conditions; more suitable hybrid maize seeds were distributed to 88,000 farmers[50]. Furthermore, using crop water deficit calculations based on climate information, the Bugesera District authorities provided supplemental irrigation water, pumped from a lake into a lined reservoir, thereby enabling 188 farmers to cope with prolonged dry spells.

Radio coverage in Rwanda is 98%. Hence, the radio has been an especially valuable tool for communicating climate information to farmers in all parts of Rwanda. By working with community radio stations like Radio Huguka and listener groups, the project created 225 RLCs, each headed by PICSA-trained farmer promoters. The clubs provide an effective platform for farmers to share their concerns about climate change and learn about different adaptation strategies. Membership in RLCs was found to be particularly effective in removing disparities in awareness, access and use of climate information that usually exist between women and men smallholder farmers (Ingabire, 2021). A recent study (Hansen, 2021) showed that gender inequities in farm investments, coping capacity, and confidence in planning were diminished, reflecting greater participation of women in household decision-making, thanks, mainly, to the RLCs. While rural radio is an important communication pathway, the wide cellular network coverage allows climate information and early warning advisories to be also shared via SMS as every rural household possesses at least one mobile phone.

Access to reliable climate information helped farmers to streamline spending -- farmers are less likely to lose seedlings due to an unanticipated dry spell like in the past and be driven into debt to purchase new seeds. Better climate forecasts also allowed the timely substitution of certain crops; for example, replacing maize with soya bean and sesame in response to a below-normal rainfall forecast.

48 Workshop report – Map room training in Rwanda. https://drive.google.com/file/d/1SooLM7leDHIuLDHAwAf6qV217jDIRbzL/view
49 Making climate maps speak in Rwanda (canafrica.com)
50 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3199&cycle=Reporting&year=2019

4.4
ICT-based Dissemination of Climate and Market Information

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 and a private sector partner (Echnoserve).

Yezare mobile phone app

Echnoserve has developed a tool, called YeZaRe[51], with an embedded geographic information system that allows farmers to receive weather-forecast information[52], bundled with market prices, specifically tailored to their location. The YeZaRe phone app and SMS service are also available through a web-based system. SMS-based market information was disseminated to smallholder farmers in two districts (Bossana Worana and Doyogena) in Ethiopia, with a potential to reach 52,000 farmers[53]. Commodity prices are disseminated twice a week for crops that the farmer produces. Currently, 35,367 farmers have registered for the service (Fikreyesus et al. 2020).

SMS-based market information was disseminated to smallholder farmers in two districts (Bossana Worana and Doyogena) in Ethiopia, with a potential to reach 52,000 farmers[53].

Commodity prices are disseminated twice a week for crops that the farmer produces. Currently, 35,367 farmers have registered for the service (Fikreyesus et al. 2020).

51 http://yezare.info/

52 It provides three-, ten- and thirty-day weather forecasts as well as seasonal forecasts. The ten-day forecast includes agro-advisory services with specific management advice, enabling smallholder farmers to make informed decisions and take relevant actions for optimal agricultural productivity.

53 https://marlo.cgiar.org/summaries/CCAFS/projectInnovationSummary.do?innovationID=419&phaseID=56

4.5 Science and Policy Engagement in Climate Services

4.5.1 Regional and continental engagement

At the regional and continental level, CCAFS engagement influenced a substantial investment in climate services through the Climate Research for Development (CR4D)-Africa program, managed by the African Climate Policy Centre (ACPC)[54,55,56]. Indeed, CCAFS support for the CR4D program helped mobilize investment in African climate services. Significant new investment from DFID (ca. USD 3.7 million) under the Weather and Climate Information and Services for Africa (WISER) program, and contributing to the CR4D-Africa portfolio, drew on the design and implementation support from the CCAFS global and East Africa Regional Program. In 2019, DFID, through the WISER program, invested (ca. USD 3,680k) in a small research grant program under CR4D. ACPC and DFID jointly developed the principles for the WISER-funded CR4D grant mechanism.

4.5.2 Policy processes in Ethiopia

CCAFS through the ACToday (Adapting Agriculture to Climate Today, for Tomorrow) project led by the International Research Institute for Climate and Society (IRI) of Columbia University, has influenced two policy processes in Ethiopia, namely, the National Framework for Climate Services (NFCS) and the National Adaptation Plan (NAP-ETH).

Box 7. ACToday (Adapting Agriculture to Climate Today, for Tomorrow)

ACToday seeks to transform the way that climate knowledge and information is brought to bear on the challenges of hunger, food security, nutrition, and sustainable agriculture. It fosters the use of climate services as a means to create a tangible impact on the food systems of six target countries; in doing so, it both improves the lives of people in these target countries and generates evidence of good practice in research translation that can help guide national and international partners to adopt appropriate solutions to the wide range of challenges posed by climate variability and change beyond the six target countries (Bangladesh ; Colombia ; Ethiopia ; Guatemala ; Senegal ; Vietnam).

Source : https://www.earth.columbia.edu/projects/view/77

54 African Climate Policy Centre | United Nations Economic Commission for Africa (uneca.org)
55 https://www.aasciences.africa/aesa/programmes/climate-research-development-cr4d#overview
56 cr4d-climate_research_for_development_in_africa_en_brochure.pdf (uncclearn.org)

The NFCS is a coordinating mechanism under the umbrella of Ethiopia's National Meteorological Agency (NMA) to improve the development and delivery of climate services in the country. The NFCS represents the collaborative efforts of climate service institutions in Ethiopia to develop and deliver reliable climate services in key climate-sensitive sectors encompassing water and energy, agriculture, health, disaster risk management, and environmental protection (NMA, 2021). It is aimed at improving risk management by incorporating science-based climate information into decisions and policy-making. The NMA unveiled the country's NFCS, drafted with CCAFS and IRI support in consultation with agriculture and other climate-sensitive sectors, at a high-level event in May 2021 in Addis Ababa[57].

Thanks to the engagement of CCAFS, the IGAD Climate Prediction and Applications Centre (ICPAC) shifted to a flexible forecast format. In addition, ACToday extended Maproom tools to the National Meteorological Services (NMS) of Ethiopia, Senegal, Colombia, and Bangladesh. As a result, the four NMS were able to improve their agro-climatic services, making available localized climate analyses to several million more farmers and agricultural workers in these four countries. In addition, Ethiopia's Agriculture and Food Security Maprooms, developed previously with CCAFS, were enhanced, thereby benefiting a 35 million strong agricultural workforce. Government and institutional decision-makers were trained to use the Maproom tools to manage agricultural risks.

Ethiopia launched its fifteen-year National Adaptation Plan (NAP-ETH) to address climate change in September 2017[58]. CCAFS-EA actively participated in consultation meetings and contributed to subsequent discussions culminating in the strategy to develop Ethiopia's Climate Resilient Green Economy (CRGE)[59].

4.5.3 Influencing climate services policy in Rwanda

The proposal for establishing a National Framework for Climate Services (NFCS) in Rwanda was endorsed in 2017[60]. Its development was supported by CCAFS and the RCSA project. The NFCS is awaiting finalization and ratification. On the other hand, the Rwandan Ministry of Agriculture and Animal Resources has taken action to advance a national agricultural insurance strategy.

Figure 17. Establishment of the Rwanda National Framework for Climate Services (NFCS), Dec 2017 Source: https://www.flickr.com/photos /cgiarclimate/albums/72157690511552774/with/39128402582/ Photo: J Hansen (CCAFS)

57 https://iri.columbia.edu/news/launching-ethiopias-future-in-climate-services/
58 https://reliefweb.int/report/ethiopia/ethiopia-launches-15-year-national-adaptation-plan-address-climate-change
59 https://unfccc.int/sites/default/files/resource/Ethiopia-NAP.pdf
60 https://ccafs.cgiar.org/news/rwanda-establishes-national-framework-climate-service

5 LOW-EMISSIONS DEVELOPMENT PATHWAYS FOR AGRICULTURE

Photo: Eryxson Fonseca

5.1
Introduction

Agriculture is not only impacted by climate change but it also contributes to climate change. Globally, agriculture and related land-use change contribute over a quarter of annual greenhouse gas (GHG) emissions. 46% in Uganda, 57% in Kenya, 60% in Ethiopia, and 86% in Tanzania .

It is therefore acknowledged that GHG emissions from the agriculture sector must, where possible, be reduced while encouraging opportunities for carbon storage in soils and vegetation in order to mitigate climate change. East African countries have therefore accorded high priority to low emission development (LED) growth when articulating their respective visions, targets and priorities for their national agriculture sectors (see box).

Box 8. East African countries have included LED among the priorities for their national agriculture sectors

1. **Ethiopia:** "Identifying options in crop and livestock systems for reducing emissions in the context of the broader agricultural development and food security agenda"
2. **Kenya:** "Reducing GHG emissions from agriculture"
3. **Tanzania:** "Increasing use of climate-smart technologies in agricultural production through research and innovations"
4. **Uganda:** "Increasing the contribution of agriculture to low-carbon development pathways through transformation of agricultural practices"

61 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.

In helping East African governments realize their objectives, the CCAFS-EA research program has engaged with farmers' groups, local governments, national ministries, as well as development banks, donors, private sector suppliers, youth organizations, women's organizations. CCAFS-EA has helped identify priorities and options for low emissions development that also ensure the attainment of food security objectives, based on efficient fertilizer use and sound climate-smart agronomy.

The primary beneficiaries of CCAFS LED research are smallholder farmers -- men, women and youth -- for whom low emissions development practices contribute to food security and climate resilience by increasing yields, reducing inputs, and improving natural capital. The private sector and national LED efforts have also benefitted from better techniques for estimating emissions, improved technical capacities to implement and monitor LED, and related policy development.

5.2

Low-emissions Strategies and Policies for Agriculture Feed into Nationally Determined Contributions (NDCs)

In Kenya, CCAFS, the Global Research Alliance on Agricultural Greenhouse Gases (GRA), FAO, Unique Forestry and Land Use GmbH (UNIQUE), and national partners worked with the country's State Department for Livestock (SDL) to assess options for updating the contribution of livestock to its NDC. UNIQUE worked with SDL and national experts to assess the potential of adaptation and mitigation options in the cattle, sheep, goats, and poultry sub-sectors. IPCC Tier 2 methods were used in the case of dairy cattle and the Cattle Methane Similarities Calculator was used to validate estimated emissions. SDL's climate change unit head acknowledged that the report was "detailed and informed the NDC revision". CCAFS EA also extended support to Kenya's submissions on agriculture, gender and climate change (Republic of Kenya, 2018) and the establishment of CSA multi-stakeholder platforms[62]. Kenya's updated NDC thereby reflects gender integration in addition to emphasizing the role of efficient livestock management systems. Kenya submitted its updated NDC to UNFCCC in December 2020[63].

62 In fact, the Kenya CSA MSP has a Thematic Working Group solely focusing on gender and social inclusion
63 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3843&cycle=Reporting&year=2020

In 2018, following 5 years of research conducted by CCAFS-EA, UNIQUE, ICRAF, and ILRI in collaboration with ministries, donors, dairy companies, and producers' organizations, Kenya's State Department of Livestock was able to develop and submit a proposal to catalyze investments of USD 223 million in Kenya's dairy sector [64]

Building on CCAFS research and engagement, the government of Kenya reached an agreement with the World Bank to submit a Nationally Appropriate Mitigation Action (NAMA) in the dairy sector to the Green Climate Fund. Purposeful gender participation was a noteworthy feature of the NAMA process to ensure that the issues and needs of diverse socio-economic groups were addressed. Roughly equal numbers of men and women participated in developing institutional arrangements for the NAMA, which included specific recommendations for increasing the impact of dairy development on women. External evaluators judged the project as "a pioneering example of how climate change mitigation and adaptation can support agricultural development objectives." (CCAFS Annual Report 2018).

This Kenya dairy sector NAMA included proposals to use the Smallholder Dairy Methodology to measure GHG emission reductions from dairy development interventions. To test the practical feasibility of the methodology, a pilot baseline survey was conducted in central Kenya[65], a region dominated by intensive dairy cattle production (Wilkes et al. 2019). This enabled field-tested methods to be replicated in other regions of the country, ultimately providing standardized baselines with nationwide coverage for the dairy NAMA. Kenya's dairy NAMA also spurred similar action in the East African region notably among livestock sector stakeholders in Tanzania and Uganda.

64 https://ccafs.cgiar.org/outcomes/kenyas-state-department-livestock-catalyzes-investments-usd-223-million-dairy-sector
65 The fieldwork was financially supported by FAO as part of the Reducing Enteric Methane for Improving Food Security and Livelihoods project supported by the Climate and Clean Air Coalition (CCAC)

Along the same lines, CCAFS-EA research assessed the potential of low-emission dairy production, investment options, and financial mechanisms in Kenya's dairy sub-sector (Khatri-Chhetri et al. 2020). Promising climate-smart livestock systems including improvements in the cultivation of specific fodder crops and feed processing as well as manure and pasture management underwent practical trials for evaluating their contribution to climate change mitigation (Table 2).

Table 2. Key GHG mitigation options for the livestock sector in Kenya

Mitigation option	Reduction in annual GHG emissions [Metric tons of carbon dioxide equivalent]
Improved feed with fodder and hay production	1.57 MtCO2e y-1
Manure management using biogas plants	0.09 MtCO2e y-1
Breed improvement production	1.2 MtCO2e y-1
Dairy processing plants retrofit	0.14 MtCO2e y-1
Reduction of milk loss and waste	2.9 MtCO2e y-1

Source: https://cgspace.cgiar.org/handle/10568/110568

The economic benefits of these mitigation options include an increase in milk production, energy-saving from biogas and dairy plant retrofit, and a reduction in loss and waste in milk cooling centers. Furthermore, the business case assessments showed that all mitigation options are economically viable with a high internal rate of return (IRR) and a relatively short payback period (< 1 year to a few years). These findings were disseminated through training-the-trainer programs and included in the curricula of relevant training and extension organizations.

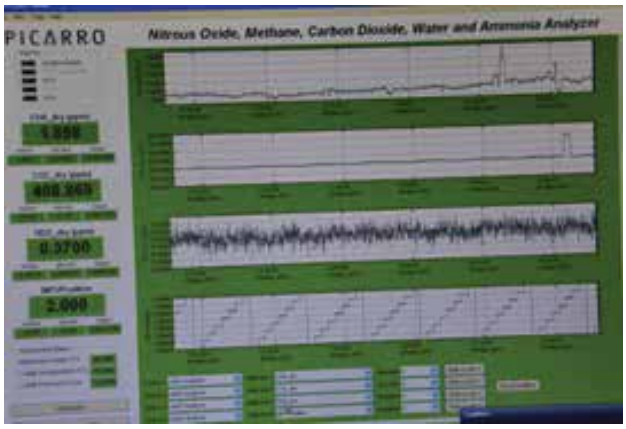
Additionally, CIAT and CCAFS via AGNES contributed text and facilitated a joint submission to the UNFCCC on Best Practices in Gender Mainstreaming in NAPs and NDCs[66]. The importance of the CIAT-CCAFS-AGNES submission is underscored by the decision on the part of the UNFCCC Adaptation Office to use the report to feed into the Adaptation Committee's 2020 agenda.

66 The NAP process is intended to support the incorporation of climate change planning into national development plans while NDCs refer to the planned efforts put forth at the country-level to help meet global climate change-related goals

5.3
Improving the Accuracy of Measurements of GHG Emissions

Acknowledging the need for quality emissions data to strengthen measurement, reporting and verification (MRV) systems, CCAFS in collaboration with GRA, FAO, UNIQUE, national partners, and CG-centers developed and introduced improved techniques for accurately estimating GHG emissions from crop and livestock production. Reliable baselines for current emission levels from crop and livestock activities were established against which the impacts of farm-level and landscape-level mitigation options can be compared, thereby allowing countries to better track their NDC-reported climate mitigation targets for agriculture. Ethiopia and Kenya were among several countries worldwide to adopt Tier 2 MRV systems in the livestock sector covering dairy and meat production and silvopastoral systems. Improved MRV systems in Ethiopia and Kenya are expected to support reductions of 18.16 MtCO2e from livestock and agroforestry-related projects[67].

Improved MRV is a prerequisite for planning and tracking mitigation. In 2015, emissions reporting in Kenya received a major boost with the inauguration of the Mazingira Center (named for the Kiswahili word for "environment") based at the International Livestock Research Institute (ILRI) in Nairobi.



Screengrab of platform for monitoring GHG emissions

Box 9. The Mazingira Center

The Mazingira Center is the result of collaboration between the Center for International Forestry Research (CIFOR), Germany's Karlsruhe Institute of Technology (KIT) and the International Livestock Research Institute (ILRI), which hosts the laboratory. The state-of-the-art laboratory enables scientists to measure emissions from a range of sources in Kenya, including livestock, manure management systems, smallholder farms, and land uses such as forests, tea and timber plantations. In addition to improving data quality and GHG inventories, the Mazingira facility also serves as an important training platform for young technicians and scientists from Kenya and elsewhere in Africa.

66https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3839&cycle=Reporting&year=2020

This is the first research center of its kind in Africa, capable of generating cost-effective and precise GHG emissions measurements. Until then, Kenya (like most developing countries) did not have the sophisticated facilities needed to measure actual GHG emissions from different land uses and had to rely on default emission factors provided by the IPCC to make its biennial GHG inventory reports to the UNFCCC on emissions and removals of GHG in the country.

Figure 18. Visit of policymakers from climate change departments of Kenya and Uganda, May 2016
Photo: T. Muchaba (CCAFS)

Results from the Mazingira laboratory suggest that the actual emissions from manure in Kenya may be substantially lower, by a factor of four, than the default emission factors currently being used for the country.

Figure 19. Kenyan and Ugandan policymakers discuss GHG measurements at Mazingira, May 2016

In order to boost capacity-building efforts in the region, CCAFS EA and ILRI hosted East African policymakers and researchers at the Mazingira Center to dialogue about the development of country-specific GHG measurements including jointly identifying gaps and opportunities in the different countries.

Ethiopia adopted its Climate Resilient Green Economy (CRGE) strategy in 2011, prioritizing the reduction of GHG emissions in four sectors, including livestock (Federal Democratic Republic of Ethiopia, 2011). The CRGE formed the basis for Ethiopia's initial NDC of 2015. Since 2019, CCAFS-EA and its research partners have supported the country in its efforts to update its GHG mitigation commitments for livestock, its highest emitting sector. A national inventory of GHG emissions from cattle, sheep and goats was compiled using the rigorous IPCC Tier 2 approach (the first of its kind in Ethiopia). The new inventory was validated and approved by MoA in 2020 and used in updating Ethiopia's national GHG inventory and its updated NDC submitted to UNFCCC in December 2020[68].

CCAFS combined scientific data collection with solution-led field research on climate-smart livestock production to help Ethiopia, Kenya and Uganda shift their monitoring and reporting systems to Tier 2 approaches as part of the Programme for Climate-Smart Livestock systems (PCSLS)[69]. The project also provided advice on formulating and implementing large-scale climate change adaptation investment projects in the livestock sector.

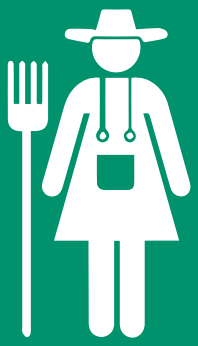
5.4 Incentivizing and Rewarding Smallholder Farmers to Reduce GHG Emissions and Increase Carbon Sequestration

CCAFS-EA led research has catalyzed the integration of low emissions strategies into agricultural development programs, policies, and practices, helping to reduce net GHG emissions and increase above- and below-ground biomass. The adoption of LED pathways has also helped to minimize and reverse land, water and forest degradation while simultaneously ensuring rural food security and improving livelihood options for smallholder farmers. A recent study (Ambaw et al. 2020) evaluated the soil carbon sequestration potential of the CSVs in Kenya, Tanzania and Uganda compared to the control land use in locations that were not implementing climate-smart agriculture practices. The findings suggest that CSA practices implemented through the CSVs approach contribute to climate change mitigation through soil carbon sequestration.

68 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3843&cycle=Reporting&year=2020
69 https://livestocksystems.ilri.org/2020/03/31/climate-smart-livestock-systems-program-kicks-off-in-kenyas-pastoral-rangelands/ & https://www.ilri.org/programme-for-climate-smart-livestock-systems

At one-meter depth, soil carbon stocks increased by 20-70%, 70-86%, and 51-110% in the Kenya, Tanzania and Uganda CSVs respectively compared to the control. Consequently, CSVs contributed to the reduction of emissions by 87-420 Mg CO2 eq ha-1. In the topsoil (0-15 cm), the CSVs sequestered almost twice more soil carbon than the control and emissions were reduced by 42-158 Mg CO2 eq ha^{-1} under CSVs. The annual increase in carbon sequestration under the CSVs ranged between 1.6 and 6.2 Mg C ha^{-1} yr^{-1} and varied according to the CSA land-use types. The forests sequestered the highest soil carbon (5-6 Mg C ha^{-1} yr^{-1}), followed by grasslands and croplands. The forest topsoil also had lower bulk density compared to the control.

The efforts of CCAFS-EA and its partners to promote low emissions agriculture in East Africa generated 1 Mt CO2e of 3rd party verified mitigation thanks to the active participation of 37,000 smallholder farmers implementing grassroots agriculture carbon projects in Kenya and Uganda.



Nearly 70% of farmers participating in this endeavor were women.[70]

70 https://marlo.cgiar.org/projects/CCAFS/studySummary.do?studyID=3140&cycle=Reporting&year=2019

A 2020 impact assessment of management innovations introduced in agricultural carbon projects in East Africa (Khatri-Chhetri et al. 2020) confirmed the impressive outcomes achieved by the projects implemented by Vi Agroforestry and ECOTRUST: a total of 1,951,407 tCO2e GHG emissions reduction credits received from 2010 to 2019.

The Vi Agroforestry projects, benefitting 29,500 farm households in 1,725 farmers groups, received a total of 624,960 tCO2e GHG reduction credits

while the approximately 9,000 smallholder farmers who participated in the agricultural carbon project managed by ECOTRUST received 1,326,447 tCO2e worth of verified emissions reduction certificates from 2010 to 2019.

5.5
Enhancing the Participation of Women and Youth in LED in Agriculture

A common thread running through all of CCAFS-EA's LED-focused activities is the emphasis on encouraging organizations to adapt their plans and direct investment to increase women's and youth's participation in LED-related decision-making. For instance, CCAFS-EA's program on women in dairy in East Africa included the design of gender and socially inclusive livestock projects. Gallina's (2016) review of the gender roles and dynamics in Kenya's dairy sector highlighted that technology change typically involves renegotiation, reassignment, or deepening of gender roles and responsibilities within households and alters traditional patterns of access to resources such as milk, land, and income.

Given the critical role women play in the dairy sector throughout different production systems, Kenya's National Dairy Board developed a gender mainstreaming strategy 2020-23 with technical support from CCAFS-EA through its partner UNIQUE Forestry and Landuse to ensure that the benefits of climate-smart practices and business models contribute to better gender equity. The associated monitoring systems that were put in place explicitly incorporated indicators to capture women's and men's participation and gender-differentiated benefits. Indeed, as emphasized by Tavenner and Crane (2016), gender indicators that address questions such as who does what, who has control over which resources, and who makes decisions at the household level will assist in measuring the goals of social inclusion and gender equity in ways that are both valid and reliable.

Bonga, Ethiopia Farmer Exchange
Photo: G. Ambaw (CCAFS)

6
KEY MESSAGES

6.1
Overall Program Design and Operation

a) The objectives, design and operation of the CCAFS-EA program reflected good congruence with the national priorities, policies and programs of East African countries. The program supported and accompanied national efforts to sustainably transform their agriculture sectors while adapting to climate change, reducing GHG emissions as well as fulfilling their national, regional and international climate- related commitments.

b) Partnerships, collaboration and engagement with relevant stakeholders in government, non- governmental and community-based organizations, the private sector as well as national and international research centers have been critical to the success of the program.

c) Gender, youth and social inclusion have been intrinsic to all the work of CCAFS-EA as have capacity strengthening and mutual learning. As a result, national governments are explicitly addressing the concerns of women and youth in their development programs besides integrating youth- and gender- sensitive approaches into their agriculture and food- and nutrition-security policies.

6.2
Evidence-informed, Gender-sensitive Climate-Smart Agriculture Technologies and Policies Developed

a) CCAFS-EA successfully developed, tested and rolled out a range of climate-smart agriculture technologies and practices in East Africa including agro-meteorological services, integrated crop and livestock schemes, multi-strata agroforestry systems, improved land and water management practices, and multi-stress tolerant crop varieties and livestock breeds.

b) CCAFS-EA research, engagement and capacity- strengthening have informed, catalyzed and targeted climate-smart agriculture solutions to women, youth and other vulnerable groups in East Africa, facilitating greater control over productive assets and resources, and enhancing their access to information and decision making. These groups were trained and equipped with the requisite skills and tools to benefit from the lower production risks and enhanced resilience of adopting and scaling CSA practices.

c) CCAFS-EA and its partners spearheaded the development of climate-resilient and biodiversity- rich seed systems, such as multifunctional community seedbanks and supportive agricultural policy environments, resulting in improved access to and increased utilization of viable planting materials that are adapted to the local climatic conditions in East Africa.

d) The successful introduction of improved livestock breeds coupled with innovative technologies and management practices contributed to strengthening the resilience of the region's livestock systems and value chains. The promotion and adoption of improved breeds of small ruminants, less demanding in terms of labor than larger livestock such as cattle, proved to be a transformative pathway to higher productivity and better livelihoods, especially for women and young people.

e) CCAFS science supported policies and investments in respect of climate-smart agriculture at national, continental and international scales.

6.3
African Position on Agriculture and Food Security in Global Climate Change Negotiations Informed by CCAFS Science

a) CCAFS contributed to capacitating African policymakers on matters related to agriculture, food security and climate change and their gender implications. CCAFS research informed gender, agriculture and climate change submissions of the Africa Group of Negotiators (AGN) to the UNFCCC resulting in several successful gender-related climate policy outcomes. CCAFS inputs to the Africa Group of Negotiators Expert Support (AGNES) catalyzed the establishment of a formal training program on climate governance, diplomacy and negotiations leadership.

b) CCAFS-EA science supported the formulation and submission of gender- and socially-inclusive approaches into national climate strategies and investment plans like the gender mainstreaming strategy of the Kenya Dairy Board and the World Bank livestock development projects in Ethiopia and Kenya.

c) Building on CCAFS research and engagement with ministries, donors, dairy companies, and producers' organizations, the government of Kenya developed and submitted a highly rated Nationally Appropriate Mitigation Action (NAMA) proposal to catalyze investments of USD 223 million in Kenya's dairy sector. Kenya's dairy NAMA spurred action on the subject among livestock sector stakeholders in the East African region, especially in Tanzania and Uganda.

6.4

CCAFS Research and Engagement Catalyzed Increased Participation of Women and Youth in LED and Improved MRVs and NDCs

a) CCAFS-EA research has improved knowledge and understanding of the challenges and barriers confronting low-emissions development in the region's crop and livestock sub-sectors. In collaboration with its partners, the program developed, field-tested, and implemented innovative LED pathways for agricultural development that enhance productivity and boost food security while also reducing GHG emissions.

b) Women, who constitute a majority of the farmers participating in agricultural carbon projects in East African CSVs, played a key role in the adoption and implementation of climate-smart agricultural practices resulting in high levels of above- and below-ground biomass; soil carbon sequestration is potentially double that of non-CSV sites with farmers earning carbon credits thanks to the reduction of GHG emissions.

c) CCAFS science supported the development and deployment of techniques for accurate and cost- effective GHG emissions measurements that, in turn, have resulted in improved MRV and NDC submissions by East African countries. Ethiopia and Kenya set evidence- based mitigation targets in their domestic climate policies and submitted updated NDCs to UNFCCC by end-December 2020 including more accurate livestock sector MRVs, progressing from IPCC Tier 1 to Tier 2.

d) CCAFS-EA's stakeholder engagement catalyzed high levels of participation of women and youth in LED in both the crop and livestock sub-sectors in East Africa. Women and youth actively contribute to agriculture carbon initiatives and make up nearly 70% of the smallholder farmers implementing grassroots agriculture carbon projects in Kenya and Uganda.

6.5
Delivery of Climate Services and Agro-advisories for Improved Risk Management and Better-informed Agricultural Decision Making

a) CCAFS-EA developed and deployed information and communication technologies, tools and guidance to enable the implementation of participatory digital- and radio-based channels for delivering climate services and market information to smallholder farmers and rural communities, thereby boosting their ability to plan farming activities and make appropriate decisions at different stages of the production cycle, resulting in less expenditure on inputs and higher productivity.

b) CCAFS-EA and its partners enabled Rwanda to achieve the distinction of becoming the first country in the world to deliver climate services to farmers and agency staff nationwide, across all of its 30 districts. The ability to access locally relevant climate data tailored to their specific needs empowered smallholder farmers, including women and youth, to make informed agricultural decisions and transformed the climate risk management and adaptive capacities of Rwanda's rural farming communities.

c) Agricultural advisory decision support systems like the Ethiopian Digital Agro-Climate Advisory Platform (EDACaP), developed collaboratively by CCAFS and national and international partners, represent a breakthrough in making available interactive agroclimatic information and advisories to strengthen the adaptive capacity and resilience of smallholder farmers and assist them in their tactical and strategic crop management decision-making.

d) National meteorological agencies within and outside East Africa, as well as the IGAD Climate Prediction and Applications Centre (ICPAC), have adopted the CCAFS-developed 'Maprooms' suite of climate information products to supply improved agro- climatic services, including localized climate analyses and flexible forecast formats, to several million farmers and agricultural workers.

7

SHAPING THE OUTCOMES OF FUTURE RESEARCH FOR DEVELOPMENT ENDEAVORS

Photo: L. Sharma (Marchmont Communications)

CCAFS-EA findings and achievements generated over its decade of existence have contributed to shaping the agenda of forthcoming research for development (R4D) endeavors like One CGIAR, AICCRA, and 2DI.

7.1 One CGIAR

The establishment of One CGIAR translates the determination of the CGIAR to transition from a partnership of over a dozen independently-focused and functioning Research Centers to a more streamlined and unified operational structure. It is expected that bringing CGIAR scientists together to work even more closely than at present with fewer institutional boundaries would unlock opportunities for greater integration and collaboration within the CGIAR and deliver even more science-based, practical, and climate-resilient solutions to realize food and nutrition security around the world.

One CGIAR, therefore, represents the collective response of the CGIAR to harness the knowledge, assets, and global presence of the CGIAR centers and their partners to achieve greater integration and impact in responding to the food, land and water systems challenges facing today's world in more timely and cost-effective ways. Global integration of the centers' capabilities will improve efficiency and effectiveness through economies of scale and minimizing duplication of effort.

7.2 AICCRA and 2DI

CCAFS-EA is exceptionally well-positioned to contribute substantively and substantially to two new upcoming R4D initiatives that reflect the One CGIAR vision:

1) Accelerating the Impact of CGIAR Climate Research for Africa (AICCRA), which aims to enhance access to climate information services and validated climate-smart agriculture technologies in Africa.

2) The Two Degree Initiative for Food and Agriculture (2DI), which has assembled a coalition of hundreds of like-minded partner organizations from around the world, pursuing the common goal of transforming the global food system for a climate-smart future.

AICCRA not only provides CCAFS-EA an opportunity to continue and strengthen its research and capacity-building activities but also allows further uptake and implementation of its Climate-Smart Agriculture (CSA) and Climate Information Services (CIS) products across the region and throughout the continent. CCAFS-EA can build on the achievements of all four of its Strategic Research Pillars (SRPs), particularly climate-smart agricultural technologies (SRP 1) and climate information services (SRP 2), to make important contributions to realizing the AICCRA aim of allowing farmers and livestock keepers improved access to climate advisories including information about appropriate response measures.

In addition, the constant attention paid to gender, youth and social inclusion that has been an underlying philosophy of all CCAFS-EA science will hold it in good stead to ensure that nobody gets left behind in deriving benefit from climate-smart innovations and solutions.

Two of the six anchor countries where AICCRA activities will be implemented, namely Ethiopia and Kenya, are already focus countries for CCAFS-EA. CCAFS-EA also worked in a third AICCRA anchor country, Zambia, on value chains, business models, and innovative finance for scaling of CSA. So, CCAFS-EA embarks on AICCRA with the distinctive advantage of an already established presence, experience, credibility, and network of partnerships in half of AICCRA's anchor countries.

AICCRA thus offers unique opportunities for wider dissemination and uptake of CCAFS-EA science products thanks to CCAFS-EA's excellent working relationships with regional economic communities and regional agricultural research and climate change networks:

•AICCRA can help make the products of cutting-edge CGIAR-led science available throughout Africa

•AICCRA can play a vital catalytic role in strengthening the agriculture research architecture in Africa.

The 2DI coalition mobilizes the science and policy expertise of the CGIAR system and its partners to meet the goals of food and nutrition security, and climate change adaptation and mitigation, expecting to bring livelihood benefits to around 200 million small-scale farmers by 2030. 2DI thereby reinforces CCAFS-EA's existing R4D efforts to bring about positive change in the adaptation of agro-ecological systems, livelihoods, and landscapes among the region's smallholder farmers through its knowledge products such as:

•Climate-smart technologies and approaches that empower smallholder crop and livestock producers, particularly groups that are most vulnerable to climate change such as women, youth and marginalized communities.

•Climate-informed digital advisories, services and decision support to provide small-scale agricultural producers and value chain actors with reliable and timely information and services to manage climate risks, improve production performance, and grow incomes.

•Detailed analyses of policy and institutional contexts, as creating appropriate enabling environments are often crucial to achieving adoption and scaling of innovations.

•Options for low emissions agriculture development pathways and value chains, covering both crops and livestock.

Indeed, 2DI offers a valuable vehicle to consolidate and maximize the use of CCAFS-EA's ensemble of knowledge, tools, technologies, and approaches developed and promoted thanks to its decade-long strength and experience in forging partnerships with research, policy and development stakeholders at multiple levels.

While CCAFS remains an important knowledge partner, its role in the 2DI coalition is complemented by the higher profile accorded to the private sector aiming to enhance markets for small-scale agricultural producers while also achieving ambitious development, adaptation and mitigation targets.

To conclude, CCAFS-EA's outstanding track record of achievements over the past decade in developing and disseminating gender-inclusive climate-smart technologies and approaches, on the one hand, and promoting the adoption of innovative suites of climate-services products, on the other hand, provides a solid platform to realizing the vision of a climate-smart African future. Indeed, AICCRA and 2DI offer further opportunities for CCAFS-EA to continue to deliver credible science and innovation-driven solutions to achieve low-carbon and climate-resilient food, land, and water systems and to translate research results into tangible development outcomes on the ground.

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