Stories of Success: Climate-Smart Villages in East Africa

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Stories of Success

Climate-Smart Villages in East Africa

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

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Foreword

Agricultural systems in East Africa are mainly rainfed and thus highly vulnerable to climate change and variability. Climate-related risks such as prolonged dry seasons, droughts and floods have become more frequent and severe with negative impacts on agricultural livelihoods and food security. These challenges are compounded by high poverty rates, declining land sizes, poor market access and high population growth rates with increasing demand for food.

Researchers, development partners and farmers are coming up with innovative approaches to address climate variability and change, building on existing knowledge and institutional systems. The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), is partnering with farmers, development organizations, and national and international agricultural research organizations in East Africa to test and promote a portfolio of climate-smart agricultural technologies and practices, including institutional innovations and linking with policy makers at sub-national and national levels. Through the partnership, smallholder farmers are changing their farming practices as they respond to climate risks and adapt to climate change.

This booklet presents some of the emerging stories of success of climate-smart agriculture technologies and practices that are positively changing the lives of smallholder farmers across East Africa. They were selected from a portfolio of climate-smart agriculture interventions and have potential for scaling up. We hope that the stories contribute to promoting climate-smart agriculture, and help other smallholder farmers in similar vulnerable systems.

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

Chapter One

Introduction

Climate change and increased climate variability present new risks and vulnerability for smallholder farmers in East Africa who depend mainly on rainfed agriculture for their livelihoods.

Poverty, reduced labour availability and limited options for diversified livelihoods make these communities more vulnerable to climate risks, with direct negative impacts on household food security and nutritional status.

To address this challenge, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) has developed the Climate-Smart Village (CSV) Research for Development (R4D) approach. Using participatory methods, we test technological and institutional options for dealing with climate change in agriculture, with the aim of scaling up and out the appropriate options and drawing out lessons for policy makers from local to global levels.

Climate-Smart Villages act as 'lighthouses', to demonstrate how communities can test, co-develop and adopt integrated portfolios of climate-smart agriculture (CSA) practices (see Figure 1). They provide a solid framework through which to investigate the enabling environment that facilitates the adoption of CSA practices, and they build the evidence base to support scaling up and out CSA.

Farmer Huruma Tweve from Lushoto showing a variety of Irish potatoes.

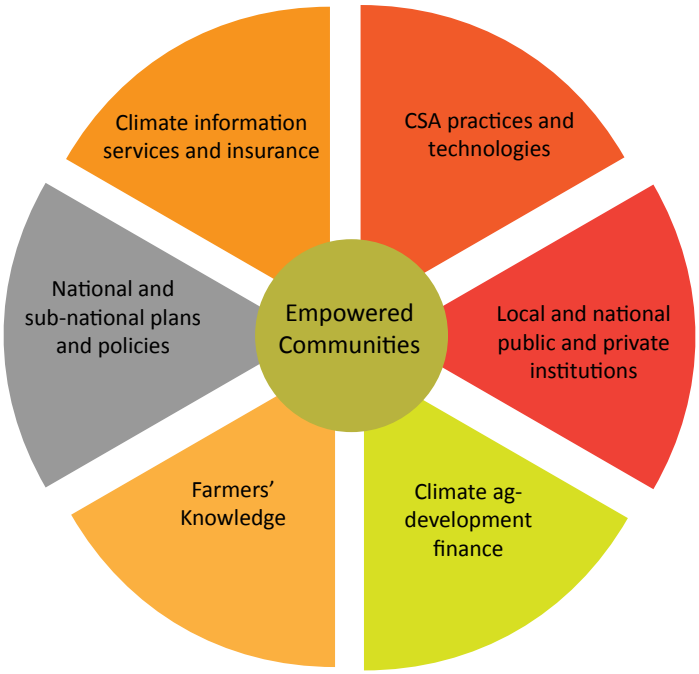


Figure 1: Components of a Climate-Smart Village

This publication highlights emerging lessons from ongoing participatory testing of a portfolio of CSA technologies and practices in the CCAFS CSVs in East Africa, including institutional innovations. In each CSV, CCAFS works in collaboration with national agricultural research and extension systems and the rural communities. CCAFS facilitates these partnerships around collective action initiatives to bring a scientific approach to delivering development outcomes in the CSVs.

Climate-Smart Villages in East Africa

Climate-Smart Villages are clusters of villages or landscapes that focus on climate change hotspots around the world. CCAFS started piloting the CSV approach in East Africa in 2012. In each CSV, a number of climate-smart interventions may be introduced, but there is no one-size-fits-all approach. The interventions vary depending on the agro-ecological characteristics of the CSV, level of development, capacity and the interests of farmers and local government partners (see Figure 2).

In East Africa, CCAFS facilitates six CSVs: Lushoto (Tanzania), Wote and Nyando (Kenya), Hoima and Rakai (Uganda), and Borana (Ethiopia). Across the CSVs, smallholder farmers face various climate-related risks that include prolonged dry seasons and increased incidence of pests and diseases, which have become more frequent and intense, and have negative impacts on agricultural production.

To address climate-related risks and improve capacity to adapt to climate change, farmers across the CSVs are coming together through collective action groups. Some of the farmers groups were initially formed with different objectives that included pooling financial resources through Rotating Savings and Credit Association (ROSCA) schemes, and pooling of labour during planting and harvesting, based on principles similar to share-cropping. Other groups were formed to provide social support to widows, orphans and vulnerable groups.

These existing and emerging groups are important platforms for innovative partnerships that provide new knowledge and skills and build the capacity of local farmers to change farming practices while adopting new crop and livestock interventions. They empower members to pool financial resources for savings, provide labour for farm operations, and make it easier to provide agro-advisory services and farm inputs of good quality at affordable prices.

Collective action has often been used by rural communities for managing natural resources. However, the stories presented here clearly demonstrate the increasing importance of collective action in addressing multiple challenges ranging from food insecurity in mixed crop–livestock systems of Nyando, Wote and Hoima, to dealing with the climate-related risks in pastoral systems of Borana as a social safety net mechanism.

The next section describes the six CSVs in East Africa from which the stories are drawn, providing a background on their agro-ecology and the community-based organizations that underpin all the interventions.

Many different CGIAR Centers are involved in research activities in the villages. These include the International Livestock Research Institute (ILRI), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Center for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA) and the International Potato Center (CIP).

Weather-smart	Water-smart	Carbon-smart	Crop-smart	Livestock-smart	Knowledge-smart
• Seasonal weather forecasts • Agro-advisories • Climate analogues	• Rainwater harvesting • Terraces for soil erosion control	• Agroforestry • Trees for fodder and forage • Fuelwood and fruit trees • Composting manure	• Improved beans • Improved Irish and sweet potatoes • Drought tolerant cereals • Seed and fodder bulking	• Improved sheep and goats • Improved poultry • Community paraveterinary workers	• Smart-farms • Collective action groups • Farmer-to-farmer learning

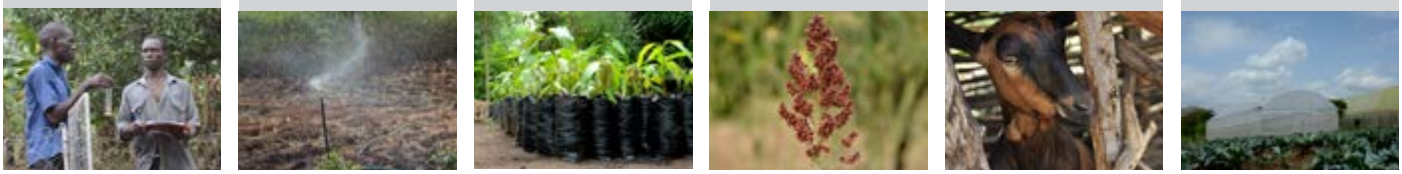


Figure 2: Climate-Smart Village activities

Lushoto, Tanzania

Agro-ecology

Lushoto, in north-eastern Tanzania, is hilly with very steep slopes. It is characterized by a diversity of micro-agro-ecological zones within a relatively small area. Land degradation is high and 65% of farmland is classified as degraded. The area is highly populated, with an average of 0.4 ha per household. Average annual rainfall is variable, ranging from 800 to 1300 mm (Figure 3). However, the first rains often start later than expected. The second rainy season is less reliable than the first and rains have been inadequate in three of the past ten years. This reduces the length of the crop growing period. This risk is made worse by an upsurge in crop and livestock pests and diseases caused by climate variability. Most households rely on crop production, rather than livestock, because of the small size of land holdings in Lushoto.

Collective action initiatives

Three community-based organizations were established in Lushoto in 2012: Kwamaga, Mbukwa and Yaboga. In 2014, these were transformed into village savings and credit cooperative societies (SACCOs). The three SACCOs operate in 29 villages in Lushoto, which include 1089 active households and 55% of the membership is made up of women. SACCOs are more appealing sources of loans for farmers than microfinancial institutions, because the SACCOs operate under a community arrangement that helps people to repay

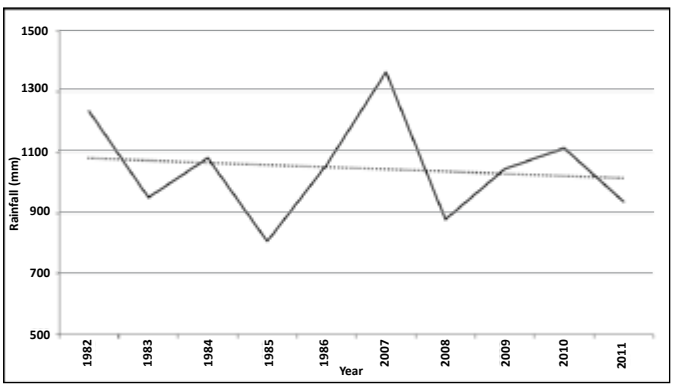


Figure 3: Annual rainfall in Lushoto

loans. Members have mobilized financial resources to create an innovation fund worth USD 35 000. Members can borrow money from the innovation fund for on-farm agricultural investments, and in particular, horticulture. The SACCOS are an avenue for climate information services and also provide access to agricultural inputs. They have been effective in mobilizing members to establish soil conservation structures, as well as tree nurseries. This has contributed to the planting of 500 000 trees in three years, supporting the target of 10% tree cover set by the Lushoto District Council.

Partners

HORTI Tengeru; Lushoto District Council; SARI; SUA; TAFORI; TMA; CIAT; CIP

Wote, Kenya

Agro-ecology

Wote, in eastern Kenya, is a semi-arid area with bimodal annual rainfall ranging between 480 and 800 mm. Rainfall is poorly distributed over the first rainy season in April and May, resulting in a short crop growing period and high water stress. Temperatures and evaporation rates are generally high and when it rains, flooding occurs. This has led to erosion that affects 25% of the landscape. An increased incidence of pests and diseases in the past 20 years negatively affects crop and livestock production. The incidence of Aflatoxin fungal disease, for example, has increased in dryland eastern Kenya including Wote, and farmers can lose up to 50% of their grain harvest.

Collective action initiatives

Two community-based organizations (Sinai-Kikeneani and Kikumini-Muvau) were formed in Wote in 2014. Initially covering seven villages, these CBOs have increased their membership from 140 to 620 households within two years, with women making up about 70% of the membership. Over the two-year period, the CBOs pooled their financial resources into a combined innovation fund of USD 39 000. Members can borrow from the fund, mostly for investment in agricultural activities such as production of high value horticultural crops and poultry farming, to help them

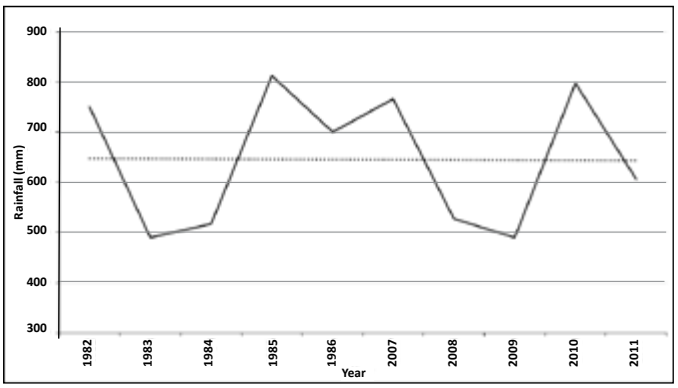
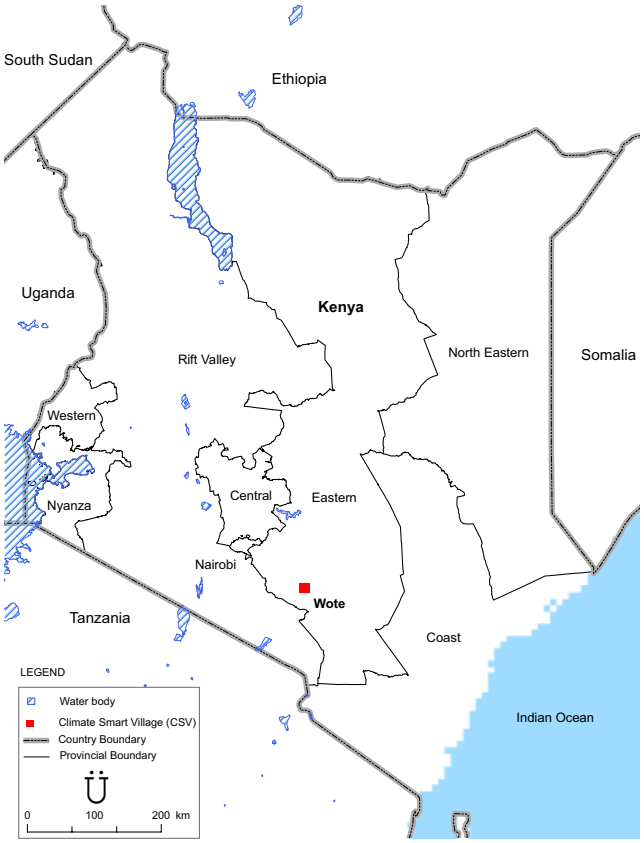


Figure 4: Annual rainfall in Wote



manage climate-related risks. The Wote CBOs also provide an avenue for dissemination of climate-smart technologies like cereal–legume intercrops, and soil and water conservation structures on-farm. The CBOs have encouraged their members to diversify their crop choices, and cultivation of new crop varieties has increased from 72% of the households in 2014 to 92% by the end of 2015.

Partners

KALRO; Makueni County Department of Agriculture, Livestock and Fisheries; ICRISAT

Nyando, Kenya

Agro-ecology

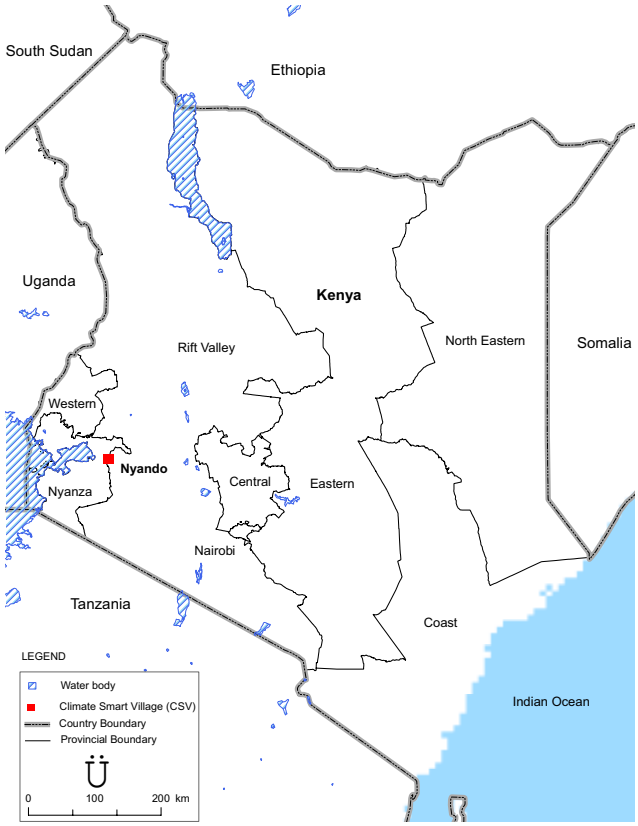
The Nyando basin sits in the rain shadow of the Mau Escarpment. Farmers grow maize, beans and sorghum, and keep livestock in a mixed farming system. About 65% of the annual rainfall of 1200 mm generally falls during the main growing season of March to May, with the other 35% expected in the minor rainy season between October and December. The onset of seasonal rainfall is highly variable. Long dry spells occur following an early onset of rains, while extreme flooding often occurs after a late onset. Dry periods after the onset of rains reduce the effective length of the main growing season. Analysis of 50-year historical data shows that the onset of rainfall appears to have drifted from what farmers perceive as the start around mid-February to a true onset about mid-March. Land degradation affects about 40% of the landscape, with negative impacts on farming.

Collective action initiatives

The communities in Nyando have organized themselves into three large community-based organizations—Friends of Katuk Odeyo (FOKO), North-East Community Development Program (NECODEP) and Kapsokale. The three organizations are made up of 50 self-help groups from 106 villages, representing about 2500 households. Women make up 80% of the members of the self-help groups.

Between 2011 and 2015, the three community-based organizations pooled their financial resources, and increased the total available from USD 14 000 to USD 95 000. This formed the Nyando innovation fund. About 90% of the farmers have borrowed from the fund. Loans are used

Figure 5: Annual rainfall in Nyando



mainly to purchase agricultural inputs, buy food, school fees and to support small trade (basket weaving and shops). The organizations have set up smart-farm demonstrations that include greenhouse farming, combined with drip irrigation. They also manage open field demonstration plots used for seed multiplication for the community.

Through the three community-based organizations, farmers receive training during field days and trade fairs organized by the Agricultural Society of Kenya. The organizations established an input supply shop to facilitate farmers' access to agricultural inputs of high quality at affordable prices. This has led to a 50% reduction in the number of farmers using local unimproved seeds. The community-based organizations also facilitate access to climate information services (CIS), which is used by some 70% of the farmers for on-farm decision-making.

Partners

FOKO; Kapsokale; KALRO; KMD; Kisumu and Kericho County Departments of Agriculture, Livestock and Fisheries; Maseno University; Magos Farm Enterprises; NECODEP; Rafiki Microfinance Bank; ThinQubator Aquaculture; Vi Agroforestry; World Neighbors; ILRI

Hoima and Rakai, Uganda

Agro-ecology

In Hoima, western Uganda, average annual rainfall is about 1400 mm (Figure 6), but this average masks a high level of variability, which can result in late onset or early cessation of rains. Hoima is characterized by a mixed farming system. Farmers commonly grow cassava, sweet potatoes and beans, while chickens and goats are found on most farms. Soil erosion is widespread in Hoima, affecting almost 20% of the landscape, and soil fertility is declining.

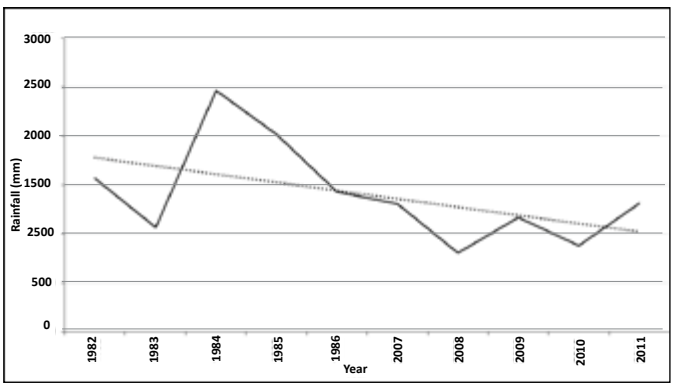


Figure 6: Annual rainfall in Hoima

Rakai, in southern Uganda, also has a mixed farming system. Bananas and beans are the common crops and, like Hoima, chickens and goats are the main livestock. The area receives an average annual rainfall of about 1200 mm, but rainfall distribution is poor, with gradually reduced river flow and high water stress over the years.

In both Hoima and Rakai, the second rainy season from August to November is less reliable than the first rains in March to May because of its uneven rainfall distribution.

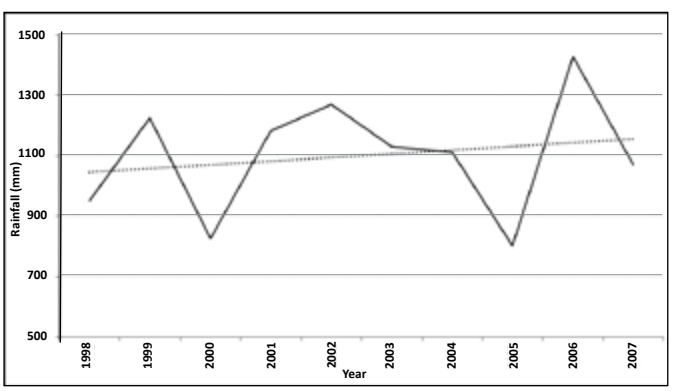


Figure 7: Annual rainfall in Rakai

These areas have also experienced an increase of diseases and pests affecting crops and livestock.

Collective action initiatives

In Hoima, two community-based organizations—the Bagonza-Kukora and Kyabigambire Farmers Organization—were formed in 2013 and initially covered seven villages. Within three years, they had expanded to reach a total of 15 villages, including 720 households, with pooled financial resources totalling USD 41 000. The membership of the farmers' organizations is equally split between men and women. Members can borrow funds, which are mostly used for on-farm agricultural investments such as horticulture, as well as chicken and pig enterprises that have a ready market. The community-based organizations have been an important avenue to promote climate-smart technologies such as resilient, new crop varieties that have now been planted by 97% of the households.

Partners

Bulindi ZARDI; HODFA; NARO; World Vision; CIAT; IITA

Borana, Ethiopia

Agro-ecology

Borana, in southern Ethiopia, experiences more frequent droughts than the other CSVs. With bimodal average annual rainfall of only 500 mm, Borana has experienced five droughts in the last ten years. In this semi-arid region, characterized largely by a pastoral farming system, most households rely on livestock and related products for their livelihoods. When it does rain, there is considerable spatial and temporal variability in rainfall amount and distribution, leading to limited forage and water resources for livestock. More than 60% of the landscape is bare and degraded, and there are increasingly frequent disease outbreaks that cause high livestock mortality rates especially during the dry season.

Collective action initiatives

In 2011, two umbrella collective action groups existed in Borana, bringing together many smaller groups. CCAFS and partners initiated a systematic capacity building programme, which has enabled the two groups to recruit more members. By 2015, this totalled 450 households. They pooled financial resources amounting to USD 4000 and this is used to fund local investments such as enclosures to provide more pasture for fattening livestock, and diversification into poultry production and dryland crops. Generally collective action has enhanced rangeland rehabilitation measures in Borana.

Partners

Ethiopian Institute of Agricultural Research; MARIL; Yabello District Government; Yabello Pastoral and Dryland Research Institute; ILRI

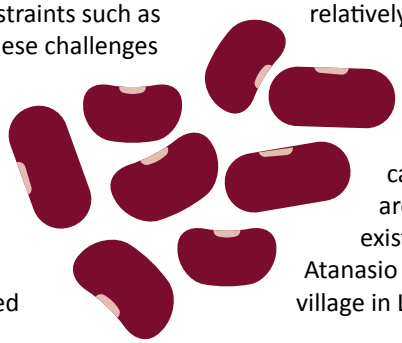
Chapter Two

Improved crop varieties and resilient livestock breeds

> *If farmers are educated on how best they can grow their favourite crops like beans, they are more likely to get higher crop yields from the existing land, and also increase their income.*

Story 1.
Better beans

Beans are an inexpensive source of protein for rural and urban households in Africa. They are vital for reducing poverty and improving food security and nutrition. But beans are a fragile crop, relying on stable temperatures and lots of water to grow. Bean production is greatly affected by environmental stresses including drought, excessive rain, flooding, heat and cold, as well as biotic constraints such as field and post-harvest pests and diseases. These challenges are expected to become more pronounced as climatic conditions change and become more variable. Vast areas of sub-Saharan Africa, especially in East Africa, are projected to become unsuitable for bean production within 50 years.



Improved bean varieties have been developed that can withstand some of these climate-related constraints. Yet adoption rates remain low. In the CCAFS learning sites of Lushoto, Hoima and Rakai, researchers from several organizations have been working with farmers through a participatory action research approach to improve farmers' access to seeds of improved bean varieties and establish a sustainable seed delivery system. Despite the erratic rainfall patterns in these sites, the research has enhanced productivity by promoting drought tolerant bean varieties, together with improved agronomic practices.

In Lushoto, community-based organizations provided a platform for distribution of the improved seeds through village seed banking. This enabled members to develop their own guidelines and policies governing the community seed bank. An estimated 300 kg of improved bean seed was contributed to each village seed bank for distribution to farmers. Improved agronomic practices were also introduced, including row planting instead of broadcasting, and disease and pest control measures to increase yield.

During the first growing season of 2013, a total of 1000 kg of the improved bean seed Lyamungo 90 were distributed to 100 farmers in Lushoto. Implemented by SARI and MALF, this initiative was supported by CCAFS, together with farmers and other stakeholders. The improved bean variety had better germination and seedling emergence, and was relatively resistant to pests and diseases, compared to local varieties. Bean yields increased three-fold compared to local varieties, and farmers harvested an average of 2500 kg per ha.

"If farmers are educated on how best they can grow their favourite crops like beans, they are more likely to get higher crop yields from the existing land, and also increase their income," says Atanasio Abel Singano, a farmer from Kwang'wenda village in Lushoto.

During the second growing season in 2013, a second bean variety, Selian 97, was introduced alongside Lyamungo 90.

© G.Smith (CIAT)

Kyamaleera Women Handicraft Association members in Hoima, with different varieties of beans.

A farmer in Lushoto with her beans.

By the end of 2014, more than 70% of farmers in Lushoto were using improved varieties, generating a further increase in yields. During the 2014 long rains, some 220 farmers in Lushoto harvested an estimated 20,000 kg of improved bean varieties. While there were no significant differences in yield between Selian 97 and Lyamungo 90, farmers preferred Selian 97 for its taste, attractive colour, shorter cooking time and uniformity in maturity.

The participatory research process in Lushoto, Rakai and Hoima (see box) has provided farmers with the technical knowledge to decide which bean varieties to grow, rather than relying on chance, price and market availability. Participatory action research enabled farmers to test varieties themselves, and select their preferred beans. Farmer adoption of improved bean varieties was promoted by distributing seed through community-based farmers' organizations and providing training in better agronomic practices. Further research is needed, however, to breed yet most robust varieties with even greater resilience to climate change.

Different beans for different farmers

In Hoima and Rakai, research under the Pan Africa Bean Research Alliance (PABRA) evaluated 15 drought tolerant bean varieties from Kenya, Malawi, Rwanda and Uganda. In 2012 and 2013, farmers in five villages, including 143 men and 215 women, evaluated the bean varieties through on-farm trials.

The farmers reported on bean performance in terms of growth, yield, adaptability to weather conditions and fertilizer use, among other traits. They also selected their preferred bean varieties based on market attributes. Farmer preferences were then compared with the scientific findings. Male and female farmers were found to look for different traits in beans. Men were primarily interested in market value and yield, while women considered additional benefits, such as short cooking times, taste and high nutritional value.

Partners

Lushoto: Lushoto District Council; SARI; CIAT
Hoima and Rakai: NARO, CIAT

> *Small ruminants are a pathway to better livelihoods in East Africa.*

Story 2.
Breeding resilient ruminants

Almost 90% of farmers in Nyando keep small ruminants—mainly local breeds of East African goats and Fat-tailed sheep. Small ruminant production in this area, however, is characterized by low productivity and poor recovery from drought and disease.

Apart from poultry, goats and sheep are the only livestock assets over which women and young people tend to have control. They are also less labour intensive than larger livestock such as cattle. Improved breeds of small ruminants, coupled with better livestock management practices are key strategies for transforming their productivity, and supporting women's and young people's livelihoods.

"Small ruminants are a pathway to better livelihoods in East Africa," says Julie Ojango, an animal breeding scientist at ILRI.

Since 2011, CCAFS has been working with its partners to help livestock farmers in Nyando improve the productivity of their sheep and goats. From 2012 to mid-2013, improved breeds of Galla goats and Red Maasai sheep were introduced to farmers in Nyando to be crossed with local breeds to increase productivity. These breeds were selected because of their desirable characteristics that include resistance to heat stress, high productivity, and high growth and multiplication rates. The improved and resilient breeds of goats and sheep were introduced through three local community-based organizations: FOKO, Kapsokale and NECODEP. Farmers in the three organizations have 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, which can serve around 12 ewes a month.

The Red Maasai sheep can withstand heat stress and are more resistant to diseases and parasites than the local Fat-tailed sheep. This is important, given that diseases and parasites are now more widespread as a result of the warmer climate. And compared to local East African goats, Galla goats mature up to six months faster, have higher milk production, and high twinning rates. They also fetch higher prices in the market, which can be three times the price of local breeds. A mature Galla goat, for example, costs USD 80–120 while the East African goats sell for only USD 25–30.

"A lot of in-breeding between the East African goats in the area had resulted in smaller sized animals that do not fetch the farmer good market prices," says George Nandi, a livestock extension officer from MALF, who works closely with farmers in Nyando.

As a result of the cross-breeding initiative, an average of 2500 cross-bred sheep and 15 000 goats are added to the Nyando flock every year. To control in-breeding and maintain high quality breeds, ILRI has initiated a monitoring and management system. 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 to manage the livestock's health.

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A Galla goat at Joshua Omollo's farm in Nyando.

© T.Muchaba (CCAFS)

Kenya Cabinet Secretary for Agriculture, Felix Koskei inspects at Galla goats at the Kisumu Agricultural Society of Kenya Fair, 2014.

The pure and cross-breeds of Galla goats are already in high demand and CBOs are 'passing on the gift': offspring are given to other community members so they also benefit from the initiative. Structured training meetings within and across groups and CBOs enhance knowledge sharing and learning thus leading to capacity building among members. Through the partnership, Vi Agroforestry, World Neighbors, MALF and KALRO have also expanded their extension services to meet the increasing demand for information about better feed management, pest and disease control and breeding practices.

Every year, farmers in Nyando hold learning events, and participate in county agricultural fairs, where they share lessons from their local adaptation practices and also learn from others about different CSA technologies. In June 2015 and July 2016, the Nyando farmers held learning events about their improved livestock breeds and other CSA technologies, with more than 5000 farmers and other stakeholders participating in the events.

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 1500 goats were auctioned. At the second annual goat auction in December 2015, the Kenyan Deputy President, His Excellency William Samoei Ruto attended as the chief guest. The Deputy President was very impressed by the CSVs, and in particular by the promotion of livestock as a way of addressing climate change, food insecurity and improving incomes. He urged the champion farmers to continue to share their knowledge with their neighbours to promote learning and wider adoption of new technologies. About 4000 goats were sold at the auction, with a single Galla goat fetching USD 130–160.

Improved breeds of small ruminants are more productive, more resilient and more valuable than traditional sheep and goat breeds. As women and young people tend to control these assets, introducing improved breeds to their flocks directly and positively impacts their livelihoods. With training and support on livestock management, and support from community paravets, farmers can rapidly increase their flock of improved sheep and goats, while maintaining the quality of the breed.

Partners

FOKO; Kapsokale; KALRO; MALF; NECODEP; Vi Agroforestry; World Neighbors; ILRI

> *"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."*

Story 3.
Championing better potatoes

Potatoes are one of the most important food crops in sub-Saharan Africa. Indeed, a much higher proportion of people's diets is made up of cereals, roots and tubers in sub-Saharan Africa than in other regions of Africa. In Lushoto, potatoes are traditionally grown for food and 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 and yields are low.

"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," says Dieudonné Harahagazwe, a researcher at CIP.

Since 2013, CCAFS has partnered with CIP and several other organizations to work with smallholder farmers in Lushoto to co-evaluate better potato varieties. The aims are to enable farmers to access potato varieties that can be grown all year round, and increase potato yields. Farmers, extension agents and NGO officers in Lushoto took part in an action research approach to help them develop their agronomic skills and select potato varieties that suit their needs.

The approach combined training-of-trainers sessions and participatory varietal selection. Participants took part in five training-of-trainers modules spanning two growing seasons, with three modules in the long rainy season and two in the short season. The first round of training covered important components of crop management, from land preparation to seed storage. The second round was participant-led, covering areas that emerged during the first round.

Participants also tested advanced potato materials (clones, yet to be formally released) and improved varieties (Asante, Shangii and Obama) with the local variety, Kidinya, as a control. With guidance from CIP and SARI, participants grew the varieties on a demonstration farm at the Lushoto Resource Center. Farmers also tested some of the varieties on their farms. Both the advanced clones and improved varieties outperformed the local Kidinya in terms of yield and resistance to late blight and high temperatures.

Three years later, farmers who participated in the trials have doubled their yields and changed their livelihoods. In 2014, Samuel Tendwa was among 70 farmers from three villages in Lushoto that worked with CIP and partners over four consecutive growing seasons.

"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.

Potato seed storage facility in Lushoto.

Potato agronomic training by CIP and SARI in Lushoto.

During the short rainy season of 2014, Samuel and nine other champion farmers from his village, each received one 80 kg bag of clean Asante potato seed. With 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.

During 2015, champion farmers who had participated in the training sessions spearheaded village learning events to share their agronomic knowledge and promote wider planting of improved varieties. A total of 135 farmers in neighbouring 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.

Farmers who participated in the training-of-trainers and participatory varietal selection processes are proud of the varieties they helped select. As two of the high yielding trial materials moved towards formal release, the farmers proposed formal names for them to reflect their qualities. Mvono, named for its high number and size of tubers, and Mkanano, meaning highly competitive, are being formally released in Tanzania in 2016.

Farmers' participation in the selection of potato varieties and training has enabled many of them to improve their crop management and made new varieties accessible to them. Improved varieties that resist disease pressure have higher yields, and have opened new, more valuable seed markets. With better potato varieties and improved agricultural practices, farmers are improving their incomes and are better able to adapt to the impacts of climate change.

Partners

Lushoto District Council; HORTI Tengeru; SARI; CIP

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

Story 4.
Testing high-yielding root crops

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

Since 2013, farmers in Hoima have been working with CCAFS and partners to test new, resilient, high yielding cassava and sweet potato varieties. NARO, in partnership with CIP, has identified and developed improved, superior sweet potato genotypes that are high yielding, early maturing, drought tolerant and contain high levels of β-Carotene, a precursor of Vitamin A. Similarly, in partnership with IITA, NARO has developed improved cassava that is more resistant to drought and water stress and has pest and disease resistance, as well as high yielding traits and high levels of protein and vitamin A.

Through participatory action research, suitable varieties of both crops were introduced in Hoima in 2013. The two local community-based organizations were instrumental in spreading the innovations and promoting uptake of the new varieties to individual farmers through village demonstrations, field days and multiplication of planting material. Within a period of three years, more than 750 households have planted a new cassava variety (NASE-14) and two new varieties of sweet potatoes (NASPOT-11 and NASPOT-8).

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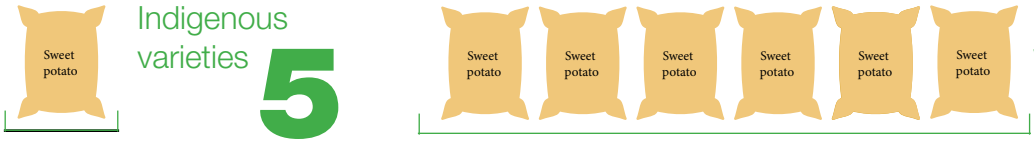
Alice Nyangoma inspects sweet potatoes on her farm in Hoima.

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

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

Apart from the improved varieties, farmers are also using better agronomic practices that include crop rotation, early planting and fertilizers, coupled with soil conservation, following training by NARO and local agricultural extension staff from the Ministry of Agriculture.

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



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Sweet potatoes from Hoima.

Besides, 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," says farmer Godfrey Kairagura, a member of Kyabigambire Farmers Organization.

Researchers have involved women's groups in the evaluation of the new varieties to hasten adoption and use of selected varieties. This participatory approach also ensures that the traits that are important to farmers are evaluated. Experienced cassava and sweet potato farmers—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.

Researchers continue to work with the farmers in Hoima to provide training on a suite of improved agricultural practices that enable optimum yields to be realized using the improved varieties. Involving local policy makers and private sector organizations in the research also supports scaling up and wider uptake.

Community-based organizations are instrumental in spreading improved varieties and promoting uptake of new varieties through village demonstrations, field days and multiplication of planting materials. The participatory approach and inclusion of women farmers in the evaluation of new varieties ensures that selection is attuned to farmers' needs.

Partners

Bulindi ZARDI; CIP; IITA

Chapter Three

Sharing innovations

> *"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."*

Story 5.
Scaling up smart farms

Farmers in Nyando wait for the major rains to start from the middle of February onwards. But the variability of seasonal rainfall and climate change have pushed the onset back, sometimes as far as mid-March, making it difficult for farmers to plan. Long dry spells and early cessation shorten the growing season, while extreme flooding occurs after late onset rains because of the intensity of the rainfall.

"A lot has changed in Nyando. Most of the times, it is very dry. When rains come, they tend to be very intense and short," explains Wilson Aore, a scientist with KALRO.

In order to address the challenges of seasonal rainfall variability, degraded land and declining farm sizes in Nyando, CCAFS is collaborating with government agencies, NGOs and the private sector to introduce the smart farm concept. Smart farms involve farming in greenhouses, combined with drip irrigation supplied by a mini-earth dam. Other smart farm technologies include water conservation and management, bulking of horticultural crop seed and fodder production for livestock. The smart farms save water, offer better control of pests and diseases, and are free from flooding and drought. Because the production cycle is regular, the harvest can be better timed for local markets.

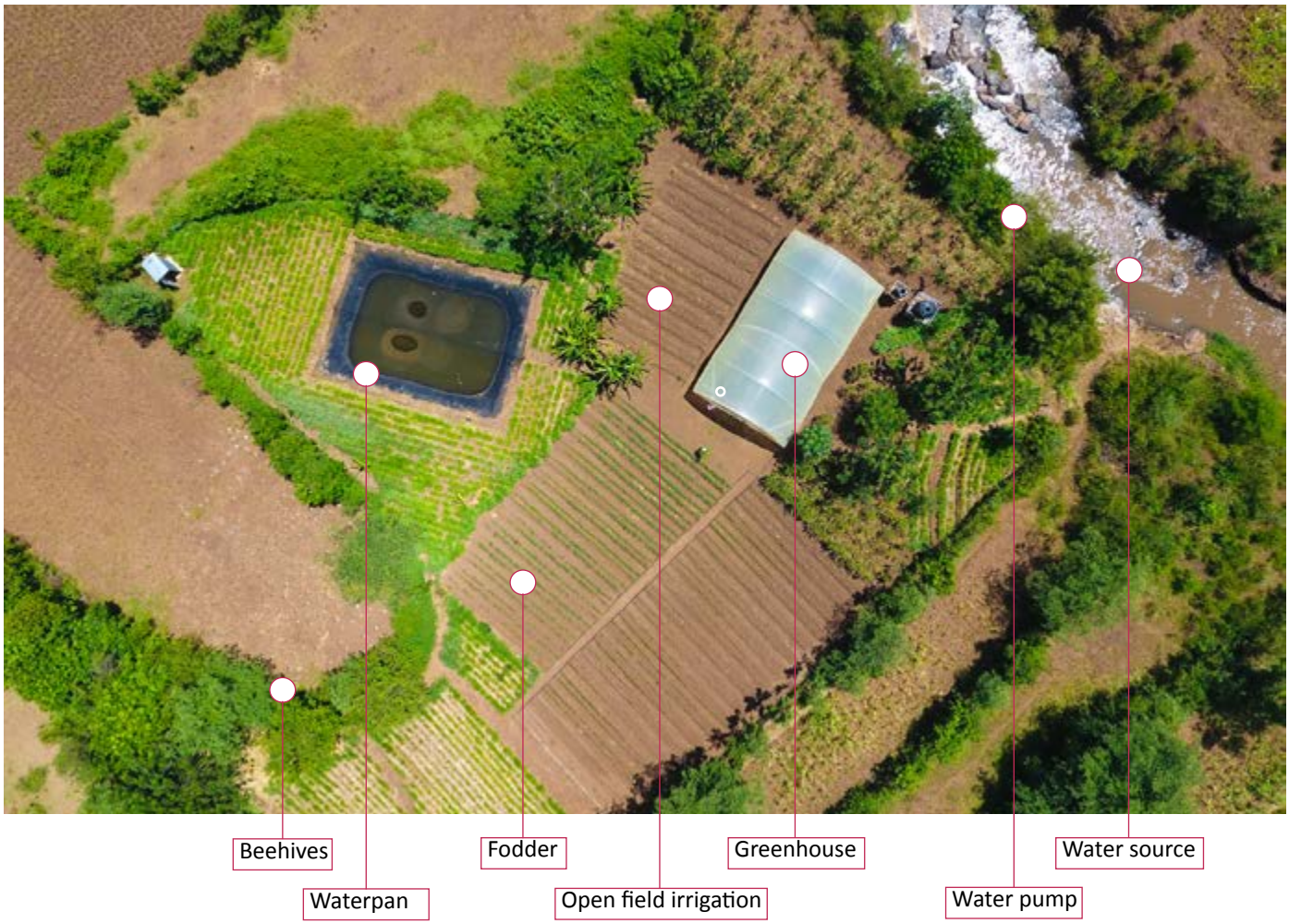
©S.Kilungu (CCAFS)

A farmer tends to his tomatoes at the Kamula smart farm in Nyando.

Smart farms can help farmers to produce reliable harvests and increase yields, despite the challenges and variability introduced by climate change. Although it has many advantages, however, greenhouse production requires a high level of skills and knowledge for successful operation. To address this, CCAFS and its partners train young people and women's groups to equip them with the skills and knowledge they need.

By the end of 2015, smart farms had been established in four villages in Nyando: Obinju, Kamula, Kapsorok and Onyuongo. 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.

The Kamula Village Youth Group, for example, is determined that their smart farm will provide a learning hub for the entire village. Ultimately they aim to see smart farms replicated across the village, boosting food production and significantly improving food and nutrition security. Kamula Youth Group's smart farm incorporates improved crop varieties, including tomatoes, cow pea, climbing beans and indigenous crotalaria. The group has created a small earth dam with a capacity of 300 000 L of water, and stock it with 1000 fingerlings per season; and they manage five colonized bee hives, as well as fodder crops such as Boma Rhodes and Napier grass.



An aerial view of Obinju smart farm, Nyando.

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 system to power operations like pumping water from the adjacent river into tanks and earth dams.

Given the interest that the group's work generates, school groups and delegations of village residents frequently visit the hub, sharing the experience generated with the wider community. And through the group, model farmers who can take the lead in transforming rural agriculture are emerging.

Smart farms, managed by young people and women's groups in a small number of villages, act as learning hubs for others in the community, and incubators for tomorrow's lead farmers. Smart farm technology has potential to boost food production, improve food security and increase incomes, but requires knowledge and skills for management.

Partners

KALRO; Kericho and Kisumu County Departments of Agriculture, Livestock and Fisheries; Magos Farm Enterprises; ThinQubator Aquaculture; Vi Agroforestry; World Vision

> *We now see the difference that the improved terraces are bringing to the landscape, through water flow control and retention.*

Story 6.

Conserving soil and water through agroforestry

Erosion is a major challenge in Lushoto affecting more than 60% of the landscape. Huge open gullies in the vast farming fields are visible from miles away. Land degradation is compounded by the high population density, and there is increasing pressure on the land. For most farmers, the only land available for cultivation is the hilly slopes. In villages like Mbuzii, for example, the light textured soils are low in organic matter and have low fertility for crop production.

Agroforestry is a promising intervention that can contribute both to climate change mitigation and soil and water conservation. Agroforestry has ecological and economic benefits too, providing farming families with the 'five Fs'—food, fuel, fodder, finance and improved soil fertility. By integrating trees on farms and rangelands, farmers can reduce their dependency on a single staple crop, diversify their livelihood options and reverse land degradation.

To address soil erosion and land degradation in Lushoto, CCAFS East Africa and several partners are working with farmers to improve land management. Over a two-year period from 2013–2015, farmers in Lushoto constructed about 100 km of terraces, in an area that includes more than 1000 farming households. CCAFS partners Lushoto District Council and SARI are providing training for households that are members of three village savings and credit cooperative societies (SACCOs), on techniques to help prevent erosion and enhance water retention. This involves the construction and integration of terraces with contoured grass strips to prevent massive loss of rich top soil, enhance water retention and provide fodder for livestock.

"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.

The initiative is also encouraging and training farmers to establish tree nurseries and plant trees on their farms. Increased tree cover controls soil erosion as it reduces the impact of raindrops on bare soils and prevents the wind removing soil particles. The ground cover and litter layer beneath the trees reduce the speed of water flowing over the land, and help control soil erosion. In 2013, TAFORI provided 17 000 tree seedlings to 100 households to initiate

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Effects of soil erosion in Lushoto.

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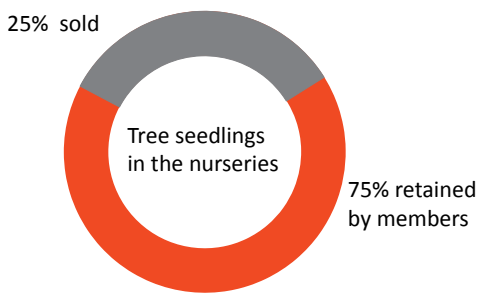
Agroforestry and soil conservation in Lushoto.

the tree planting campaign. The target is to achieve tree cover of at least 10%, in line with Lushoto District Council's policy.

Priority areas have been identified that require urgent tree cover. These include open areas, farmland and road sides. Selection of tree species is based on the needs of farmers in the village. Farmers' preferred tree species include *Pinus patula* and *Eucalyptus grandis* for wood; *Grevillea robusta* for farm boundaries and contours; *Casuarina cuninghamiana* for wind breaks and along roadsides; and avocadoes, plums and apples for fruit.

To meet the growing demand for tree seedlings, farmers have established tree nurseries within their villages. The three farmer SACCOs have established 20 nurseries, which are managed by affiliated farmer groups and have 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. Each member of the group is entitled to



2013 – 2015
farmers constructed

100 Km
terraces covering

1000
Farming households

a number of tree seedlings from the nursery, depending on their level of involvement in the group's activities. To ensure sustainability, 25% of the seedlings are sold and the proceeds used to sustain the nursery. Members take the other 75% of the seedlings for planting on their farms. By scaling up the interventions through local policy engagement processes, it is expected that at least 100 000 farmers will have 10% tree cover on-farm within the next four years.

Similar initiatives supporting farmers to plant trees on farms are seen across the other CSVs. These efforts are underpinned by local community-based organizations, local government, partners and researchers, in collaboration with CCAFS (see boxes).

Working through farmers' organizations has potential to scale up agroforestry interventions across wide areas, increasing tree cover on farms, and supporting soil conservation and water management at scale.

Tree nurseries managed by farmers' groups and CBOs provide income and seedlings for group members, while also supplying other farmers with seedlings.

Combating soil erosion in Nyando

In Nyando, Kenya, soil erosion is a key challenge every rainy season, with run-off forming deep gullies that affect about 40% of the landscape. To tackle this problem, farmers in Nyando have organized themselves into community-based organizations that include more than 10 000 households. The members, 60% of whom are women and young people below the age of 25, are working with CCAFS and other partners to increase on-farm tree cover. Through this partnership, more than 40 tree nurseries have been established, with capacity to produce 140 000 high quality seedlings per season.

The selection of the tree species is based on farmers' needs and technical advice from Vi Agroforestry extension staff. These species include *Grevillea robusta, Markhamia lutea, Casuarina* spp*., Carica papaya* and *Eucalyptus* spp. Sale of the seedlings will generate income for the group and the nursery will supply the local community with high quality tree seedlings for agroforestry and woodlots. The number of tree nurseries, as well as their capacity, have increased five-fold between 2011 and 2015. With a survival rate of 75%, the on-farm tree population has increased by at least 500 000 trees over the five-year period.

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Tree nursery in Lushoto managed by Mbukwa SACCO.

Intercropping fruit trees

In Hoima, Uganda, farmers are intercropping 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. By planting the trees across contours and on terraces, they aim to conserve the soil by reducing erosion. Farmers are advised to intercrop the mangoes with sweet potatoes in the first year and a half, to reap the benefits of intercropping while conserving soils and water. They also dig water retention ditches and trenches for soil and water conservation.

Julius Masanyu, an agroforestry scientist at Bulindi Zonal Agricultural Research and Development Institute, says the improved mangoes take a maximum of three years to produce their first yield, compared to local varieties that can take up to six years. Improved mangoes are also higher yielding, and have better tasting fruit, with better market prices, than the local mangoes. An improved mango tree produces up to 1500 fruits a year, compared to about 250 mangoes produced by the local varieties.

Partners

Lushoto: Lushoto District Council; SARI; TAFORI
Nyando: KALRO; Kericho and Kisumu County Departments of Agriculture, Livestock and Fisheries; Vi Agroforestry
Hoima: Bulindi ZARDI

> *"The regular seasonal weather forecasts that I receive through text message to my phone, through radio, and through village elders has been useful in selecting specific crop varieties, and determining the planting dates for crops like maize, beans and Irish potatoes because they are sensitive to water stress."*

Story 7.
Sharing better climate information

Farmers need reliable, relevant and local climate information to help them make sound farming decisions—what to plant, when to plant, when to harvest and so on. With increasing climate variability, reliable climate information services (CIS) become ever more important. Since the climate related risks are location specific, CIS providers need to find innovative ways to involve and reach out to local users.

Providers of CIS are approaching the process in a number of ways. Bringing in indigenous knowledge and sharing climate information in ways that improve access to farmers are key strands of these approaches.

In Lushoto, Tanzania, three partner organizations have spearheaded an initiative, with coordination from CCAFS, to provide such information. The initiative started by identifying and documenting existing indigenous knowledge on weather forecasting in Lushoto. They recorded indigenous indicators like changes in behaviour of domestic and wild animals, plant characteristics, wind movement, appearance of the moon, cloud formation and air temperature.

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On-farm rainfall recording in Nyando.

Working with the three village savings and credit cooperative societies (SACCOs) in Lushoto, they created three indigenous knowledge forecasting teams. Each team also represents an agro-ecological zone (humid, sub-humid, and lowlands), ensuring a local focus to the forecasts. Every three months the teams meet with experts from the Tanzania Meteorological Agency (TMA) to compare indigenous forecasts with seasonal outlook forecasts from TMA. Following the meetings, the integrated forecasts are packaged for dissemination to the wider community using a number of tools. Gradually this has resulted in the cross fertilization and gradual integration of indigenous knowledge and scientific weather forecasting for risk management.

A variety of tools are used to share forecasts, ranging from word-of-mouth to mobile phone applications. The Farm SMS tool uses a mobile phone short message service (SMS) to send climate forecast information to farmers. This enables subscribing farmers to receive timely alerts, advisories, and weather forecasts that are issued by TMA in the national language, Swahili. More traditional mechanisms such as word-of-mouth and printed flyers help broaden the reach of the forecasts. The service, which began in 2012, now reaches more than 1000 households in Lushoto, enabling them to make better farm management decisions.

"The regular seasonal weather forecasts that I receive through text message to my phone, through radio, and

700 farmers in Nyando receive 5-day forecast via **SMS**

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A farmer accesses climate information by mobile phone.

through village elders has been useful in selecting specific crop varieties, and determining the planting dates for crops like maize, beans and Irish potatoes because they are sensitive to water stress," says Mrs. Mwajuma Abdala Abdala of Bohelo Village.

Involving farmers in data collection

In Hoima, local farmers and Uganda's National Agricultural Research Organization (NARO) are also working to integrate indigenous knowledge with scientific forecasts. Here farmers actively participate in the collection of rainfall data. Rain gauges were installed on selected farms and farmers take daily readings, which they submit for expert analysis. This climate information is then shared with other farmers through the Kyabigambire and Bagonza-Kukora farmer groups. More than 720 households now use the climate information service, enhancing their ability to make the right decisions about planting dates and types of crops to plant.

The stories from Hoima and Nyando show some of the diverse ways in which farmers are engaging in other CSVs (see boxes). In another new initiative supported by USAID, CCAFS and partners are seeking to transform Rwanda's rural farming communities and national economy through improved climate risk management. By the end of the project in 2019, nearly a million farmers will have timely access to climate services. The project builds on many years of applied research on climate services for agriculture by CCAFS and our partners in Africa and beyond.

Integrating indigenous knowledge and farmer data collection with scientific forecasting keeps climate information systems relevant to farmers and locally applicable. A combination of new technology and traditional communication helps disseminate climate information, enabling farmers to make better farming decisions.

Interactive SMS forecasts

Within the Nyando basin, a partnership of five organizations provides about 700 farmers with local, village-level seasonal and short-term (5-day) weather forecasts through mobile phone SMS. The SMS is followed by face-to-face discussions between farmers, agriculture extension officers and researchers to interpret results and analyse the risks. Following this consultation, farmers are better equipped to make informed decisions about what crops and varieties to plant, as well as planting dates. At the end of each season, a review meeting is held to assess the yields resulting from farming decisions made on the basis of the climate information. The system reaches 1675 households through three community-based organizations.

Partners

Lushoto: Lushoto District Council; SUA; TMA
Hoima: NARO
Nyando: KMD; Kisumu and Kericho County Departments of Agriculture, Livestock and Fisheries; Magos Farm Enterprises; Maseno University
Rwanda: Rwanda Meteorology Agency; Rwanda Agriculture Board; USAID; CIAT; IRI

> *"I started growing sorghum in 2010 and this has transformed my family's life. I have been able to get income, build a house, have food to eat and pay school fees for my two children. This is possible because sorghum thrives well with or without rain and fetches more money than maize."*

Story 8.

Introducing intercrop innovations

In Wote, eastern Kenya, farmers cultivate maize, cowpeas and pigeon peas as their staple crops. Food insecurity resulting from frequent droughts is a major challenge and crop failure is common, partly because of inadequate rainfall and poor soils that are deficient in phosphorous and nitrogen. A household baseline survey conducted in early 2012 showed that only 2% of the surveyed households were 'food secure' all year long. A further 1% reported that they had enough food for their families for ten months of the year. More than 95% of the households surveyed stated that they had sufficient food to feed their family for only two months a year.

In order to increase farm resilience, as well as improve food security and incomes, a number of partners are working with the Makueni County Government and farmers through community-based organizations, to evaluate and promote cereal–legume intercrop technologies. Since 2012, with CCAFS' support, drought tolerant varieties of sorghum, cowpeas and green grams have been introduced to farmers in Wote.

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Peter Nguli, inspects a sorghum plant on his farm in Wote.

The intercrops provide multiple benefits to farmers. Legumes fix nitrogen in the soil, leading to better harvests; and the intercrops suppress weeds and reduce crop susceptibility to insects and diseases, reducing use of chemicals such as pesticides. The crops efficiently utilize limited soil moisture during the growing period, increasing productivity and reducing incidences of crop failure.

"In Wote, only one in four years is a reliable season. Farmers need to diversify their crops and embrace improved varieties of sorghum, cowpeas and green grams," says Rachel Kisilu, a researcher at KALRO in Katumani.

These improved varieties were developed by KALRO and ICRISAT for semi-arid areas. They are early maturing, disease resistant, pest tolerant and high yielding. Three improved sorghum varieties—KARI Mtama I, Seredo and Gadam—are intercropped with a legume crop (cowpea, pigeon pea or green grams) each time.

"Sorghum is a good and nutritious food just like maize, and it can thrive and yield under water stress conditions compared to the maize," says Muoti Mwangangi, Wote sub-county Deputy Agricultural Officer.

Between 2012 and 2015, farmers and researchers co-evaluated the intercrops, focusing on specific indicators that are important for farmers and their families: number of days to maturity, disease and pest incidence, ability to

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Justus Ngesu, an agricultural extension officer in Wote explains to farmers the benefits of intercropping.

withstand lodging (for sorghum), yield levels and palatability. In 2012, 210 farmers across five villages were involved in the evaluations. By 2015, more than 10 000 farmers had adopted resilient cereal–legume intercrops, with most farmers reporting an average yield of 4 tons of sorghum per ha, a four-fold increase since 2012.

"I started growing sorghum in 2010 and this has transformed my family's life. I have been able to get income, build a house, have food to eat and pay school fees for my two children. This is possible because sorghum thrives well with or without rain and fetches more money than maize. We sell sorghum at 26 shillings per kilogram, and maize if we are lucky to harvest at 15 shillings per kilogram," says Mary Mathuli, a farmer in Wote.

The evaluations are complemented by farmer field days that bring together farmers, extension officers and researchers to share their knowledge. Individual farmers are encouraged to try at least one sorghum–legume intercrop on their farms. During the field days, stakeholders noted that sorghum–legume intercrops were outstanding, with robust growth and uniform flowering compared to the maize–bean intercrop commonly grown in the area. Some improved sorghum varieties, such as Gadam, were also found to mature faster than other varieties. To add value to the new intercrop combinations, agricultural extension officers also teach farmers how to prepare sorghum dishes and livestock feed, and about post-harvest processing and storage. Finally, they incorporate training on composting and mulching sorghum–legume residues.

Cereal–legume intercrops offer farmers multiple benefits that contribute to increased farm resilience, greater food security and better incomes. Working through CBOs and sharing knowledge through farmer field days has encouraged farmers in the area to adopt the intercrop combinations and improved varieties. New crop varieties like sorghum are better adapted to frequent drought conditions and can fetch better prices in the market than traditional local varieties.

Partners

KALRO; Makueni County Department of Agriculture; Livestock and Fisheries; ICRISAT

Chapter Four

Linking local actions to policy

> *"CCAFS' on-farm experimentation with emissions levels is providing data that will serve us all."*

Story 9.

Linking local action with national, regional and global policies and processes

Maintaining agricultural growth while minimizing climate shocks is crucial to building resilient food production systems and meeting development goals in vulnerable countries. Climate-Smart Villages (CSVs) act as test grounds for combinations of climate-smart agricultural (CSA) technologies. They are 'lighthouses' that demonstrate how communities can test, co-develop and adopt integrated portfolios of options to increase their resilience to climate change.

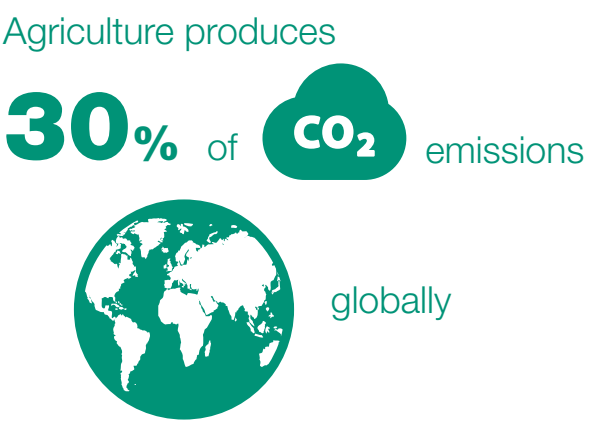
What have we learned?

The stories described here provide many beacons of light, that can inform local, national and international climate change policies and strategies. They highlight common features that recur throughout the different cases in different villages:

- Community-based organizations underpin successful interventions, providing an organizational structure and local financing. This helps farmers to invest in new technologies and practices, share and scale up interventions across wide areas, as seen in the agroforestry initiatives in Lushoto and Nyando.
- Farmers have capacities to test, select, adapt and adopt technologies when given the right skills, opportunities and knowledge. Farmers' participation in the selection of bean varieties in Hoima, Rakai and Lushoto ensured that the new climate-resilient varieties met their needs and were rapidly adopted.
- Inclusion of women, young people and men is fundamental to success. Working through community-based organizations that include young people, women and men helps develop new technologies that are appropriate for all farmers.
- Training and technical support are key to the adoption and sharing of improved technologies, and are a feature of all the stories. Training-of-trainers, farmer learning events and agricultural trade fairs help farmers share their knowledge with others, scaling out technologies.
- Research is essential for all climate-smart agricultural interventions, whether this is through the development of new crop varieties, improved breeds of livestock, new technologies or new social innovations to share and support them.
- New technologies bring opportunities for farmers to participate in new markets, such as the goat auction in Nyando and seed potato sales in Lushoto. Ensuring farmers can access and benefit from markets is essential to success of many interventions.

Taking lessons from local to global level

The need for evidence-based policy making for agricultural transformation in Africa cannot be overlooked, especially in the context of a changing climate. CCAFS is building on the evidence that is emerging from the CSVs to support policy at all levels.



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Rachel Kyte (right), former World Bank Group Vice President and Special Envoy for Climate Change in Nyando during a visit in 2013.

At a local level, CCAFS is working with the county governments in Nyando and Wote in Kenya to integrate CSA practices into the County Integrated Development Plans and Local Adaptation Plans of Action. This process will provide further lessons on how to engage policy makers to support scaling out and up of good practices from the field.

At national and regional levels, CCAFS is collaborating with governments, development partners, research institutions and the private sector to support the integration of CSA into policy and programmes. As a result, pilot CSA country framework plans have been developed for Botswana, Kenya, Namibia, Tanzania and Uganda through technical support from CCAFS, CIAT and ICRAF. The CSA plans in Kenya and Tanzania have been integrated into the countries' Intended Nationally Determined Contributions (INDCs) and were submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015.

The CSVs also provide learning grounds for policy makers and other stakeholders. For example, policy delegations from Ethiopia, Kenya, Rwanda, Tanzania and Uganda have had opportunities to interact with farmers and research institutions in the Nyando CSVs and engage personally with the farmers. They have been able to gather first-hand experience of farmers' efforts to improve their livelihoods, build resilience, and reduce emissions from agriculture.

The CCAFS CSVs have also hosted a series of high level delegations of development partners, as well as media crews from national, regional and international media, which has enabled the success stories from the villages to be widely shared. Key media and communication partners include local television and radio stations in the region, as well as SciDev, France24, BBC, German TV and the World Bank.

In November 2013, Rachel Kyte, the World Bank Group Vice President and Special Envoy for Climate Change, visited the Nyando CSVs in western Kenya. In her blog, published on the World Bank site, Rachel highlighted the importance of linking local action to global processes:

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Maren Radeny (second left) of CCAFS EA with policy makers during the launch of an online platform at COP20 in Lima.

"From a global perspective, however, identifying farming practices that increase production and resilience and reduce pollution or capture carbon is critical. If agriculture and land use change continue to produce up to 30% of global greenhouse gases, it will be close to impossible to slow or stop global warming. CCAFS' on-farm experimentation with emissions levels is providing data that will serve us all."

Next steps

During the 9th International Conference on Community-based Adaptation to Climate Change, delegates from 21 countries took the opportunity to learn from CCAFS' ongoing work in the CSVs of Wote. As Jean-Pascal Van Ypersele, Vice-Chair of the Intergovernmental Panel on Climate Change (IPCC) asked:

"The various adaptation initiatives being demonstrated here are quite encouraging since farmers are now able to feed their families, as well as earn income to address other household needs. However, the big question is: how can we upscale such initiatives?"

The CSVs offer a testing ground for diverse combinations of CSA technologies in different contexts. They provide the emerging evidence base that will support development of portfolios of interventions that can be adapted and adopted elsewhere.

The key, as highlighted by Jean-Pascal Van Ypersele, is to find the mechanisms to scale out these initiatives effectively to other farmers, investors and practitioners; and to scale up the results by incorporating the knowledge into national, regional and global policies and investment plans.

CCAFS scientists are working with policy makers to identify suitable policy and institutional frameworks to ensure the lessons from the CSVs contribute to achieving food security in a changing climate at country, regional and global levels, and to integrate climate change and agricultural policies.

Further reading

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List of partners

National and local partners

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