



# EVIDENCE OF IMPACT

Climate-smart agriculture in Africa



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*Agriculture across Africa must undergo a significant transformation to meet the multiple challenges of climate change, food insecurity, malnutrition, poverty and environmental degradation. The case studies described here are just some of the climate-smart agricultural practices that already exist in Africa. This publication aims to inspire farmers, researchers, business leaders, policy makers and NGOs to take up the mantle of climate-smart agriculture and accelerate the transformation of Africa's agriculture into a more sustainable and profitable sector.”*

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# Africa tackles the climate challenge

Across Africa, farmers are embracing “climate-smart” innovations that could help fuel a dramatic increase in food production despite an increasingly challenging agriculture environment. Equally important is the potential to achieve these gains without adding to the global build-up of greenhouse gases.

**A**frica’s climate is changing. Across the continent rainfall patterns are set to alter. In many areas droughts will become more frequent, more intense, and last longer. In others, new patterns of rainfall will cause flooding and soil erosion. Climate change is emerging as one of the major threats to development across the continent.

## Many innovative climate-smart agriculture practices take place in Africa with the capacity to increase productivity and build resilience

Africa’s agriculture must undergo a significant transformation to meet the simultaneous challenges of climate change, food insecurity, poverty and environmental degradation.

Climate-smart agriculture includes practices and technologies that sustainably increase productivity, support farmers’ adaptation to climate change, and reduce levels of greenhouse gases. It can also help governments to achieve national food security and poverty reduction goals. Climate-smart approaches can include many diverse components from farm-level techniques to international policy and finance mechanisms.

At the same time, Africa’s population continues to grow. Annual growth is estimated at 2.4% and the population is predicted to double from its current 0.9 billion people by 2050. According to the Food and Agriculture Organization of the United Nations (FAO), more than a quarter of sub-Saharan Africa’s people are currently undernourished. Crop production will need to increase by 260% by 2050 to feed the continent’s projected population growth.

Many innovative climate-smart agriculture practices take place in Africa with the capacity to increase productivity and build resilience. Yet they remain largely unknown at the continental, or even regional, levels. This book highlights just some of the array of climate-smart agriculture practices that exist across Africa’s diverse farming systems and climatic conditions. These strategies and practices can provide the impetus and the models for transforming Africa’s agriculture. ■





People selling seeds and beans in a market in the town of Wote, Kenya.

## Strategies for success

The case studies highlight many impacts and challenges of different approaches to climate-smart agriculture. Eight key lessons for successful climate-smart agriculture emerge from the case studies.

### 1. Align climate-smart agriculture practices and national policy

Climate-smart agriculture practices must be aligned with and supported by national policy and a legal and regulatory framework. Policies and legislation affecting seeds, inputs, finance, credit, insurance, land tenure and a range of other areas all have scope to help or hinder the uptake of climate-smart agriculture.

### 2. Enhance women's capacity to adapt

Women play a fundamental role in African agriculture. Despite this, agricultural extension and capacity development interventions predominantly focus on working with men. For widespread adoption of climate-smart agriculture, interventions must specifically aim to enhance women's capacity to adapt.

### 3. Build effective partnerships with the private sector and universities

Critical partners such as universities and the private sector should be central to the development of African agriculture. But they are largely missing from these case studies. African universities could become centres of innovation and technology transfer for climate-smart agriculture, while the involve-

ment of the private sector could generate investments for research and development.

### 4. Involve communities and encourage farmers to innovate

Multi-stakeholder participation and active community involvement in project design and development are critical for successful climate-smart agriculture. Innovation by farmers is also essential, but is lacking from the experiences described in the case studies. Practitioners, scientists and policymakers must encourage farmers to become actively engaged in innovation for climate-smart agriculture.

### 5. Address multiple challenges and scales simultaneously

Food insecurity, persistent poverty, climate change and variability, and environmental degradation are closely interlinked. Each can be both a cause and an effect, and interactions occur between them at local, national, regional and continental scales. The case studies highlight the need to work at landscape and transboundary levels and on multiple challenges at the same time.

**Food insecurity, persistent poverty, climate change and variability, and environmental degradation are closely interlinked**





© Mike Goldwater/Alamy

People from Ukamo village in Ethiopia take part in a tree planting project.

## **6. Foster political goodwill**

Projects and programmes with government support have significant impacts and are replicated across different countries and regions. Political goodwill can make the difference between success and failure, especially for scaling up to landscape or transboundary levels.

## **7. Capacity development is needed at all levels**

The widespread uptake of climate-smart agriculture practices must be supported by capacity development at all levels. Farmers' limited knowledge about promising initia-

tives, combined with inconsistent and conflicting advice provided by extension agents, leads to poor uptake of climate-smart agriculture practices. At a policy level, capacity also needs to be built among legal departments and government ministries.

## **8. National budgetary support is important**

Most financing of CSA initiatives is based on donor funding. Given the importance of CSA in national and local economies, African governments need to provide budgetary support for CSA by allocating their own resources to promising initiatives.



© Timothy Mwaure/CCA/AFS

Learning route participants interact with local communities in Isiolo, Kenya.



# Building resilience through value chains

**F**armers need markets. Helping farmers gain access to fair markets helps them increase their incomes, improve their food security, and create sustainable livelihoods. Adopting a value chain approach to tackling climate variability and risk means helping farmers at all stages of the value chain, from production, business organisation and market access, to financial services. CSA practices that adopt a value chain approach typically work on the supply side to improve productivity and farmer organisation, and on the demand side to create fair markets for farmers' produce and appropriate financial services.

Well-functioning value chains allow farmers to earn more from their produce. Better organisation empowers farmers to negotiate collectively and gain better prices for their produce. Higher incomes allow farmers to save money for household use, education and health care; they may invest in greater productivity, diversify into other business areas, and keep funds for a buffer against climate shocks. All these options have potential to increase farmers' ability to manage risks and adapt to climate variability.

Farmers often struggle to access financial services, especially credit. Increasing farmers' access to financial services is therefore a key component of CSA practices that focus on value chains. Access

to credit gives farmers more options to purchase inputs – seed and chemicals – and increase their productivity. It enables them to diversify into other business opportunities beyond farming, or into other areas of the value chain for their crops. And access to appropriate banking services offers farmers better ways to save after the sale of their crops.

Stronger, more competitive markets also have potential to support a larger number of producers. So, a key component of these CSA interventions is to build the whole sector and work with governments to catalyse national markets.

Agricultural interventions that aim to improve farmers' access to markets may not have climate adaptation as their primary aim. Nonetheless, getting farmers integrated into robust and fair markets can help them become more resilient to climate change. ■

**CSA practices that adopt a value chain approach typically work on the supply side to improve productivity and farmer organisation, and on the demand side to create fair markets for farmers' produce and appropriate financial services**

## STORY 1

## Building better markets to increase farmers' resilience

Dairy farmers in Eastern Africa are growing their income, thanks to a program that helps develop skills, strengthens links to markets, and improves access to financial services.

**F**or small farmers in East Africa, coaxing a living out of less than 2 ha of land is a tricky business. The majority of the population is engaged in subsistence agriculture, growing staple crops, cash crops and keeping livestock. Yet farmers often lack the business skills, knowledge of production techniques and access to inputs, services and markets that they need to make a thriving business.

**Productivity and incomes have increased; monthly milk intake at the dairy enterprises increased from 529,000 litres to 8 million litres between 2008 and 2013. Milk aggregation at the dairy enterprises has empowered farmers to negotiate for better prices**



12%

of greenhouse gas emissions attributed to human activity are contributed by livestock.

The East Africa Dairy Development (EADD) programme is working to transform the lives of dairy farming families with improved market access to a wealth-creating, robust dairy value chain. Launched in 2008 in Kenya, Rwanda and Uganda, it aimed to assist 179,000 smallholder farming families to participate profitably in the dairy industry.

The project works at all levels of the value chain. During its first 5-year phase it worked with farmer community groups to organize them into business associations that manage dairy chilling

plants. This allows farmers to access formal dairy markets and improve the quality of milk sold on traditional markets. The associations act as business hubs, providing farmers with access to services like agricultural inputs, animal health services, finance, credit and health care.

The results have been impressive. During Phase I, 82 sustainable farmer-owned dairy enterprises were established. In order to improve market access, the programme improved market links between farmer enterprises and leading processors. EADD-supported Dairy Farmer business Associations have earned US\$131 million in revenue since the programme started. Productivity and incomes have increased so that monthly milk intake at the dairy enterprises has increased from 529,000 litres to 8 million litres between 2008 and 2013. Milk aggregation at the dairy enterprises has empowered farmers to negotiate for better prices: farmers now earn an average of US\$0.3 per litre of milk, 50% more than they earned in 2008.

The programme has also helped expand access to finance. A partnership with 5 leading commercial banks now provides access to credit and commercial loans to farmers at competitive rates. In Kenya farmer enterprises themselves have established 13 financial services associations.



Together, access to these financial services has allowed farmers to save US\$10 million.

At a bigger scale, the programme has helped build a more competitive dairy sector. EADD-supported dairies supply a significant amount of milk for processing by dairy companies, especially in Kenya. Processors, recognizing a more competitive market, have entered into strategic alliances with farmer enterprises that go far beyond milk supply contracts, to cover technical assistance, farmer training, access to inputs and transport.

And the project has catalysed national markets. In Uganda the project spearheaded the launch of a National Dairy Strategy that aims to double

milk production by 2020. Phase II focuses of Kenya, Uganda and furthers expands the project to Tanzania targeting to 136,000 farming families, with the aim of doubling their incomes by 2018.

The project also supports the development of agricultural practices that mitigate climate change. Better livestock feeding and manure management have potential to reduce greenhouse gas emissions and increase farmers' incomes. The project is therefore experimenting with techniques like fodder banks, improved pasture species, feed legumes and the use of crop by-products for livestock feed to achieve these twin climate change mitigation and improved livelihood goals. ■



Milk delivered to the chilling plants established through the project can be sold into formal dairy markets and offers better quality milk for traditional markets.



© Panos

A beekeeping project in the village of Utosi, Tanzania.



# Reaping multiple benefits

**A**cross Africa, farmers face a multitude of challenges around climate change and climate variability, land degradation, poverty and food insecurity. With the effects of climate change already being felt, many projects and millions of farmers are seeking solutions.

Climate-smart agriculture has potential to help farmers adapt to, and mitigate, climate change. Many agricultural practices contribute to both adaptation and mitigation goals simultaneously. Where farmers plant trees to control land degradation, they also contribute to climate change mitigation by removing CO<sub>2</sub> from the atmosphere. And conversely, projects that have a primary objective of reducing CO<sub>2</sub> emissions – for example by halting deforestation and forest degradation – also have great potential to provide many other benefits to local communities. Forests produce wood and non-wood products, fruits, fibre, medicines and honey, all of which can be important for people living nearby. Practices that promote sustainable management of forests for their role in climate stabilisation can simultaneously provide multiple benefits for local communities.

Similarly, practices that control land degradation and reduce soil erosion have many benefits for farmers beyond adaptation to, or mitigation of climate change. Where reforestation results in

greater productivity in nearby crops because of changes to the microclimate, farmers are reaping just some of the multiple benefits of climate-smart agricultural practices.

And these other benefits from climate-smart agricultural interventions don't stop at tangible products and environmental services. In some cases, helping local communities understand what resources are available also empowers them to exert control over their resources. Mapping resources such as forests, water and land, as part of a climate-smart intervention helps local communities exert their right to manage their resources.

**Practices that promote sustainable management of forests for their role in climate stabilisation can simultaneously provide multiple benefits for local communities**

Farmers are more likely to adopt an agricultural practice if they can see the immediate benefits of doing so. In many cases, these other benefits of climate-smart agricultural practices may be far more important for farmers and communities in Africa than climate adaptation or mitigation. They are more immediate, more tangible, and easier to communicate. Climate-smart agricultural practices build on these multiple benefits. ■

## STORY 2

## Strengthening resilience, greening the desert

An African alliance to combat desertification is improving food security, through tree planting and farmer-managed natural regeneration.

**A**cross Africa, the threats of desertification and land degradation are always present, especially in the Sahel and the southern edge of the Sahara. Poverty and hunger are a constant prospect. In response, farmers and communities in dryland areas are developing ways to sustainably manage forests, rangelands and other natural resources.

A range of projects is supporting farmers in their efforts to prevent desertification and improve their lands. At their heart, these projects aim to improve food security of communities across Africa, by helping them improve food and timber production. The projects also contribute to farmers' resilience to climate change. And replanting and regeneration of trees also has significant potential for CO<sub>2</sub> sequestration and climate change mitigation. There are clearly multiple benefits from these practices.

**The trees contribute to climate change adaption by reducing wind speed, and decreasing damage to crops from windblown sand. They contribute to climate change mitigation by removing CO<sub>2</sub> from the atmosphere**

In Niger, farmer-managed natural regeneration has been carried out for the last 30 years. Local

farmers have greened some 5 million ha, simply by protecting and managing the natural regeneration of trees and bushes on their land, producing the largest environmental transformation in the Sahel, and possibly anywhere in Africa.

Farmers have grown 200 million new trees on cultivated fields; where they had only 2 or 3 trees per hectare 20 years ago, now farmers have 40, 60 or 100 or more trees. The natural regeneration and the improvements that it brings in soil fertility, fodder, food and fuelwood, have been valued at US\$56/ha/yr, or a total annual value of US\$280 million. These fields contribute an additional 500,000 t of cereals, providing food for about 2.5 million people. The trees contribute to climate change adaption by reducing wind speed, and decreasing damage to crops from windblown sand. They contribute to climate change mitigation by removing CO<sub>2</sub> from the atmosphere. Now farmers only need to plant once, a huge improvement on the 3 or 4 times needed 20 years ago. It's a huge range of benefits to stem from the simple act of protecting naturally regenerating trees.

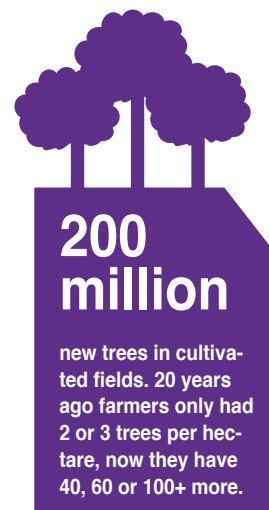
In an even more ambitious project, in 2008 the Great Green Wall of the Sahara and the Sahel Initiative began, with the aim of planting a wall



of trees across Africa at the southern edge of the Sahara, to halt desertification. Again, the overall goal is to improve food security in the Sahel and the Sahara, by supporting local communities' efforts to manage forests and rangelands sustainably. From a wall of trees, this initiative has flourished into a mosaic of interventions across the region. Farmers have managed natural regeneration to rehabilitate 5 million ha of land across southern Niger; in Senegal 27,000 ha of degraded land were restored by planting 11 million trees and the area is now being converted to a community-based reserve for ecotourism. And in Burkina Faso, Niger and Senegal a mechanized technology, inspired by traditional practices and known as the Vallerani system, has been used to restore 50,000 ha of agro-

forestry system, boosting the production of crops, gums, resins and fodder for livestock.

In another project, Regreening the Sahel is also using farmer-managed natural regeneration to integrate trees, crops and livestock into a more drought-resilient, productive and sustainable agricultural system. While the project clearly helps farmers to adapt to climate change, it also brings many other immediate benefits such as improved household food security, higher crop yields and more diverse household production. The multiple benefits of these projects are clear, and help support objectives of climate change adaptation, mitigation as well as improved food security and reduced poverty. ■



A farmer waters papaya trees in Mali.

© Amadou Keita/IFAD

## STORY 3

**Twin gains from reforestation**

© Tessema Getahun/World Vision Australia

**Forest restoration helps farmers to increase their production of fruits and many other forest products.**

**E**nvironmental shocks such as droughts and flooding can cause problems for any community. But communities whose livelihoods depend on scarce resources and have high levels of poverty are particularly vulnerable. In Ethiopia, where 90% of the population depends on agriculture for their livelihoods, recurrent droughts and floods create poverty traps for many households.

Ethiopia's diversity of landscapes – from temperate mountainous plateaus to hot, humid lowlands – means climate change will have varying impacts across the country. In the Humbo region, increased rainfall and cyclone activity mean the highlands face even higher soil erosion, flooding and mudslides, while the lowlands can expect prolonged droughts.

The Humbo Community-based Natural Regeneration Project was launched in 2007 as a Clean Development Mechanism under the Kyoto Protocol. It is also Ethiopia's first Land Use, Land Use Change and Forestry (LULUCF) carbon trading initiative. Recognising the link between forests and livelihoods, the project has twin goals – to mitigate climate change and alleviate poverty through reforestation.

The project is restoring 2,700 ha of degraded native forest with a diversity of indigenous species. These areas of degraded forest were continually exploited for wood, charcoal and fodder, but are now protected and on the path to sustainable management. Rather than replanting trees with

costly nursery stock, farmers manage natural regeneration and more than 90% of the project area has been reforested from the stumps of trees that were previously cut. New tree nurseries have also been established to raise more than 450,000 seedlings each year to restore forests where no living tree stumps remain.

The outcomes of the project are twofold. Over the 30-year crediting period, more than 870,000 t CO<sub>2</sub> will be removed from the atmosphere. Eventually, credits for this carbon may provide a supplementary community-based income stream, but it is unlikely ever to be the primary benefit farmers receive from the project.

In the meantime, forest restoration has enabled farmers to increase their production of wood and tree products, including honey, medicine, fibre, fruit and wildlife that contribute to household economies. Improved land management has stimulated grass growth, providing fodder that can be cut and sold to provide additional income.

Reforestation is also providing other benefits by reducing land degradation and soil erosion, and improving water infiltration. With the likelihood that climate change will cause increased rainfall in Ethiopia's highlands, improved soil stability is an important benefit. Crops surrounding reforested areas are also benefiting from changes to the microclimate – resulting from a combination of reduced wind speed, lower temperatures, higher humidity and greater infiltration of water. ■

## STORY 4

# Multiple benefits of conservation agriculture

**M**alawi faces complex social, economic and environmental problems. At the heart of the crisis is the nation's high and growing population. Landholdings are shrinking, marginal lands are being cultivated, and fallowing has been replaced by continuous cropping under destructive and labour-intensive practices.

Family labour, so vital to smallholder households in Malawi, is decreasing as family members find off-farm employment. Female-headed households are particularly vulnerable, as they are burdened by the added tasks of collecting fuelwood and water, cooking, child rearing and other domestic chores. In their struggle to survive, farmers are unable to make the critical trade-off between sustained resource use and their short-term needs.

Any agricultural intervention here must provide multiple benefits to farmers: they need low input, low labour techniques that increase yields and protect soils. It's quite a challenge. For the past 10 years, Total LandCare and the International Maize and Wheat Improvement Center (CIMMYT) have been developing conservation agriculture practices to meet these needs. Conservation agriculture aims to improve the productivity and profitability of smallholder farms while also enhancing their resilience to climate change.

The conservation agriculture system is based on three core principles. The first, minimum soil dis-

turbance, is a non-negotiable basic. This means no ploughing, ridging, tilling or heavy mechanical weeding. Two other principles can be used afterwards: maintaining good soil cover means keeping plant residues and weed biomass on the ground surface without burning; and rotations, intercropping and relay cropping can incorporate legumes into the system.

Years of trials on farmers' fields have shown that conservation agriculture produces higher and more stable yields compared to the traditional conventional ridge tillage system. From the second cropping season onwards, maize yields for example are 11–70% higher with conservation agriculture, especially in years of low rainfall.

Conservation agriculture brings many other benefits. The absence of tillage and weeding, and the maintenance of good soil cover, mean that rainfall is captured better. Soil structure improves and organic matter increases, as well as populations of beneficial termites and earthworms. Intercropping with legumes improves soil health and reduces pests and diseases; it can also produce an extra crop, offering farming families a more nutritious diet or extra income. There are significant benefits from savings in labour too, allowing farmers time to expand production, or diversify into other ventures. ■



© Jennifer O'Gorman/Concern Worldwide

**Doris Malinga showing her ground nut crop to show how conservation agriculture has benefitted her. Dwerog Field, Kabudula, Lilongwe District, Malawi.**



# More resilient, more productive farms

**A**frica is a drought-prone continent, making farming risky for millions of smallholder farmers who rely on rainfall to water their crops. Drought leads to crop failure and climate change will only worsen the problem. Other effects of climate change will be felt in Africa too – the distribution of rainfall through the year is changing, and temperatures are rising. While rainfall in Eastern Africa may increase slightly, other parts will receive less rain overall. Drought conditions are likely to be more frequent, more intense and longer lasting. By 2080, the area of arid and semi-arid land is likely to have increased by 5–8%.

To meet these challenges, farmers need crop varieties and agricultural practices that continue to produce – or even produce more – under different weather conditions. Concerted efforts are underway to breed new varieties of crops that are more resilient to the changing climate, and especially to drought. Many farmers across Africa are already using improved drought tolerant and insect resistant varieties of crops that help them improve productivity.

It isn't just about breeding new varieties of crops. Projects that produce drought tolerant crops are working together with government officials to speed up releases of the new varieties and help

develop competitive seed markets to provide widespread access to high quality seed at affordable prices.

**Drought conditions are likely to be more frequent, more intense and longer lasting**

Climate-smart farming practices can help farmers be more resilient to drought and other changing weather patterns. Changing the way farmers manage their livestock can help them produce more and better quality animals; other interventions reduce livestock keepers' dependence on degraded rangelands, or help them use water better.

A multitude of climate-smart agricultural practices and interventions are being developed in Africa to meet the challenge of a changing climate and especially the prospect of more droughts. Their success will provide the foundations for the climate-smart agriculture of the future. ■



© Neil Palmer/CIAT

Bean breeding at CIAT in Kawanda, Uganda.

## STORY 5

## Many approaches build climate resilience in North Africa

Countries boost productivity in the face of drought through more resilient crops and livestock, and more diversified production systems.

**T**he highland areas of North Africa face some key challenges, all of which are likely to be exacerbated by climate change. Recurrent drought and water scarcity are worsened by decades of inefficient water use; land for agriculture is limited and desertification threatens it further.

The Sustainable Agricultural Development of Highlands Project operates across North Africa in Algeria, Libya, Mauritania, Morocco and Tunisia. The project seeks to reduce poverty and improve food security and nutrition by developing and disseminating new technologies, and by building community capacity. It is working at multiple levels, in breeding for improved crop and livestock productivity; in improved and diversified production systems; and in markets and national policy. Common to all these approaches however, is the move towards climate-smart agriculture by increasing the resilience of agricultural systems to drought and increasing productivity even under drought-prone conditions.

The project has made a number of advances. New planting materials have been made available to farmers. In 2013 the project produced more than 8,000 t of certified wheat and barley seeds across the region, and facilitated farmers' access to over 750,000 fruit tree seedlings. In Egypt, high-yielding, rust-resistant wheat varieties were distri-

buted to 2,000 farmers across 22 governorates; three barley and three faba bean varieties were also released. Improved wheat varieties that can withstand salinity and increase productivity were distributed to 12 African countries.

**Recurrent drought and water scarcity are worsened by decades of inefficient water use; land for agriculture is limited and desertification threatens it further**

Increasing livestock productivity is equally important in North Africa. Remote sensing of rangelands by the project shows that in the last 20 years the area of crops has expanded by up to 20%, encroaching on rangelands. In remaining degraded rangelands, the quality of grazing has fallen as livestock overgraze palatable plants. The project is therefore developing low-cost livestock feeds, such as species of acacia and cacti. Agroforestry systems that intercrop shrubs and cacti with barley, oats, feed legumes and native vegetation have significantly reduced the cost of feeding livestock and reduced farmers' dependence on rangelands. The programme is also helping farmers to improve their livestock management, with better quality stock improving the productivity of flocks.



New farming techniques are being introduced too. Farmers have adopted water harvesting and supplemental irrigation techniques introduced by the project. This makes best use of rain, surface water and groundwater, which is increasingly important as water becomes scarcer and less reliable. In Morocco, the project introduced farmers to a no-till technique to conserve water, which boosted wheat yields by at least 25%, and up to 300%, compared to previous methods.

Beyond farmers' fields, a diversity of approaches to increasing resilience is underway. In some countries, governments are adopting community development plans for low rainfall areas. Improvements to value chains for honey, olive

**Agroforestry systems that intercrop shrubs and cacti with barley, oats, feed legumes and native vegetation have significantly reduced the cost of feeding livestock and reduced farmers' dependence on rangelands**

oil, cheese and goat meat are improving incomes in rural areas. And at national level, the Government of Tunisia has developed a national strategy to conserve and identify markets for medicinal, herbal and aromatic plants.

At a multitude of levels, and through interventions of many different types, this programme seeks to help farmers move towards more resilient, drought-resistant and climate-smart agricultural practices. ■



A man of the Tuareg tribe in Tamanrasset, Algeria, harvesting beans.

© Alamy

## STORY 6

## African farmers face reduced or unpredictable rainfall

Drought tolerant maize varieties are boosting yields for 2 million farmers.

**A**cross sub-Saharan Africa maize is an essential staple food crop. More than 300 million people depend on it for their food security, and the majority of them rely on rainfall to water their crops. But maize is also severely affected by drought. The results can be catastrophic; in 2011 more than 12.5 million people suffered from the effects of drought and the resulting famines in the Horn of Africa.

With climate change, droughts are expected to become both more frequent and more severe. In response, the Drought Tolerant Maize for Africa (DTMA) project was launched in 2006 in 13 countries of Eastern, West and Southern Africa. Its aim is to develop and disseminate drought tolerant, high yielding, locally adapted varieties of maize. In specific terms, the project seeks to increase yields by at least 1 t/ha under moderate drought, with an increase of 20–30% over farmers' current yields. It aims to benefit 30–40 million people. It's a huge task.

Across the 13 countries, farmers are starting to see results. More than 34 new, drought tolerant maize varieties have been developed and distributed to 2 million farmers whose yields have increased by 10–34%. Not only do the new varieties provide a decent harvest under reduced rainfall conditions, they also match or exceed yields of other popular varieties under good rains.

Farmers have adopted the new varieties and the cumulative economic benefits to farmers and consumers amount to about US\$900 million. In the 2011/2012 season, 29,000 t of seed were produced – enough to sow 1.1 million ha and benefit 20 million people.

**Not only do the new varieties provide a decent harvest under reduced rainfall conditions, they also match or exceed yields of other popular varieties under good rains**

The project goes beyond traditional crop breeding to increase its impact. Working with government officials has helped to speed up releases of new varieties and create competitive seed markets, giving farmers more widespread access to high quality seed at affordable prices. The project has run capacity-enhancement events for maize breeders, technicians, seed producers, extension workers, non-governmental organisations (NGOs) and farmer groups. Working through partnerships with national maize programmes and private sector seed companies, the project shares its international resources and knowledge with local partners. This allows them to test varieties under local conditions and draw on the expertise of farmers and extension workers. ■



**34**

new, drought tolerant maize varieties have been developed, yields have increased by 10–34%.



An attendant displays KDV1 drought-tolerant seed at the Dryland Seed Company shop in Machakos, Kenya.





© Corbis

A finance self help group (SHG) called the Neema group based near the Kitengela Centre, 40 km from Nairobi, Kenya.

# Helping women feed a continent

**W**omen play a central role in African agriculture. Almost 8 out of 10 farmers that produce staple food in Africa are women and the high numbers of men migrating from villages to cities means that rural women are playing an even bigger role in farming.

Despite their fundamental role in feeding the continent, women farmers in Africa face many challenges. Women have significantly less access to credit, markets and market information, agro-advisory services, agricultural technology and transport. They are disadvantaged in many other ways too. They often control less land than men; and the land they do control is frequently of poorer quality. Women's land tenure is often insecure. They are less likely than men to use modern inputs such as improved seeds, fertilizers, pest control measures and tools.

Women's abilities to adapt their farming practices to cope with the effects of climate change are strongly affected by the technological interventions and training that they can access. Some organisations that provide microfinance lending, health and education services explicitly and consistently target women. By contrast, many government agencies and NGOs that focus on agriculture, livestock, forestry and the manage-

ment of natural resources, primarily, and often exclusively, target men and their needs.

And yet, women's incomes are known to be an important determinant of children's development. Women tend to invest their income in their families, so that for every dollar a woman earns, 80 cents goes towards health care, nutrition and housing for her children. Women have a key role in both food security and land management, and both of these will be affected by climate change. There is clearly a need to make sure that women – who produce most of the staple foods of Africa – can continue to feed the continent in a changing climate. As the effects of climate change are felt, and new climate-smart agricultural interventions are developed and disseminated, there is an opportunity to direct these efforts to the needs of the continent's women.

Women may need different strategies to men to enable them to adapt to climate change. Climate-smart agriculture should inform women, empower them and mobilize them to express their needs, and engage them in developing solutions to the problems of climate change. Without the active participation of women, the continent will go hungry. ■

## STORY 7

**Better yields, higher prices**

Helping women – and men – increase their incomes from farming.

**A**griculture is the mainstay of the economy in Malawi and yet smallholder farmers face many obstacles in both the production and marketing sides of their business. Depleted soils, poor quality seed, lack of fertilizers, drought, pests and diseases combine to depress yields. After harvest, farmers have limited information about prices, and few options to transport their crops to the market. This leaves them vulnerable to traders who pay prices well below those of commercial buyers.

The Anchor Farm Project was set up in 2008 to help smallholder farmers in the Mchinji district of Malawi increase their incomes by both increasing their yields and providing access to formal markets and better prices. It's a commercial farm, working in partnership with thousands of neighbouring smallholder farmers, and providing them with access to high quality farm inputs for maize and soybean production, as well as training and market access.

The project in Malawi initially worked with 21,000 neighbouring farmers, 35% of whom are women. Since 2012 this has been scaled up to reach more than 28,000 farmers and the target is to support 100,000 smallholders by the 2015–2016 growing season.

Anchor Farm works at several levels to support its partner farmers. The project provides training in climate-smart agricultural practices, which

focus on improving food security with farming techniques that are resilient to climate change. About 30,000 farmers, as well as several hundred farmer associations and agricultural extension workers, have been trained in integrated soil fertility management (ISFM) technologies. These include applying manure, composting, crop rotation and conservation farming using nitrogen fixing trees and shrubs in agroforestry systems. Farmers have planted 2 million trees to provide timber, fruits and fuelwood for home use and to provide additional income. About 18,000 farmers, half of whom are women, have adopted the ISFM technologies.

**About 30,000 farmers, as well as several hundred farmer associations and agricultural extension workers, have been trained in integrated soil fertility management (ISFM) technologies**

As well as better farming techniques, partner farmers also have access to high quality inputs for maize and soybean production. Smallholder farmers in the Anchor Farm Project have seen yields increase by an average of 150%. More than 16,000 t of grain was sold through contracts facilitated by the project. And because Anchor Farm negotiates these sales contracts with large commercial buyers, the price that smallholder farmers receive for soybean has increased by 167%. As



**567%**

2011 increase in smallholder profitability compared to the year before the project began.



a result of both productivity and market access improvements, smallholder profitability was 567% higher in 2011 than in the year before the project began.

The project also works with banks in Malawi to provide smallholder farmers with loans to finance their input purchases and bank accounts to help them save money after the sale of their crops. Approximately 3,200 farmers obtained farm input loans to help them increase their area under soybean.

Women in particular have benefited from growing soybean, because it is a fast growing legume that fetches good market prices compared to other legumes such as common beans, peas and pigeon peas. Women also use soybeans to feed their families, which in itself has increased demand for the crop. The income farmers earn from selling soybean is used to pay for school fees and medical expenses, farm inputs and home improvements. Some have invested in non-farm businesses such as grocery stores, and project communities are undergoing an economic revolution. ■



**Female Soya Farmer at the Anchor Farm Project.** A female farmer cleans soya in Malawi at the Clinton Development Initiative (CDI) Anchor Farm Project. The Anchor Farm Project operates five commercial farms in the Kasungu and Mchinji districts of Malawi and partners with 21,000 neighboring smallholder farmers, providing them with access to quality inputs for maize and soy production as well as training and market access.

# Managing risk through better services

**F**arming is a risky occupation wherever you are in the world. Farmers must cope with the vagaries of the weather – drought, floods, cold, heat, humidity, hail, wind. In Africa the risks are higher still, due to recurrent droughts, low soil fertility and poor access to markets for inputs and outputs.

It is not surprising then that smallholder farmers are often deeply averse to taking risks. They cannot afford to invest scarce resources – high quality seed, fertilizer, equipment and other inputs – if there is a danger that an unpredictable weather event will destroy their crop. The danger is that they are left with no return on their investment, or worse, with debts that they cannot pay back. It's often safer not to invest: low inputs in, low productivity out. It's a cycle that traps smallholder farmers and their families in poverty and

**To break this vicious cycle of low input, low output poverty, farmers need knowledge, tools, techniques and institutions that lower their risk of investing**

subsistence. Low investment in turn leaves farmers' crops more prone to drought. According to the United Nations Office for Disaster Risk Reduction, rural poverty is both a cause and a consequence of drought risk. And climate change

will only make the weather less reliable, and the risks greater.

To break this vicious cycle of low input, low output poverty, farmers need knowledge, tools, techniques and institutions that lower their risk of investing. Without such risk, farmers will be more willing to invest in farm inputs and new climate-smart agricultural practices.

Research shows that poor access to innovation, knowledge, inputs and markets for produce are the most important constraints on investment in agriculture. Even where national governments have access to relevant knowledge and tools, they are not necessarily conveyed to the farmers who need them most.

Providing farmers with better services can help to break the cycle of low input, low output subsistence agriculture. These might include policy-level interventions, underpinning a large-scale technological service such as irrigation; information services to share technological solutions through appropriate channels; access to finance and credit; or safety-net services, such as insurance, that can enable farmers to invest without fear of incurring future debt. ■



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Mobile phones offer farmers access to new services and information, enabling them to manage risk better.



## STORY 8

## Insuring against the weather

Innovative insurance schemes protect farmers against catastrophic losses, and help them plan for the future.

**W**hen drought strikes, national governments and farmers alike need to be able to draw on extra resources to keep food available. A variety of insurance schemes in Africa promise effective financial support when weather calamities happen.

**By protecting farmers in the event of extreme weather, crop insurance also reduces the risk of debts incurred by farmers taking credit at the start of the season**

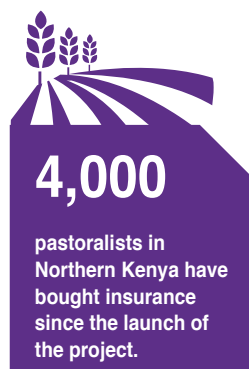
As almost all regions of Africa are expected to experience more drought conditions that are more intense and longer lasting, farmers throughout the continent face riskier growing conditions. With this threat of crop failure present, farmers cannot afford to take risks with their livelihoods and invest in higher crop productivity.

To combat the risk at a national level, a number of countries have come together, with help from international development institutions, to join a new mutual insurance scheme. Under the auspices of the African Union, the Africa Risk Capacity Insurance Scheme provides prompt payments to member countries in the event of drought. This allows the member countries to plan their response to drought and prevent it leading to a full-blown humanitarian crisis, knowing they will be able to afford to respond.

Payments are pre-determined and based on estimates of the severity of the drought, as well as the vulnerability and exposure of the population. The scheme has issued policies to the Governments of Kenya, Mauritania, Mozambique, Niger and Senegal, providing US\$135 million in drought insurance coverage.

National schemes are also being tested, to provide weather index-based insurance directly to farmers. Ethiopia, Kenya, Malawi and Mozambique have all experimented with schemes in the crop and livestock sectors. These schemes protect farmers from catastrophic losses as a result of weather events such as droughts, floods and extreme temperatures.

By protecting farmers in the event of extreme weather, crop insurance also reduces the risk of debts incurred by farmers taking credit at the start of the season. Even if crop losses are severe, farmers don't risk ending up in debt. And this frees farmers up to take loans – and encourages banks to offer credit. In 2005, Malawi launched a pilot scheme under which almost 900 groundnut farmers purchased insurance worth US\$36,600. As the crop insurance contracts mitigated the weather risk associated with lending, local banks offered loans to insured farmers, who used them to purchase certified seed. The credit thus allowed them to invest in higher yield, higher return activities. In 2007, the pilot scheme was expanded



to cash crops and by 2008, participation had increased significantly, as 2,600 farmers bought policies worth US\$2.5 million.

In Ethiopia, a weather-based insurance scheme has taken a broader approach to risk and strengthening farmers' food and income security. Their four-part approach helps the community to reduce risk through better natural resource management; enables prudent risk taking by providing microcredit; helps transfer risk by offering insurance; and supports farmers to build up risk reserves in the form of savings. In 2012, more than 12,200 farmers in northern Ethiopia benefited from drought protection and each farmer received a share of the US\$322,000 paid through

the Horn of Africa Risk Transfer for Adaption Program (HARITA).

In Kenya, another pilot programme covers livestock for drought losses. In the north of the country, about 4,000 pastoralists have bought insurance since the project was launched in 2010. The insurance was linked to a 50% drop in distress sales of livestock and a 33% drop in reliance on food aid.

Insurance may be an important mechanism for farmers to break the cycle of low input, low output farming. The challenge now is to scale up the many pilot schemes and make insurance easily available to the smallest smallholder farmers. ■



Weather-based insurance in Kenya covers pastoralists for livestock losses in drought conditions, resulting in fewer distress sales of animals and less reliance on food aid.

## STORY 9

**Selling more than agricultural inputs**

AGRA supports agro-dealers who are prepared to operate in rural areas close to farmers. Here, AGRA grantee dealer Mauricio Ignacio Denbo is in his base in Chimoio, and trades with farmer Joaquim Anibal. Mozambique.

© AGRA

**W**ho do farmers in rural Africa turn to when they need inputs and advice about their crops? Information about the efficient use of inputs is essential for farmers to cope with the vagaries of the weather. But stretched agricultural extension services may not be on hand to provide advice at the time and place where it is needed.

Agro-dealers, on the other hand, are often local entrepreneurs, keen to provide products and services to farmers. Here is a natural channel to provide agricultural extension services and advice on the efficient use of farm inputs to farmers in rural areas.

The Agro-dealer Development Programme builds on this potential by training and providing capital and credit to 9,000 certified agro-dealers across Africa. Most of these dealers are women, so the programme helps them develop their livelihoods, while offering them products and services that are more relevant to them. Women, for example, tend to ask for seeds for crops such as local vegetables, which are mostly grown by women, as well as vaccines and drugs to treat their chickens.

The programme trains agro-dealers to provide extension advice on the best inputs for different agro-ecological zones, depending on the season. Farmers who come to purchase inputs such as fertilizers and certified quality seeds can access extension advice at the same time. The programme also aims to link agro-dealers to wholesalers, seed

companies and market information systems.

In Mozambique, more than 380 agro-dealers have been trained and linked to suppliers of seed and fertilizers. District level agro-dealer trade associations have been created to help persuade agro-dealers to sell certified seeds in rural areas where government extension services are limited. And through the programme, more than 150 agro-dealers gained access to a credit guarantee fund totalling US\$269,000.

Similar results are being seen in Kenya. With greater numbers of agro-dealers in project areas, the distance farmers need to travel to reach an agro-dealer has been reduced from 40 km to just 7 km, and 1.5 million households have access to better information about agricultural inputs. Fertilizer use has increased by 30% in these areas, representing a genuine move towards more productive agriculture.

In Malawi and Tanzania too, rural entrepreneurs have been trained as agro-dealers and certified in business management skills. They are supported by associations who have links to suppliers and output markets for farmers.

Clearly, agro-dealers can't prevent droughts or extreme weather events! But providing a better information service to farmers about agricultural inputs, as well as better access to the inputs, can help develop more robust, profitable farms that are more resilient to climate shocks. ■



## STORY 10

# Putting pressure on water resources

**E**ritrea is a country of extremely limited water resources. About 80% of the country receives less than 500 mm of rain per year and that rainfall is erratic. Only half a million hectares are cultivated nationally, and 90% of this is farmed using traditional methods of rainfed, subsistence agriculture. Farmers are vulnerable to increasingly frequent droughts; crops now fail 1 in every 3 years on average, when previously they saw an average of failure once in 5 years. Complete crop failure in some areas and partial failure in others has halved national grain output in some years.

Given the evidence of changes in rainfall patterns and increasing temperatures in Eritrea, agricultural systems must adapt. Better national information to support improved water services are therefore a key component of the National Agricultural Project. Efficient irrigation systems, water harvesting, soil and water conservation, and agricultural water control and management, all have a role to play.

But providing better water services to farmers at scale is no easy task. The project is approaching it in several ways. GIS and satellite imagery are being used to characterize watersheds, and meteorology and hydrology systems are being improved to provide real-time information on rainfall. Run-off and river flow data provide a basis for better control, management and use of agricultural water, while agricultural infra-

structure is being developed, including soil and water conservation technologies, in rainfed areas. Pressurized and spate irrigation areas are also being expanded and improved.

Because of the erratic rainfall patterns, smallholders can see the benefits of irrigated cropping, and are willing to contribute significantly to the costs of their development and operation. Nonetheless, the shift from surface irrigation systems to pressurized irrigation has its challenges. Farmers are familiar with flood and basin irrigation, but they have limited technical and management capacity to run a pressurized system efficiently. Progress towards more pressurized systems is slow.

Using better information to understand rainfall, meteorology and hydrology, the project has benefitted more than 81,000 households, 20% of which are headed by women. Yields have increased by 300–900% for sorghum and pearl millet, compared with rainfed agriculture in a similar environment.

Better information at all levels is helping to improve the management of water resources available to smallholders. And with the effects of climate change being felt, the National Agriculture Project is making water management a priority. ■



Irrigation channel and salicornia field at Seawater Farms Eritrea, the world's first commercial-scale integrated seawater farm.



© Neil Palmer/CIAT

A farmer in Western Kenya uses agroforestry and intercropping on his small plot of land. His approach to sustainable intensification boosted food production, increased resilience to climate change, and helped develop a profitable business.

# Policies for profitable agriculture

**F**arming is the mainstay of millions of farmers' livelihoods in Africa. According to the African Development Bank, agriculture supports the livelihoods of 80% of the African population, while 70% of the population depends on agriculture for full-time employment. When agriculture stimulates growth in Africa, this growth is twice as effective in reducing poverty as growth in other sectors.

Farmers' efforts to gain access to inputs, equipment, quality seed and markets can be supported or undermined by national policy. Technological solutions that could support farmers' climate-smart agriculture will be ignored, if government policies result in incentives that undermine their adoption by farmers. And conversely, national policy to support smallholders can boost productivity, help them access markets and create a vibrant, competitive, agricultural sector.

A wide range of policies affect farming and food production, including those related to agriculture, food security and climate change. Ensuring that these policies are consistent with each other, at national, regional and international levels is important as they can create conflicting incentives or barriers for farmers. Policies that affect financing mechanisms (such as credit and insurance markets) and the government safety nets

available to support farmers in the event of crop failure, will affect farmers' willingness and ability to invest in adopting new, more productive climate-smart agriculture.

**National policy to support smallholders can boost productivity, help them access markets and create a vibrant, competitive, agricultural sector**

Climate-smart agriculture interventions are important not only at the project level of farms, processors and traders. Working with governments to design climate-smart policies is often an integral part of projects – as seen in the East Africa Dairy Development Project and Drought Tolerant Maize for Africa. For some projects, policy is the primary target.

National policy has great potential to support or undermine investment in climate-smart agriculture. Farmers' responses to these policies will be fundamental in determining their ability to develop profitable, vibrant farming communities. ■





## STORY 11

## Seed policy without borders

Aligning national seed policies to increase seed availability for smallholders.

**S**mallholder farmers in countries of the Southern African Development Community (SADC) are limited in their efforts to increase agricultural productivity by a lack of high quality seed. In years when there is a shortage of seed, countries in the region need to import seed from neighbouring countries. But disjointed laws and regulations between countries make this process slow and complicated, and limit the trade in seeds between countries. Farmers are restricted from both producing and buying seed.

The Harmonised Seed Security Project (HaSSP) was launched in 2010 to address the problem of seed security across the SADC region by aligning national seed policies. The aim is to make high quality, affordable seed available to smallholder farmers in SADC countries.

**The pilot phase of the project, completed in December 2013, was successful in aligning policies for releasing seed varieties, phytosanitary requirements and seed certification across the four countries**

It started with a pilot project in Malawi, Swaziland, Zambia and Zimbabwe. This focused in part of strengthening smallholders' – and especially women's – capacity to produce seed by supporting community-based seed production enterprises. At

the policy level, the project helped governments in the pilot countries to align their seed protocols with the SADC Seed Security Protocols.

Phase II of the project is scaling this up across the SADC region. It aims to bring all countries in line with harmonised, effective and efficient seed systems that will make improved seed varieties available to farmers when they need them. To achieve this, the project needs to work on both legislation and knowledge management. At the policy level, different countries are working to align the policies that govern the release of new seed varieties. Policies for seed certification and phytosanitary policies also vary between countries, causing difficulties for cross-border trade and these policies are another focus area for the project.

But policy harmonisation can only be achieved if supported by training and capacity development. At the practical level this means assessing institutions' and individuals' ability to implement the policies, and the support they need to administer these harmonised policies. Equipment and facilities for seed certification too are being improved.

The pilot phase of the project, completed in December 2013, was successful in aligning policies for releasing seed varieties, phytosanitary requirements and seed certification across the four countries. Now National Seed Acts in each country need to be brought in line with

the SADC Seed System, to allow region-wide SADC variety releases.

The project has already resulted in the establishment of two seed producing communities in Swaziland. The challenges faced by the pilot project also provided some lessons for its expansion. The need for training and early engagement was highlighted in particular. Because the aim of the project is to alter national policy, it is essential to engage with high-level government officials throughout the process and to bring in legal officers from the relevant ministries right from the start. Policy training too is essential, to improve understanding of the legal issues and processes.

Harmonizing these national policies should make a significant difference to the region and culminate in a larger SADC market for improved seed, benefitting farmers across the region. But policy can't do it alone. HaSSP shows that effective policy change must be supported by training and capacity development, and at the practical implementation level. ■

**Because the aim of the project is to alter national policy, it is essential to engage with high-level government officials throughout the process and to bring in legal officers from the relevant ministries right from the start**



Trade in high quality, affordable seed is facilitated by alignment of national seed policies among countries in the SADC.

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## ▶ Partners

- The EADD programme is funded by the Bill & Melinda Gates Foundation. Over US\$76 million has been invested in the project in two phases. It is implemented by Heifer International in partnership with the International Livestock Research Institute (ILRI), TechnoServe, World Agroforestry Centre (ICRAF), African Breeders Service Total Cattle Management (ABS TCM), and farmers.
- The Great Green Wall project is led by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS). It is funded by the African Union with a total budget of US\$2.2 million. The farmer-managed Natural Regeneration project is supported by World Vision Australia, in partnership with the Niger Ministries of Agriculture, Livestock, and Rural Development and the Forestry Department. Regreening the Sahel is supported by IFAD, in partnership with ICRAF and the Centre for International Cooperation, VU University Amsterdam.
- The project is funded by World Vision Australia and the World Bank at cost of US\$1.3 million. It is implemented by World Vision Australia, in partnership with seven village cooperatives, the Federal Republic of Ethiopia, World Bank and World Vision Ethiopia.
- The Conservation Agriculture project is led by Total LandCare. It partners with the International Maize and Wheat Improvement Center (CIMMYT), and national partners: the Department of Agricultural Research Services (DARS), Ministry of Agriculture, Irrigation and Water Development (MoAIWD), National Conservation Agriculture Task Force (NCATF), NGOs, seed companies, and farmer groups. It is funded by the Royal Norwegian Embassy Malawi and Zambia; USAID; DFID and private corporations. The total estimated budget is US\$8.5 million.
- The Sustainable Agricultural Development of Highlands project has received US\$63 million in funding from the African Development Bank, as well as US\$24 million of in-kind contributions. It is coordinated by the International Center for Agricultural Research in the Dry Areas (ICARDA) and implemented by ICARDA and three other CGIAR Centres (the International Institute of Tropical Agriculture (IITA), AfricaRice and the International Food Policy Research Institute (IFPRI)), in partnership with national agricultural research institutions in Algeria, Libya, Mauritania, Morocco and Tunisia.
- DTMA is coordinated by CIMMYT and the International Institute of Tropical Agriculture (IITA). The Bill & Melinda Gates Foundation, Howard G. Buffett Foundation, USAID and DFID have funded the project, with a total budget of US\$5.8 billion.
- Anchor Farm Development Project is led by the Clinton Development Initiative, in partnership with Alliance for a Green Revolution in Africa (AGRA).
- The Africa Risk Insurance Mechanism is implemented by Africa Risk Capacity, a specialized agency of the African Union. It has funding of US\$150 million. Initial capital comes from participating countries' premiums and one-time partner contributions. It is supported by international development institutions



including DFID, and the German Development Bank KfW, which have committed up to US\$200 million to support the initiative.

- The Agro-dealer Development Programme is led by the Alliance for a Green Revolution in Africa (AGRA). It is supported by the Government of the Netherlands, the Bill & Melinda Gates Foundation, The Howard G. Buffett Foundation, USAID Feed the Future, the Rockefeller Foundation, and DFID, with a total budget of US\$150 million.
- The National Agriculture Project is led by the Ministry of Agriculture, Eritrea, in partnership

with the private sector, the National Agricultural Research Institute, Eritrea; Hamelmalo Agricultural College; Agriculture Promotion and Development Department, Eritrea; and the Agriculture and Extension Services. It is funded by IFAD and the Government of Eritrea, with a budget of US\$26.4 million.

- HaSSP is funded by the Swiss Agency for Development and Cooperation and managed by the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN). It has a total budget of US\$4.8 million.



A woman harvests all the leaves from *Gnetum* spp. (okok) in the village of Minwoho, Lekié, Center Region, Cameroon.

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Isaka Mashauri, managing director of Tanzanian seed company and long-term CIMMYT partner Tanseed International, showing the performance of the TAN 250 maize variety on one of the company's demonstration plots, in Morogoro, Tanzania. These plots allow farmers to observe the attributes of different varieties in the field.





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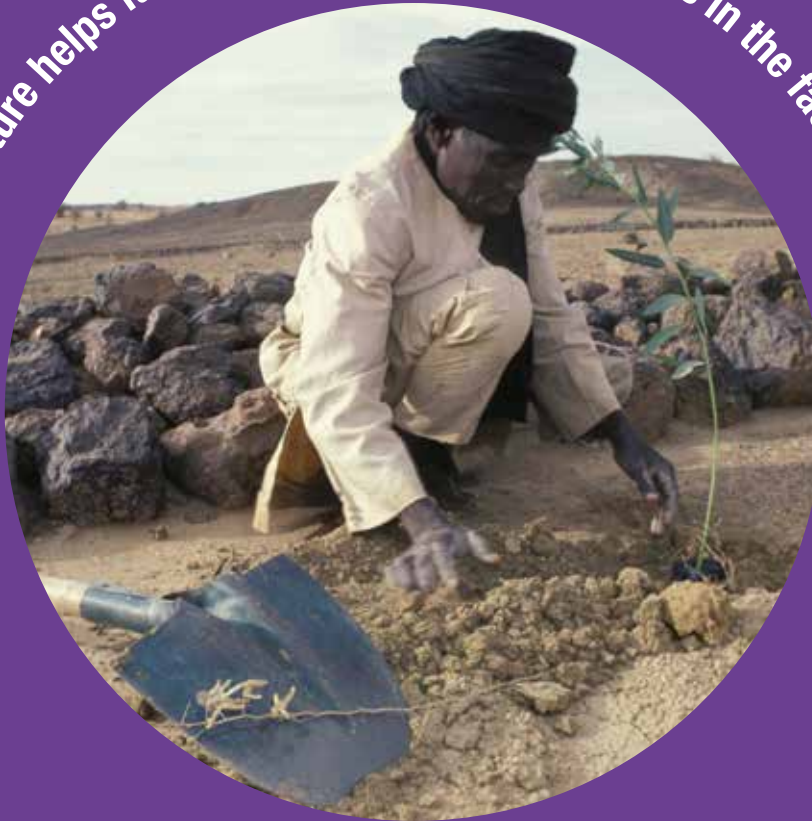


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