Agriculture and Food Systems

KEY MESSAGES

- **Food security in Africa needs urgent and serious attention from policymakers.** Rates of hunger are growing and progress towards the Malabo Declaration of 2014 is off-track. Climate change is already stalling progress towards food security in Africa, interacting with multiple other stresses and shocks, including inequality, conflict and the COVID-19 pandemic. A 3°C trajectory will cause catastrophic disruption to African food systems within the next 30 years. A 1.5°C trajectory provides more options for adaptation of African food systems, but still demands urgent action.
- **All indications are that financing adaptation to climate change will be more cost-effective than financing increasingly frequent and severe crisis response, disaster relief, and recovery pathways.** For Sub-Saharan Africa, the cost of action on climate adaptation of agriculture and food systems is less than a tenth of the cost of inaction: $15 billion compared to $201 billion per annum.
- **Leading adaptation options for food systems are well-defined and build on evidence and experience, including in Africa.** They include public policy and incentive solutions, food value chain and livelihood solutions, and on-farm and productive landscapes solutions. Among these options, the priorities for public sector investment in Africa are fivefold: research and extension, water management, infrastructure, sustainable land management, and climate information services.
- **The adaptation investments by small-scale producers will be a vital component of building resilience of African farmers.** Therefore increasing and targeting flows of capital to these farmers, livestock keepers, fishers and small businesses is critical.

> **“My region East Africa has been battling swarms of desert locusts that have devastated thousands of hectares of cropland, the perennial droughts, and an encroaching desert that have laid bare the vulnerability of the entire horn of Africa.”**
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> **H.E. President Sahle-Work Zewde of Ethiopia**
> Leader’s Dialogue on the Africa Covid-Climate Emergency, April, 2021

CLIMATE CHANGE, FOOD SECURITY, AND THE RESILIENCE IMPERATIVE IN AFRICA

Status of food and nutrition security in Africa

Food and nutrition security in Africa is off track. In 2020, more than one in five people in Africa faced hunger—more than double the proportion of hungry people in any other region.[1] About 282 million of Africa's population are undernourished. In West Africa alone, nearly 17 million people needed immediate food assistance in 2020 due to a combination of drought, poverty, high food import prices, environmental degradation, displacement, poor trade integration, and conflict—a set of interlinked threats.

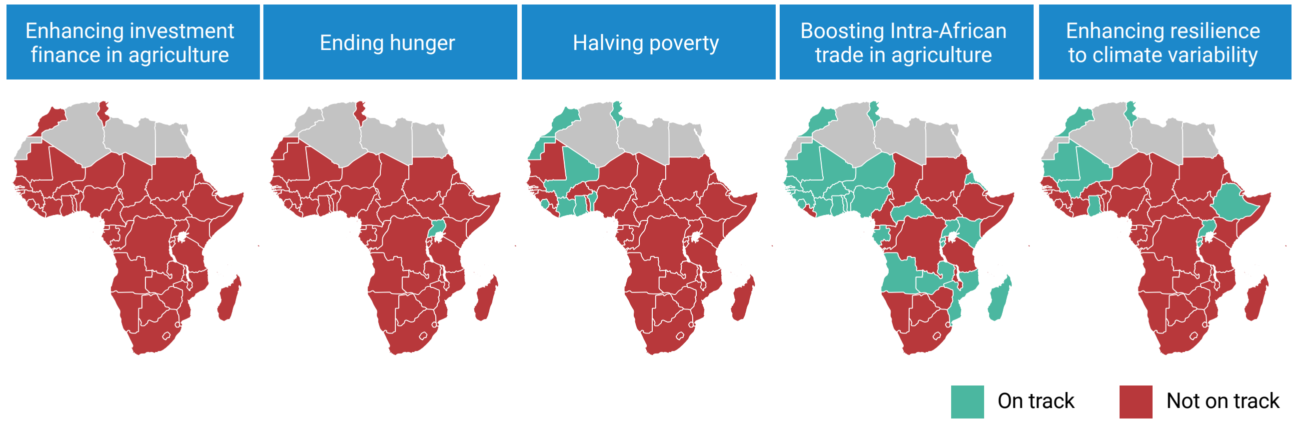
Africa's agricultural exports are rising, and many countries are net food exporters. However, largely driven by four countries (Nigeria, Angola, Democratic Republic of the Congo and Somalia), the continent remains a net food importer at an annual cost of $43 billion. Without action, the continent's food import bill could top $110 billion by 2025.[2] Demand for food is rising and will continue to do so, exceeding 3 percent per year through 2025. Population growth at the rate of about 3 percent per year, per capita income growth and urbanization, and changing consumer preferences—towards processed foods and agricultural products that are more nutritious and higher in calories—are the key drivers of demand. The continent's poorly integrated food markets cannot accommodate large yearly fluctuations in food crop production by directing surplus food to areas with shortages (for a more detailed analysis, see the Trade chapter). As a result, localized food shortages and price volatility are common, while farmgate prices remain low.[3]

The economic shocks arising from the COVID-19 pandemic are having deep impacts across Africa. Economic growth fell across the continent, most sharply in South Africa.[4] The recent locust outbreaks in East Africa, resulting in severe crop and livestock losses, have added additional pressure to food systems, with the burden falling heavily on low-income producers and consumers. While the pandemic has been one driver of increasing levels of food insecurity, the trend in numbers of hungry people was already on the rise since 2015, due to factors such as conflict, climatic shocks, food system inefficiencies, and increasing wealth and income disparities—all of which make healthy and sufficient diets less affordable.

The African Union's most recent Biennial Review shows that only 4 of 49 member states are on track to achieve the goals and targets of the Malabo Declaration on Accelerated Agricultural Growth by 2025.[5] This means that Africa is also lagging on progress to achieve Sustainable Development Goal (SDG) 2, which calls for ending hunger in all forms by 2030, and SDG 13, on taking action to combat climate change and its impacts. Looking at African countries' performance (summarized in Figure 1) the key takeaways from the African Union's Biennial Report scorecard are:

- On the Malabo commitment of 2014 to end hunger in Africa by 2025, African leaders resolved to accelerate agricultural growth, reduce post-harvest losses, increase agricultural productivity and improve nutritional status. Only Uganda is on track.
- Only seven member states are on track to reduce the prevalence of stunting among children to under 10 percent.
- On the commitment to invest 1 percent of agricultural GDP into research and development, only 12 countries did so between 2018 and 2020. In terms of access to agricultural advisory services, only seven countries are on-track.
- Performance on women's empowerment through agriculture has retreated, with only eight countries (out of 14 reporting) on track, compared with 16 on track in the last reporting period.
- On commitments to building climate resilience, only Morocco has a dedicated budget line at the national level. Less than a quarter of member states are on track towards the 2025 targets that encompass sustainable land management and support to farmers.
- In better news, 26 countries (65 percent) are on track to double the area under irrigation by 2025, and 16 are on track to double the current levels of quality agricultural inputs for crops, livestock and fisheries.
- Similarly, while most countries remain off track on increasing the value of trade of agricultural commodities and services within Africa, there has been a good deal of progress since the last reporting cycle, when only three countries were on track.

Figure 1: Performance by African member states on their commitments under the Malabo Declaration (2014) on food security



Source: African Union 2020

Impact of climate change on African food security

Climate change is already stalling progress towards food security in Africa. African agriculture and food systems are already suffering the impacts of climate change. Visible effects include changes to the start and end dates of growing seasons, and the frequency and intensity of dry spells and heavy rainfall events. Evidence shows that climate change has stalled productivity growth in the continent's foremost staple, maize.[6] Overall, Sub-Saharan Africa has experienced about a 1.4 percent reduction in food calories per year from key food security crops (maize, cassava, sugarcane, sorghum, rice) due to climate change.[7] Increasing climate variability exacerbates the climate challenge. From devastating droughts in North, West and Southern Africa to cyclones and intense flooding in East Africa, extreme weather is threatening crops, fisheries, and livestock and putting millions of Africans at risk of food insecurity. Food insecurity increases by 5–20 percent with each flood or drought.[8]

A trajectory of global temperature rise of 3°C will cause catastrophic disruption to African food systems within the next 30 years. In a 3°C scenario, by 2030 climate change is predicted to reduce the income of the poorest 40 percent of African people by more than 8 percent, further constraining their ability to respond to climate shocks and adapt to climate change.[9] Many more million Africans will suffer from hunger.[10] By 2050, the 282 million of Africa's population who are undernourished today is expected to rise to 350 million.[11] Climate change jeopardizes development gains by undermining food, environmental, water, and energy security. The impacts of climate change will deepen existing vulnerabilities and capacity gaps, leading to poverty, fragility, conflict, and violence.

Though human-induced warming is greater at high latitudes, climate impacts are emerging especially rapidly in the tropics, for both biophysical and socioeconomic reasons.[12] The most profound impacts will be on the production end of the food system—agriculture, wild foods, and the land and water systems that support them—though direct impacts on processing, distribution, storage, food environments and consumers' choices will also hit hard, particularly around food safety, seasonal food availability, and access to culturally preferred diets.[13] The level of upheaval to food systems under the 3°C scenario will require wholesale changes in what African people eat, where it is produced, and how supply is managed and governed.[14]

Massive changes in agricultural suitability can be expected across the continent, with farming systems, food production and import dependency changing beyond recognition. For example, under a 3°C (RCP8.5) scenario, Africa is expected to lose 30 percent of current growing areas for maize and banana and 60 percent for beans by 2050. By the end of the century, 1.85 million hectares of current bean cropping systems in Uganda and Tanzania, which grow 41 percent of the total Sub-Saharan African bean supply, will no longer be suitable. Other crops will see smaller but significant effects, with up to 15 percent loss of production area for cassava, yams, millets and sorghum.[15] High-nutrition and high-value-add fruits, vegetables and perennial crops also look set for major yield and quality declines.[16]

Large areas will need to shift out of crop production altogether. Over the 2050 to 2100 timeframe, Africa's typical mixed cropping-livestock systems will need to change to pure livestock systems across 3 percent of Africa's land area, directly supporting around 35 million people in agricultural livelihoods. At the same time, these pastoral systems will be under increasing threat in terms of forage quality, fire frequency and water availability.[17] Significant drops in African marine fisheries catches are also expected, putting further pressure on people's access to highly nutritious animal foods.[18] For example, under a 3°C trajectory, by 2050, West African marine fisheries are projected to experience a loss of a fifth of annual landed value, half of all fisheries-related jobs, and $311 million annually in foregone income across the food system.[19]

On the 3°C trajectory, climate change will be experienced primarily as increases in frequency and severity of climatic extremes, such as heatwaves, droughts, floods and storms. For example, heatwaves, defined as three or more days during which daily temperatures are in the top 5 percent of the 1971–2000 average for the region, currently occur 1–3 times per year in different African regions. Under a 3°C scenario, this is expected to increase five-fold by 2030, with Cameroon, Gabon, Somalia and Ethiopia particularly exposed.[20] These heatwaves will impact agriculture both by exceeding the temperature tolerance limits of key crops—cereals like maize and wheat are especially susceptible—and by reducing labor productivity.[21] Meta-analyses show that the heat and drought interact to bring about devastating impacts on crop harvests by shortening lifespan, interfering with reproduction and reducing the number, size and quality of grains, legumes and fruits).[22] For African people, the heat stress will be increasingly deadly; by the end of the century mortality-related heat stress levels are very likely to occur far more frequently—for example an additional 200 days per year in West and Central Africa.[23] As well as the direct threats to human health and lives, this heat is likely to drive labour, migration and patterns of settlement, with profound impacts on African food systems.

North Africa and southern Africa will face severe reductions in rainfall in the 3°C scenario, with more intense and frequent droughts, lower discharge in rivers, and higher likelihood of fires—with major impacts on crop productivity, irrigation potential, pasture quality and ecosystem services.[24] Other African regions will experience a smaller overall decline in rainfall, but highly impactful changes in rainfall patterns. Flood events, which can destroy production, particularly in low-lying irrigated zones, are likely to increase throughout Africa, including Madagascar.[25] Even more critically, a range of climatic tipping points are plausible in the 3°C scenario. For Africa, a critical potential future climate tipping point is a collapse of the Atlantic Meridional Overturning Circulation (AMOC), which would result in a southward shift in the Intertropical Convergence Zone, which would in turn drive drying and desertification across large areas of Africa south of the Sahara, with calamitous impacts on food production and agricultural livelihoods.[26]


Photo: Ozbalci/iStock

A 1.5°C trajectory provides greater options for the adaptation of African food systems but still demands urgent action. The world is already on the 1.5°C trajectory and is likely to exceed 1.5°C within the decade.[27] Even under this low-emissions scenario, more frequent region-wide food system shocks can be expected, with yield failures across multiple neighbouring countries, food safety breakdowns, food price spikes and social unrest . The likelihood of extreme droughts will double across North Africa and southern Africa[28] and heavy rainfall events and associated flooding are projected to be more frequent and more intense across most of the continent.[29] These rapid changes in both means and extremes will have unavoidable effects on the productivity, quality, safety and stability of cropping, livestock and fisheries systems, and on the health, productivity and mobility of the people who manage those systems.

Current actions to build resilience to climate change and related shocks across Africa's food systems are promising—but not nearly enough to meet the scale of the problem. Even on a 1.5°C trajectory, a more ambitious and urgent set of adaptation interventions are required. On a 3°C trajectory, which approximates more closely to current socioeconomic pathways and emissions trends, disruption to current systems will be profound everywhere and catastrophic for millions. Adaptation is an imperative, not a choice.

ACCELERATING ADAPTATION AND RESILIENCE FOR AFRICA'S FOOD SYSTEMS

This section provides an overview of the adaptation actions most relevant to African food systems. As a starting point, Table 1 gives a summary of the key solutions relevant to Africa, and these examples are then expanded on in the subsequent text. Three families of adaptation interventions are covered: public policy and incentive solutions, food value chain and livelihood solutions, and on-farm and productive landscapes solutions. Within these three families, all of the examples discussed have value, and many work in concert with each other. Moreover, the synergies with national and continental development agendas for jobs, productivity, nutrition and sustainability are very strong—delivering on climate adaptation will also deliver on the SDGs and Malabo goals. Some of the examples have long-term African experience to build on (e.g., livestock management, agroforestry), while others are newer areas of endeavor on the continent or globally (e.g., fiscal measures, co-benefits of mitigation finance). Some are lower hanging fruit (e.g., low-cost early warning systems) while others need more complex multi-sector reforms (e.g., affordable healthy diets).

Based on the leading reviews and modelling exercises of recent years (see the sources under Table 1), we identify five solutions within the three families for which public sector investment is most strongly needed in Africa. These are:

- Ramping up support to research and extension services
- Strengthening inclusive climate information & risk management services
- Provision and maintenance of adaptive climate-resilient infrastructure
- Improving sustainable water management at farm and catchment levels
- Restoration of degraded landscapes and practicing sustainable land management

These groups of solutions are not 'better' than others, nor will they solve all adaptation problems in food systems on their own. They are highlighted because they are areas in which the case for public sector investment is high for the following reasons: strong public good benefits; need for interventions at a large scale, such as the national level or whole landscapes or whole catchments (often cross-boundary or transnational); opportunities for progressive distributional outcomes, improving equality of access for women and poor people; initially high capital outlays that may be prohibitive for all but the largest of private operators; and associated need for policy incentives that provide signals to land and water managers and to food system participants.

A modern approach to climate adaptation moves beyond purely agricultural solutions into whole food system approaches. For example, problems with agricultural production can be addressed not through on-farm solutions alone but also through trade, social safety nets, and policy incentives for consumers and food businesses. The task is to provide suites of adaptation support, and to increase the set of choices available to farmers, consumers and businesses, rather than to identify a small number of the most promising 'silver bullet' types of solutions. Targeting to beneficiaries also matters greatly: public sector support should be actively designed and distributed to provide preferentially for low-income producers and consumers, with a focus on opportunities for women to participate on an equal footing.

Given the pace and unpredictability of climate change, another principle is that building of ongoing adaptative capacity is more important than one-off investments; hence the importance attached to enhancing systems for rapid learning, foresight and lesson-sharing, through digital-based R&D and extension systems. This capacity will be critical as farmers, governments and businesses increasingly need to build proactive preparedness for the larger transitions that the 3°C scenario will demand—such as a country or region needing to move out of production of a major staple crop, for example in Nigeria and South Africa.

Table 1: Climate change adaptation solutions for African food, land, and water systems

Key: high | medium | low

Family of adaptation solutions		Adaptation benefits	Food security co-benefits	Mitigation co-benefits	Priority for public sector investment	Early examples in Africa (expanded in text below)
Public policy and incentive solutions	**Ramp up support to research and extension services**	high	high	high	high	Mauritius, Namibia, Botswana
	Strengthen inclusive climate information & risk management services	high	high	low	high	Senegal, Rwanda, Angola
	Implement insurance schemes against shocks, and wider social safety nets to counter climate risks	medium	high	low	medium	Ethiopia, Mauritania, Niger
	Repurpose subsidies and eliminate policy distortions that increase climate vulnerabilities	high	high	low	low	Botswana, Senegal
	Deploy mitigation policy and finance in ways that support adaptation	medium	medium	high	low	Climate-Smart Agriculture Investment Plans, e.g. Mozambique, Mali
	Reduce barriers to trade in times of crisis	high	high	low	low	African Continental Free Trade Area
Food value chain and livelihood solutions	**Provide and maintain adaptive climate-resilient infrastructure**	high	high	low	high	Malawi, Zambia
	Reduce and manage food loss and waste	medium	high	high	medium	The Gambia, Malawi
	Create demand for affordable healthy low-carbon diets	high	high	high	low	South Africa, Egypt
	Link small-scale producers to value chains	medium	high	low	low	Nigeria, Rwanda
On-farm and productive landscapes solutions	**Improve sustainable water management at farm and catchment levels**	high	high	low	high	Burkina Faso, Madagascar
	Restore degraded landscapes and practice sustainable land management	high	medium	high	high	Ethiopia, Niger
	Scale up context-specific climate-smart soil management	high	high	high	medium	Zambia, Ethiopia
	Improve livestock management	medium	high	high	medium	Kenya, Nigeria
	Monitor and manage new trends in pests and diseases	medium	high	low	medium	International networks and services, e.g. FAO and CABI
	Promote diversification of crops and livestock	high	medium	medium	low	Morocco, Rwanda
	Use climate-ready species, cultivars, and breeds	medium	high	low	low	Pan-African—but adoption levels need to be raised
	Incorporate perennial crops, including agroforestry	medium	medium	high	low	Zambia, Côte d'Ivoire

Key sources for adaptation solutions: Niang et al., 2014; Mbow et al., 2019; Shukla et al., 2019; IMF 2020; Sulser et al., 2021 (country examples sourced more widely)[30]

WORLD BANK CLIMATE ACTION PLAN

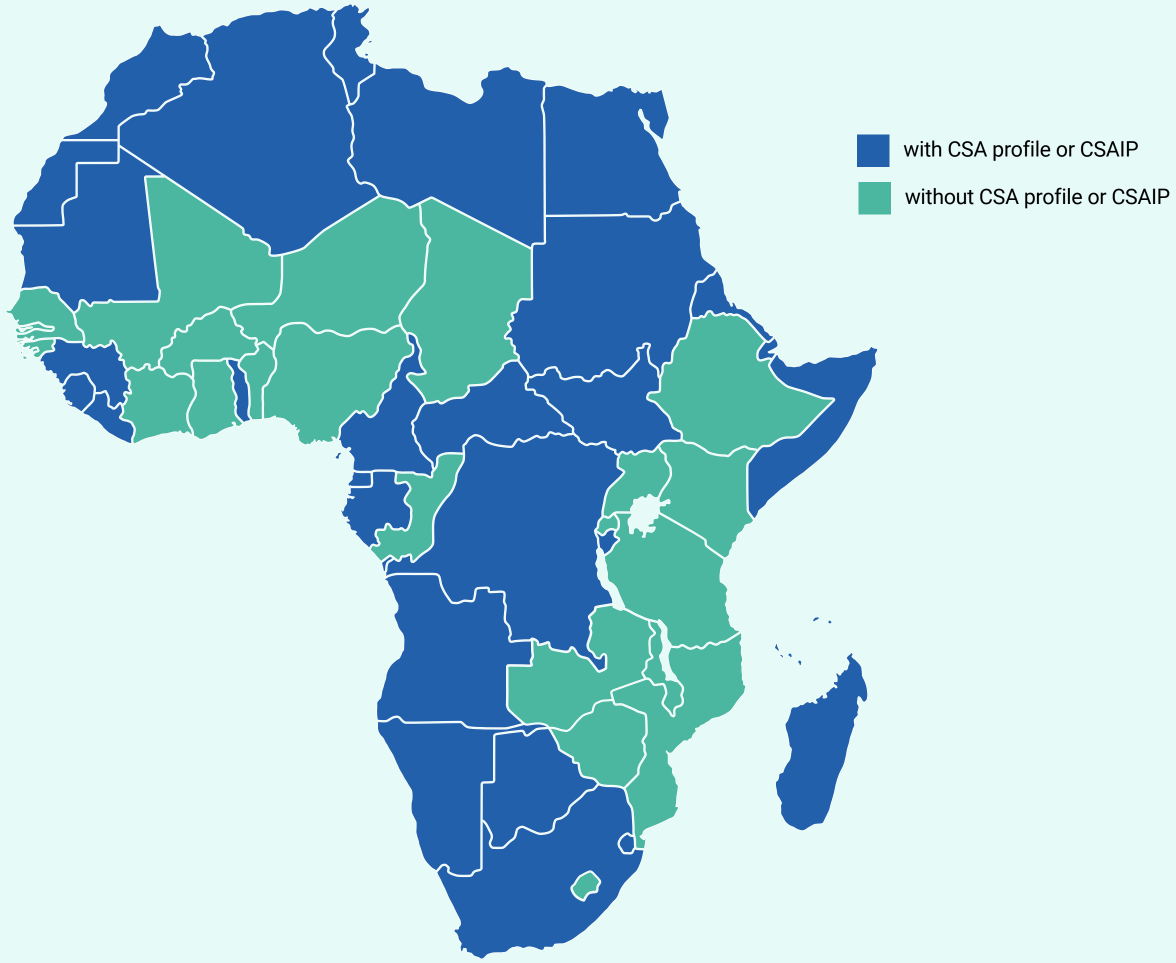
Box 1: Africa World Bank Climate Business Plan and Climate Smart Agriculture

The Africa Climate Business Plan (ACBP) was launched by the World Bank at the 21st Session of the Conference of the Parties (COP 21) in Paris in 2015 to address Africa's intricately linked climate and development agendas. The ACBP calls for funding to help Africa adapt to climate change and build up the continent's resilience to climate shocks. The ACBP includes a focus on climate-smart agriculture (CSA). This integrated approach aims to address the interlinked challenges of food security and climate change by sustainably increasing agricultural productivity to support equitable increases in farm incomes, food security, and development; adapting and building the resilience of agricultural and food systems to climate change at multiple levels; and reducing greenhouse gas (GHG) emissions from agriculture.

Between January 2016 and June 2021, the World Bank invested over $11 billion in agriculture projects across 40 countries in Africa. The portfolio includes country-level projects and regional programs that aim to catalyze coordinated action to generate shared regional public goods and provide a platform for policy dialogue and reforms. For example, the World Bank is supporting CGIAR to implement the Climate Change, Agriculture and Food Security (CCAFS) initiative aimed at enhancing access to climate information services and validated climate-smart agriculture technologies across Africa. Climate finance (co-benefits) account for $6.8 billion or 60 percent of these investments, with 68 percent of the climate finance flowing into adaptation.[31] Higher finance flows to adaptation compared to mitigation reflect the priorities of African countries to address the agriculture sector's climate vulnerability and increase resilience. However, given the vast potential for African agriculture to reduce emissions through climate-smart practices, the mitigation flows should expand in the future, with co-benefits to adaptation. In response to diminishing conditions for food production, the World Bank plans to invest $5billion between 2020 and 2025 across 11 countries of the Sahel, Lake Chad, and Horn of Africa regions, stretching from Senegal to Djibouti. The funding will be used to restore degraded landscapes, improve agriculture productivity, increase climate-resilient infrastructure, and boost livelihoods and jobs, in line with the Great Green Wall Initiative.

To strengthen the evidence base for CSA implementation, a set of development partners (CGIAR, FAO, USAID, and the World Bank) actively support countries in the preparation of CSA country profiles and CSA investment plans (CSAIPs). The CSA profile provides baseline information for initiating discussion about entry points for investing in CSA at scale. It characterizes a country's climate vulnerability, specifies promising CSA technologies and level of adoption, and documents institutions and policies for CSA. The CSAIP takes the information provided by the profile further by identifying investments that offer the greatest potential to transform a country's agriculture into a more productive, climate-resilient, and low-emissions sector. It identifies potential pathways for scaling up CSA, the impact of several factors on adoption, and policy actions required to support effective scaling up. Currently, CSA profiles or investment plans have been prepared for 23 countries, with investment project financing initiated in 17 of these countries. The profiles and investment plans are major drivers of climate-smart agriculture and food system investments in Africa.

Figure 2: Countries with CSA profiles or investment plans



Source: World Bank

Public policy and incentive solutions

Climate change adaptation in food systems can be enabled and driven through various policy instruments, not only in the environment and agriculture sectors but also in economic development, finance, health, infrastructure, gender equality, digital, trade and social safety net policies. The food system offers opportunities for win-win-win outcomes for food security, adaptation and mitigation.

Several African countries have released national green growth strategies or roadmaps. Examples are Ethiopia's Climate-Resilient Green Economy Strategy, Rwanda's Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development, and South Africa's Green Economy Accord. These national strategies and roadmaps show green growth as an emerging agenda in policymaking across Africa.

The following public policy and incentive solutions are the most relevant for climate-adapted and resilient agriculture and food systems in Africa.

> **"Importing staple foods into the continent when 60% of the population still lives on the land is madness by any measure. We can do better. It is time for a new approach, one that creates locally produced food for a local population. (...) The answer lies in initiatives such as Africa Improved Foods (AIF) (...) it is the first big public-private partnership in Africa to specifically address malnutrition and hidden hunger."**

Feike Sijbesma, Co-Chair of the GCA Board and Honorary Chairman of Royal DSM

Ramp up support to research and extension services. As climate change accelerates, real-time data collection, analysis and learning become increasingly important to manage emerging unpredicted climate risks. This is important on the 1.5°C trajectory where research and extension are critical to dealing with climate shocks, and even more important on the 3°C trajectory, under which climatic conditions will soon move beyond anything experienced by farmers since the introduction of agriculture. Investment in robust research functionalities has been identified as a key adaptation solution for food systems.[32] This is not just a matter of one-off filling of knowledge gaps; what is required is sustained investment in agile research services that are rapidly responsive to emerging risks, and also provide intelligent foresight into future risks and trends to enable proactive and systemic adaptation. Equally important, extension services that support innovation in both agriculture and food systems are critical to enabling rapid adaptive learning loops among farmers and other networks of food system participants.[33] Raising agricultural productivity requires the development of modern innovation systems for technology generation and diffusion.

Public spending programs would need to focus on innovation systems (the institutions and partnerships that link new ideas with impact at scale) because a robust supply line of technologies is not enough. It is critical that the knowledge on these technologies and innovations reach farmers, especially small-scale producers, and that they adopt them. However, the ability of farmers to adopt potentially transformative technologies is influenced by the policy incentives, market conditions and human capacity that affect the monetary and non-monetary costs of such technologies, including access to finance, land ownership, ICT connectivity, and the level of farmers' knowledge and skills. Thus the set of complementary areas of investments that will be critical for technology generation and adoption include:

- strengthening agricultural innovation systems;
- reorienting agricultural R&D to meet emerging climate challenges;
- modernizing agricultural extension services;
- building skills for technology innovation and adoption; and
- reducing policy barriers and maximizing enabling factors.

In Sub-Saharan Africa, agricultural research spending grew by about 50 percent between 2000 and 2014. However, this growth was concentrated in a small number of countries; expenditure actually fell in more than half the countries measured. Furthermore, the growth comes from a very low base, and still falls far short of what is needed. In 33 out of 40 countries for which data were available, less than one percent of agricultural GDP was spent on agricultural research).[34] For comparison, the intensity of agriculture R&D spending (total agricultural research spending as a share of agricultural GDP) in the Organization for Economic Co-operation and Development (OECD) countries is about 2.5 percent.[35] Key areas for ongoing research into climate adaptation in African food systems include a deeper understanding of the impact of (and response options to) climatic extremes; the deployment of cost-effective climate services; and farming inputs, including crop and livestock genetics; integrated land management and economic incentive schemes.[36] Systems-level analysis that can provide critical information for policy decisions also needs to be enhanced—for example, on synergies and trade-offs across adaptation, mitigation and food security options; or across water, energy and food supply; or across different groups of winners and losers in food.

Strengthen inclusive climate information and risk management services. Climate information services—the provision of tailored information related to current and forecasted weather, on a timeframe ranging from daily to seasonal to multi-year—is vital to cost-effective planning by farmers, food businesses and governments. Climate information services can be characterized as the set of institutions and processes that connect observers, modelers and forecasters (of both near-term weather and long-term climate) with interpreters of that information (e.g., agricultural advisories on planting dates or livestock care) and ultimately to users of that information: farmers, livestock keepers, fishers, agricultural service providers, governments and food businesses. The intent is to provide users with preparedness, to inform adaptation not only to seasonal variability in weather, but to longer-term trends in climate change itself. This can lead not only to better-informed decision making on the part of farmers, but to the creation of climate-smart agricultural value chains, in which agricultural investment up and down entire supply chains is able to manage climate risk over a period of several years.[37]

Key climate information services (CIS) include seasonal weather forecasts for farmers and early warning systems that can help anticipate and manage natural disasters, pest outbreaks and yield failures. CIS enables access to timely, cost-effective, and user-relevant information on weather and impending disasters, for improved agronomic decision-making. At the national level, climate advisories help countries to identify conditions that may endanger food security and inform farmers' decisions to adequately respond to, and when possible, capitalize on the changing conditions.

Much as climate information services are central to effective agriculture and food security risk management, the approach in Africa is still reactive rather than proactive. Inadequate early warning systems coupled with limited investment in climate information services and weak institutional and technical capacity, are implicated in contributing to food insecurity–related emergencies in the region. As discussed in the Present and Projected Climate Risks chapter, Africa needs to invest much more in technical and institutional capacity across the whole climate information value chain, including observations and monitoring, data processing, forecasting and modeling, coupled with agricultural advice, information delivery, and two-way communication channels. Early investments are underway, but much more needs to be done to scale up and to provide a more inclusive and higher quality level of service.

For example, African countries are leveraging the big data and geospatial capabilities of the Agricultural Intelligence Observatory (Ag Observatory) in targeting climate-smart interventions to improve their agricultural systems. Launched in 2018, the Ag Observatory is a climate-information services tool for near real-time detection of farming system shocks and initiate proactive response measures. The Ag Observatory integrates high-resolution private sector agrometeorological data (aWhere) with public domain meteorological and agricultural monitoring databases (e.g. crop calendars), linked to crop yield models and other forecasting tools.[38] aWhere is a subscription-based, artificial intelligence tool that collects and analyzes weather and agronomic data from 1.9 million virtual weather stations globally. Next challenges for the Ag Observatory are greater interlinkages across African countries, and the building of stronger and more inclusive links with end users, particularly small-scale farmers and their service providers (inputs, extension, and financial services).

Early warning systems are adaptive measures for climate change, using integrated communication systems to help regions, countries, or communities prepare for hazardous climate-related events. An ideal early warning system saves lives, jobs, and infrastructure and supports long-term sustainability. The Africa Road Map for Improving the Availability, Access and Use of Disaster Risk Information for Early Warning and Early Action identifies activities and practical recommendations aiming to improve the availability, accessibility and use of risk information at the continental, regional, national and local scales, for the African Union Commission, the Regional Economic Communities and four countries: Angola, Ethiopia, Tanzania and Zambia. Common priorities include improvement of monitoring and forecasting systems, development of inclusive communication systems, and implementation of preparedness plans.[39] A vital service in Africa is FEWSNET, the Famine Early Warning Systems Network created in 1985, which provides early warning and analysis on acute food insecurity worldwide. Examples at national level include the Strengthening Climate Information and Early Warning Systems project in Uganda, which has replaced outdated and inadequate meteorological stations with updated systems, improving disaster risk reduction with more effective means of generating and sharing information.

Reaching farmers with usable weather forecasts, preferably linked to agricultural advisory services, is another priority for climate information services. For example, the national meteorological service in Senegal works with an association of 83 community-based radio stations across the country, as well as text message services, to reach around 740,000 rural households with seasonal weather forecasts that inform planting dates and help farmers maximize effective use of inputs. In Rwanda there has been a focus on two-way communication with farmers, both through extension agents and the Radio Huguka community radio network that delivers bi-weekly climate information programming, with call-in shows and live debates with experts.[40]

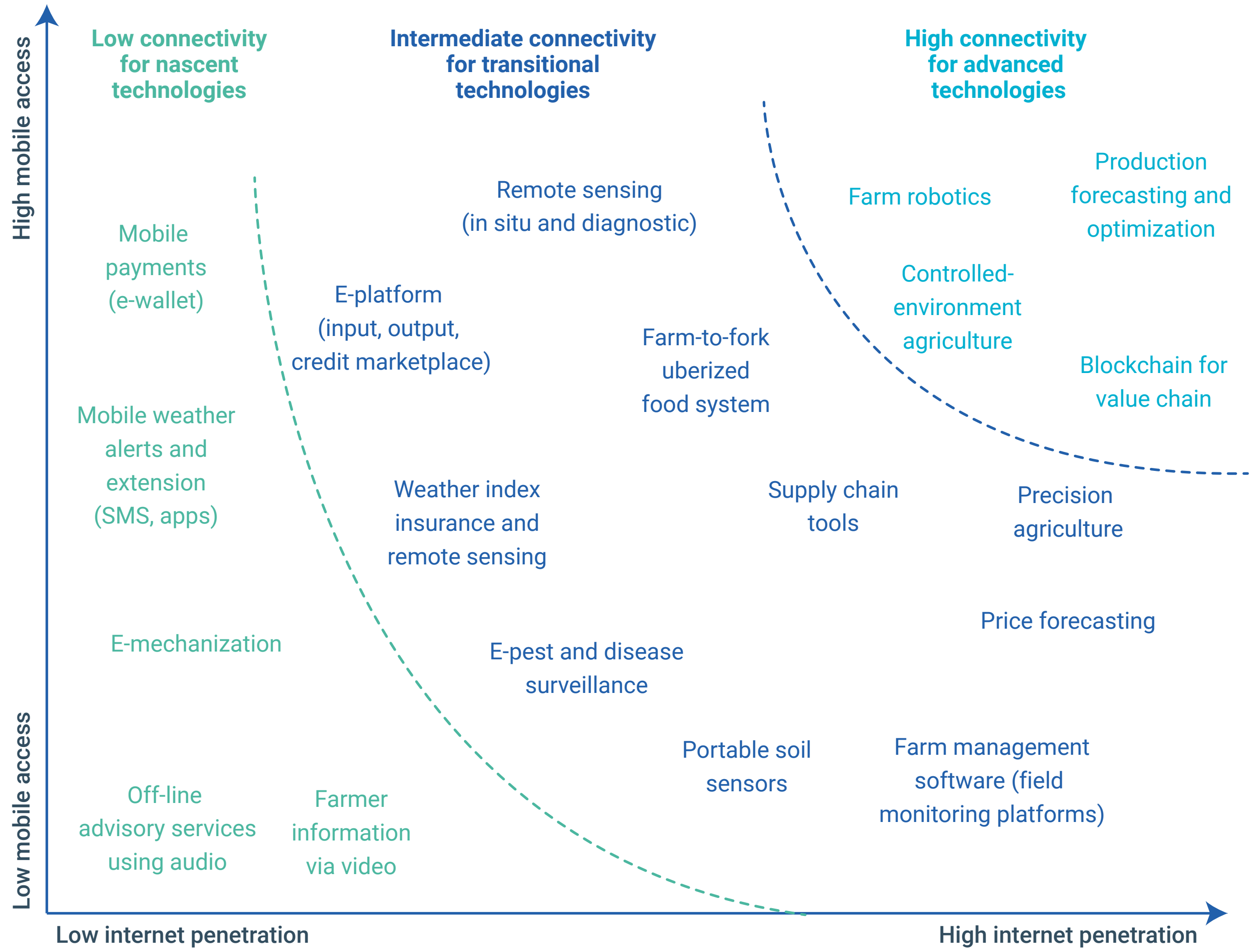
Box 2: Scaling up Digital Solutions in Africa


Photo: PeopleImages/iStock

Technologies for collecting, storing, analyzing, and sharing information digitally, including mobile phones and the internet, have great potential to solve several agricultural challenges, thereby improving the food system's efficiency, equity, and environmental sustainability. From video-based agricultural advice to the Internet of Things-enabled climate-smart irrigation tools to agroweather advisories that provide personally relevant information on weather and impending disasters and help farmers capitalize on changing conditions, digital solutions could be a game-changer in sustainably boosting agricultural productivity and resilience in Africa. The technologies enable actors within the food system to make informed decisions, improve productivity and incomes, and achieve better nutrition, health and resilience outcomes. To encourage adoption more broadly, digital technologies should be user-friendly and require low-level skills and literacy for its use, for example, with interactive voice response functionality.

Increasing the adoption of digital technologies in the food system will require expanding mobile internet coverage and promoting relevant digital applications tailored to different participants across the food system. As network coverage increases, so do potential users of digital solutions, which increases the incentives for digital solution providers to develop relevant applications. Digital technologies can also be applied to food e-commerce, thereby helping to match buyers with sellers, shortening agricultural value chains, providing access to new markets, reducing transaction costs, and creating new business opportunities for actors within the food system. E-commerce in Africa is growing rapidly each year.[41] In principle, digital agriculture also has the potential to help address Africa's youth bulge—the gap between job creation and the large number of young people entering the workforce each year—by leveraging the greater digital connectivity among younger age groups.

Figure 3: Digital agriculture technology continuum



Source: World Bank

Implement insurance schemes against shocks and wider social safety nets to counter climate risks. Designing climate-responsive social protection strategies can strongly support proactive measures to avoid, minimize and address the complex, long-term impacts of climate change on human health, livelihoods, poverty and inequality (See Climate-adapted Social Protection Systems insert). For smaller climate events, revenue diversification and remittances are helpful; market insurance is best for more intense events. Adaptative social protection mechanisms such as international aid, insurance and contingent finance and government reserve funds protect households from medium and large climate events; adaptive social protection programs combining multi-year cash transfers with direct efforts to promote productive employment have proven effective for improving food security and welfare of the poorest. Financial inclusion is helpful against medium climate events.

Weather insurance can be loosely grouped into micro (for individuals), meso (for businesses) and macro (for governments). An example at the macro level is the African Risk Capacity, which insured four governments and nine governments in its first and second year of operations respectively. In the first year, three of these four governments received payouts following insufficient rainfall in the Sahel, which was used to assist 1.3 million drought-affected people.[42] Currently, 24 countries have a memorandum of understanding with the ARC. At the micro level, Index-Based Livestock Insurance (IBLI) is a prototype commercial insurance product for small-scale livestock keepers in northern Kenya and southern Ethiopia. IBLI leverages the strong correlation between remotely sensed vegetation index and losses associated with forage shortages.[43]

Repurpose subsidies and eliminate policy distortions that increase climate vulnerabilities. No country in Sub-Saharan Africa is currently on track to meet its commitment of allocating at least 10 percent of total budget funding for agriculture in 2019. Yet, in many Sub-Saharan African countries, a significant share of public spending goes to poorly targeted and distortionary market price supports and subsidies. This calls for adopting smarter public spending programs. COVID-19-induced declining fiscal space and increasing government debt levels require repurposing public resources to support services and infrastructure in producing sustainable agri-food systems while addressing existing policy distortions. This provides opportunities for building more fiscal responsibility through repurposing public agriculture spending programs for longer-term productivity growth and climate adaption agenda (including infrastructure, early warning, R&D and extension, and skills development). This repurposing of public resources can also enhance resilience against short-term shocks by integrating budget lines for disaster preparedness and emergency response into medium-term expenditure frameworks for greater flexibility to manage shocks.

Ten African governments (Mali, Senegal, Burkina Faso, Ghana, Nigeria, Kenya, Tanzania, Zambia, Malawi and Ethiopia) spend roughly $1.2 billion annually on poorly targeted input subsidies.[44] Reallocation of expenditures from such programs to resilience-building investments, such as climate-smart technologies, research and development, and infrastructure, could bring major food security gains and promote the efficient use of scarce public resources. In addition, public support programs and policies can and need to focus on improving enabling environment and policy predictability to encourage private sector investments.

Repurposing agricultural policies and public spending does not only help to deliver more efficient and resilient food security outcomes, but it could also provide an opportunity to develop investment strategies aligned with the formulation of Nationally Determined Contributions under the Paris Agreement. Examples of opportunities for repurposing could include support to protecting forests, grasslands, peatlands and wetlands; direct conservation support and platforms toward integrated projects that bring together producers with scientists to develop needed innovations; and conditional funding on environmental practices, including use of graduated payments that reward farmers for better performance. Policies for financing land retirement (i.e., restoring agricultural land) on carbon-rich peatlands and lands with limited agricultural productivity and restoring them using native vegetation would also be beneficial.


Photo: Afrimages/iStock

Policy distortions also disadvantage women and their effective participation in food systems. Women are significantly more vulnerable to climatic risks than men, largely due to unequal access to governance systems, resources, services, and markets (see Gender chapter). Gender-responsive climate change policies, programs and planning are vital to effective adaptation and equal outcomes. Many tools and methodologies for gender mainstreaming into policy and programming are available, including CRiSTAL, Gender Impact Assessment, the Climate Vulnerability and Capacity Analysis methodology, and Participatory Vulnerability Analysis. Actions to eliminate discrimination against women in ownership of and access to productive resources, including land, are especially important. Mechanisms such as gender-responsive budgeting and auditing are also useful. In Uganda, gender budgeting in pilot sectors, including agriculture, yielded significant positive effects on social outcomes, such as reduced maternal mortality rates and improved primary school enrolment for girls—both of which build longer-term societal resilience as well as being of intrinsic value in themselves. In Rwanda, local-level gender budgeting has helped improve gender equality indices and inspired new land policies that require property registration in the name of both spouses, thus increasing women's ownership of productive resources.[45]

Deploy mitigation policy and finance in ways that support adaptation. Agriculture is the largest source of GHG emissions in Africa, accounting for about 58 percent of emissions in the continent.[46] Several adaptation and mitigation measures can help address climate change, but no single measure is sufficient by itself. Effective implementation of climate action in Africa depends on policies and cooperation at all scales and integrated responses that link mitigation and adaptation with other development goals. There has been increased national and subnational mitigation plans and strategies in recent years, though without robust financing propositions. Climate mitigation finance is critical as large-scale investments are required to reduce GHG. In addition, mitigation finance is an adaptation tool that will allow African regions to mitigate the adverse effects and reduce the impacts of climate change. The use of Climate-Smart Agriculture Investment Plans (Box 1) is an important step towards integrating mitigation and adaptation planning, and is expected to be reflected in African countries' revised submissions of Nationally Determined Contributions to the UNFCCC.

Reduce trade barriers, especially in times of crisis. As discussed in the Trade chapter, international trade is an important adaptation mechanism to deal with the geographic variation in climate-related harvest failures. Climate change affects parts of the world differently, shifting crop suitability and regional comparative advantages and altering trade patterns. Trade between African nations in agricultural products as a percentage of Africa's total agricultural trade has remained below 20 percent over the last few decades, one of the lowest in any region. Implementing the African Continental Free Trade Area (AfCTA) would enable trade to play its rightful role in improving food security and facilitating more efficient allocation of resources in agricultural production. For example, intra-regional trade within Africa on agriculture commodities and products could increase by an estimated 49 percent, while processed food trade could increase by 90 percent, and trade between Africa and the rest of the world could increase by 10 percent.[47] The increased movement of food commodities will increase food availability in deficit areas and help improve food security.

Furthermore, the AfCTA is projected to facilitate faster growth of the agriculture sector in all parts of Africa except for North Africa—as the sub-region would shift towards manufacturing and services. Real incomes would increase, and poverty will decline, enabling more people to access healthy diets. The impacts of AfCTA depend on the extent to which its agreements are implemented, including reduction of tariffs and technical barriers to trade among member countries, and the extent to which countries undertake trade facilitation measures. The AfCTA reforms would undoubtedly establish a regional policy and regulatory framework capable of mitigating against countries reverting to retrogressive trade policies such as export bans or rapid escalation of tariffs in times of crisis. There is evidence that such policies exacerbate the impacts of climate change on food security and hunger. In contrast, mechanisms to keep trade open will alleviate negative effects on the affordability of healthy and sufficient diets.[48]

This would, however, require establishing shared compliance standards as it relates to tariff and nontariff barriers, streamlining customs procedures and meeting environmental and climate requirements. AfCTA is supported by a fairly new regional institution, the Ecosystems Based Adaptation for Food Security Assembly (EBAFOSA), in developing Climate and Environment compliance standards along the entire food supply chain, along with the related Health and Quality and Safety Compliance standards. Together, these standards aim to ensure that processes along the food systems do not degrade ecosystems and enhance nature-based approaches in production while creating an open market for healthy, high-quality, environmentally friendly agro-produce—all of which are expected to contribute to agricultural transformation, which increases its climate resilience and reduces greenhouse gas emissions.

Photo: BOULENGER Xavier/Shutterstock

Food value chain and livelihood solutions

Many of the impacts of climate change on food production have adaptation solutions beyond agriculture. Just as there is climate-smart agriculture, there are also climate-smart food value chains and climate-smart food systems. All continents, including Africa, are still in the early days of exploring, testing and implementing value chain and livelihood-oriented mechanisms for building food system resilience in the face of climate change.

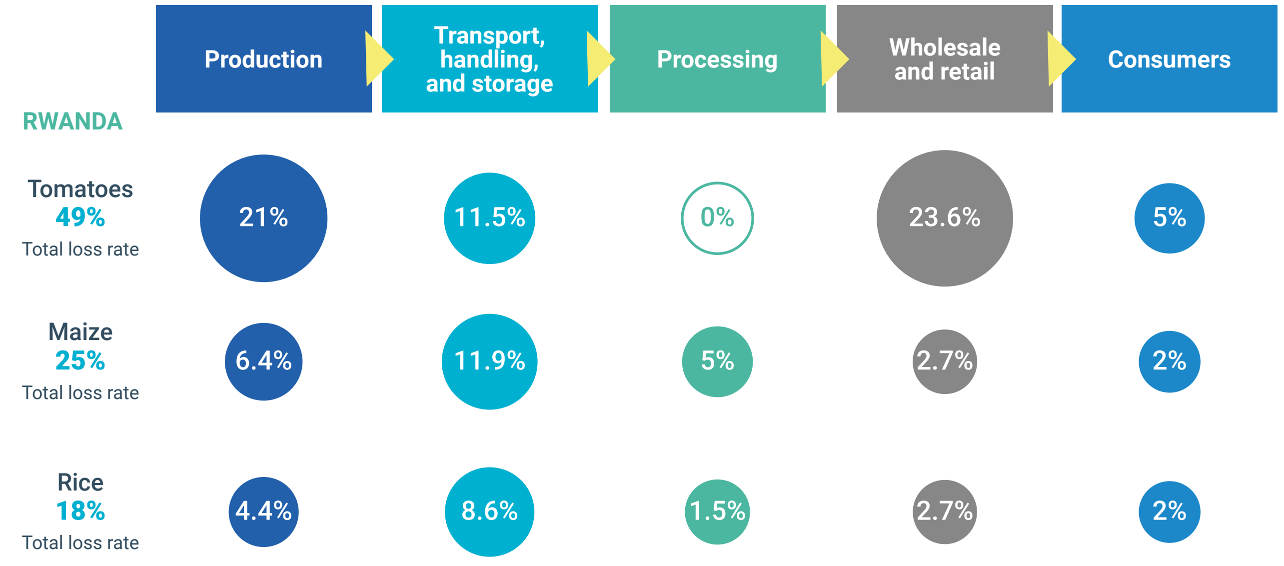
Provide and maintain adaptative climate-resilient infrastructure. In the food supply chain, practical logistics and infrastructure for food storage, such as the correct use of metal drums and hermetic bags, can drastically reduce grain losses. Other options include drying equipment (e.g., for grains, fish or vegetables) and enabling cold storage for fresh produce (where the highest losses typically occur). Commercial collective storage facilities with formal warehousing receipt mechanisms are viable solutions for farmers who cannot afford to build their own storage facilities. Roads and transport are also a primary enabler of rural connectivity and adaptation—and currently the leading sector for African infrastructural investments. The provision of transport routes facilitates market access, decreases transport time, reduces spoilage, and enables rural people's access to services and emergency relief, urban labor opportunities, and connectivity with family—all vital elements of resilience to climate change.

Two main strategies can be adopted regarding transport infrastructure development: either transport corridor development strategy or rural feeder strategy depending on intended impacts.[49] As a leading example, the AfDB has led the construction of 17 cross-border road corridors impacting agriculture in Africa from 2004 to 2018, such as the completed Nacala Road Corridor Phase I and II. These add up to to 12,700km of roads affecting 239 million people across the continent.[50] Transport corridors have more benefits for larger farms. When chosen as an adaptation strategy, road-building needs to be augmented with rural feeder roads and storage facilities to benefit small-scale farmers, fishers and livestock keepers.[51]

Reduce and manage food loss and waste. About 36 percent of the food produced in Sub-Saharan Africa is lost or wasted, and the largest proportion of the losses occur at the production and handling stages.[52] There is much variation across different food types (Figure 4), but in general the most nutrient-rich foods, such as fruits, vegetables, dairy, meats, fish and seafood are often highly perishable, making them disproportionately susceptible to food loss and waste.[53] Helpful interventions to manage food loss and waste include biological controls, storage infrastructure, management and information systems, and diversification of value addition and byproduct use. For example, Aflasafe® products, which are natural biocontrol agents, drastically reduce aflatoxins in crops, reduce post-harvest crop losses and, in turn raise farmers' incomes, delivering tangible and positive impacts for food security and livelihoods throughout Sub-Saharan Africa.[54] Strategies to reduce food loss and waste (FLW) need to be context-based for different countries and value chains, and to be clear on the different roles of public and private sectors. Working with the midstream of the food value chain—the processors, packers, transporters and wholesalers—to counter these losses and wastages is a valuable adaptation mechanism with potential in Africa.[55] Subsidies can be useful to support initial capital outlays.


Photo: africa924/Shutterstock

Figure 4: Food loss and waste hotspots along the value chain in Rwanda (loss percentages occur at each stage)



Source: World Bank Food Smart Country Diagnostic, Rwanda, 2020

Create demand for affordable healthy low-carbon diets. In general, solutions have framed adaptation and resilience for African food security in the light of supply and neglected the demand-pull aspect of the food system. For both nutrition and sustainability reasons, Africa needs to accelerate its transition towards diets that meet people's health and cultural needs, and are widely accessible and affordable, while also remaining within global environmental boundaries.[56] At present, the average African diet is low in emissions by global standards, but also falls short of national and global dietary guidelines for macro- and micro-nutrients.[57] Thus there is ecological space in Africa for more emissions-intense consumption patterns, for example greater consumption of animal products among low-income households and more diverse diets in all income brackets, but without overshooting dietary health recommendations, which are generally well aligned with environmental criteria.[58]

An increasing number of African countries, including Burundi, Central African Republic, Chad and Egypt, now have multi-sectoral strategies to decrease non-communicable diseases, which include action on healthy diets. There are many opportunities in African food environments to channel the demand that aids climate adaptation and resilience, beginning with building strong markets that deliver a diversity of more nutritious food products to local and urban markets. Components of successful demand creation include motivating consumers to take action, convening food businesses to be proactive ahead of regulation, and enacting enabling policies.[59] An array of regulatory options can help governments to drive demand for healthy food, including regulation of: trade in goods and services, Foreign Direct Investment, food health/nutrition claims, food composition standards for processed foods, food marketing, and procurement and provision in public institutions, particularly schools.[60] Consumer tax mechanisms are commonly thought to be appropriate only in high-income settings, but, in 2018, South Africa introduced Africa's first major tax on sugar-sweetened beverages based on grams of sugar. This health promotion levy coincided with large reductions in purchases of taxable beverages, in both volume and sugar quantities.[61]

Link small-scale producers to value chains. The midstream of the food value chain is the closest the market gets to the farmer—the traders, truckers and processors that connect farmers with retailers. There has been rapid growth and abundance of SMEs in the midstream of the output value chains, constituting a 'hidden middle'.[62] Wholesale, logistics, and processing SMEs in the aggregate are the most prominent investors (making up the lion's share of the private sector's volume) in creating markets for farmers in Africa today. About 80 percent of the midstream of the value chains are SMEs, and they are the motors of the value chain transformation and rural employment off-farm. For instance, input value chains, such as for improved seeds and fertilizers, have moved from being controlled by the public sector (and with private sector agents primarily involved in the 'last mile' of input delivery) to a supply system of both governmental and private sector providers. In Nigeria, the trader segment of the maize supply chain exemplifies the impact of the hidden middle. Though not yet modern with an extreme concentration of large firms, it is no longer traditional. The maize supply chain is run by dynamic small and medium-scale traders supported by a third-party logistics market for trucking and warehousing. This vibrant logistics market covers 85 percent of the maize volume sourced by traders from the northern maize basket, linking it to about 80 percent of the southern traders who buy maize from the north.[63]


Photo: Madalin Olariu/Shutterstock

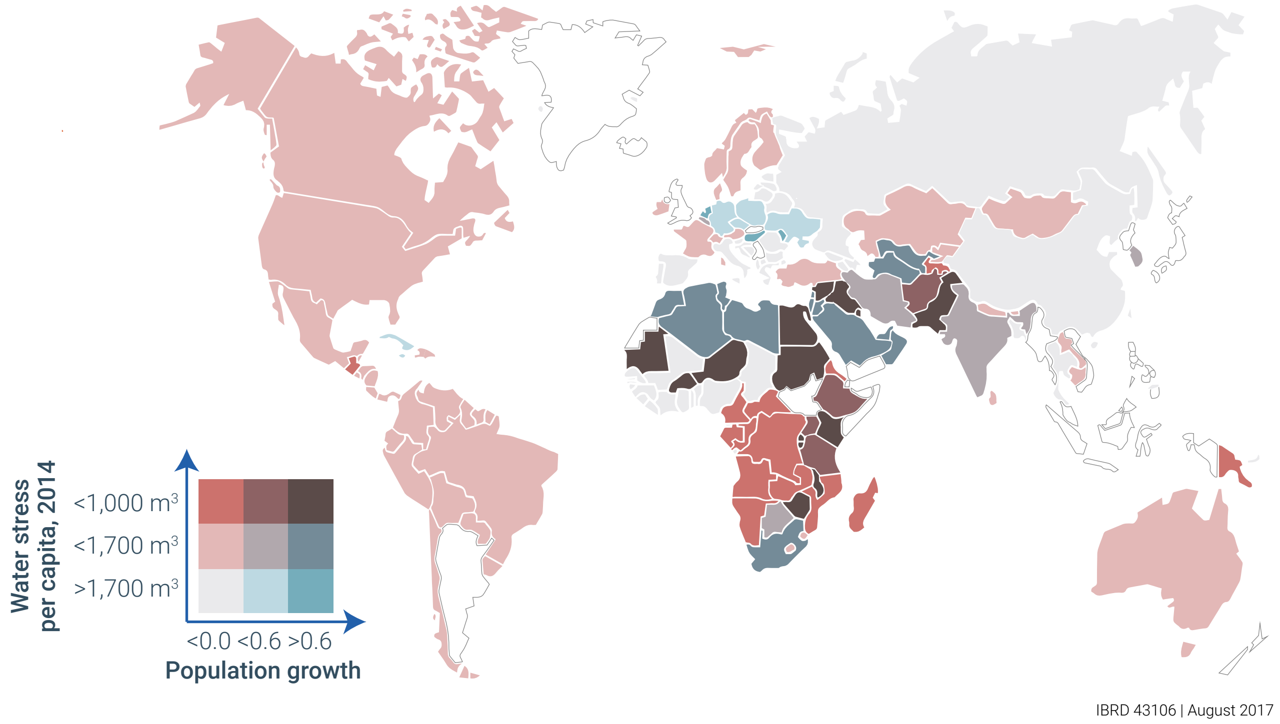
On-farm and productive landscape solutions

Climate-smart agriculture (CSA) interventions increase productivity, adjust farming systems to perceived or projected climate change impacts, and reduce or remove (where possible) GHG emissions. The climate-smart approach does not advocate specific measures or interventions for widespread application. Instead, it seeks packages of measures tailored to local conditions that improve the basket of choices for producers and consumers faced with increasing challenges to meet household and national food security needs under climate change. Climate-smart solutions can extend from the farm to the broader value chain and encompass productive land and water systems beyond the farm.

Improve sustainable water management at both farm and catchment levels. Agriculture accounts for the highest percentage of total water withdrawal in Africa, up to 81 percent. Water management is one of the key priorities for adaptation in Africa and a fundamental element in the goal of achieving sustainable food systems and zero hunger.[64] Persistent and severe droughts, aggravated by climate change, are causing increasingly severe water shortages in Africa's farming systems, which are predominantly rainfed and under small-scale management, threatening rural livelihoods. Water supply is also affected by poor water management, a growing population, and degradation of watersheds, among other factors, creating cascading effects on food and nutrition security and health. Across North Africa, economic losses of 6 percent to 14 percent of GDP are expected by 2050 due to climate-related water scarcity.[65] In Sub-Saharan Africa, where rainfed agriculture accounts for 95 percent of the region's farmed land, more than 1.1 billion people are at risk due to water constraints. With populations rising and climate change, water-related stresses will mount.

Many regions that are likely to see the highest rates of population growth by 2050—including Sub-Saharan Africa, with yearly population growth rates at 2.7 percent—are already the most water-stressed and impoverished and will endure even greater water deficits (Figure 5). Projections suggest that by 2050, global demand for water will increase by 30–50 percent, driven by population growth, rising consumption, urbanization, and energy needs. Even the most optimistic climate change trajectory (1.5°C) will put severe pressure on water resources for Africa's food system.

Figure 5: Per capita water availability and future population growth, 2050



Sources: Freshwater availability data: FAO AQUASTAT database. Population gowth estimates: United Nations Population Division, World Population Prospects, 2015 revision (moderate scenario), for the year 2050.

Measures to improve water security under climate change in Africa suitable for different spatial scales (farm, catchment, basin, see Table 2) and farming systems (from fully rainfed to fully irrigated) include water conservation, water harvesting, supplemental irrigation, ground water irrigation, surface water irrigation, and drainage, among others.

The Malabo Declaration of 2014 identifies irrigation as a priority investment to end hunger by 2025 in Africa. However, its potential for increasing farm yields and income and reducing risks from climate variability is currently untapped. Only three percent of the cropland in Sub-Saharan Africa is irrigated or equipped for irrigation, and many irrigation schemes suffer from water wastage.[66] Irrigation infrastructure could be expanded to up to 38 million hectares compared to the current 7.7 million.[67] Best practices for irrigated agriculture include increasing water-use efficiency in conveying and distributing irrigation water in the field; deficit irrigation, which involves optimal water use by spreading limited irrigation water over a larger area; supplemental irrigation to provide additional soil moisture during periods of water deficits and at critical plant growth stages; and water harvesting and improved water storage for irrigation during times of surplus.[68] While there are many barriers to expanding irrigation across the continent—including investment costs for more sophisticated equipment, access to capital, and land tenure regimes—small-scale irrigation systems have expanded recently. Burkina Faso, Ghana, Tanzania, and Zambia provide notable examples of farmer-led initiatives that have helped increase yields and address risks at lower costs.[69]

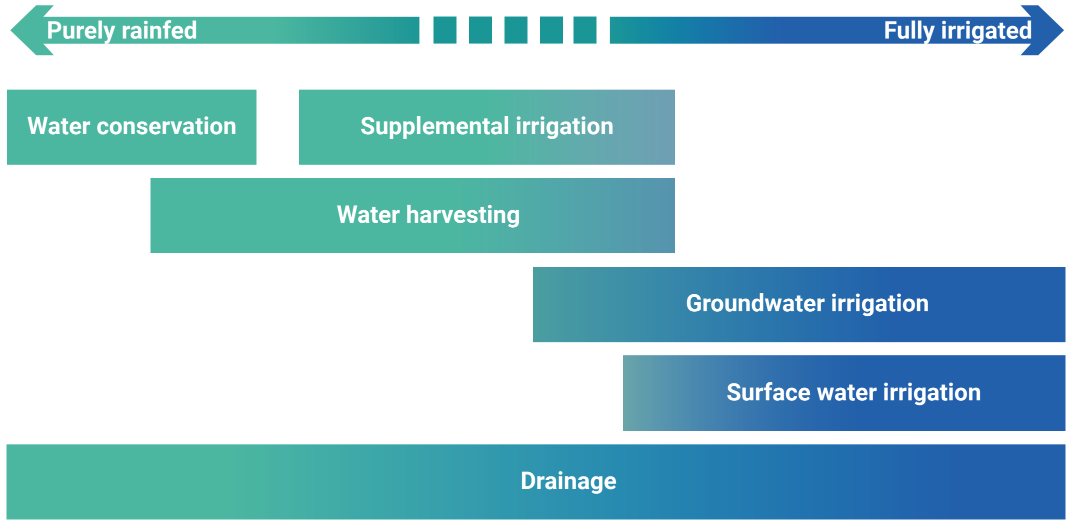

Photo: boezie/iStock

Table 2: Agricultural water management technologies at different spatial scales

Scale	Water source	Water control	Water lifting	Conveyance	Application	Drainage & reuse
Smallholder farm-level	Rain water	• In situ water • Farm ponds • Rain Column Green Wall • Cistern and underground ponds • Roof water harvesting • Recession agriculture	• Treadle pumps • Water cans	• Drum • Channels • Pipes	• Flooding • Direct application • Drip	• Drainage of water logging • Surface drainage channels • Recharge wells
	Surface water	• Spate and flooding • Diversion • Pumping	• Micro pumps (petrol, diesel) • Motorized pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Drainage of water logging
	Ground water	• Spring protection • Hand dug wells • Shallow wells	• Gravity • Treadle pumps • Micro pumps (petrol, diesel) • Hand pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Drainage of water logging • Recharge wells
Community or catchment	Rain water	• Soil water conservation • Communal ponds • Recession agriculture • Sub-surface dams	• Treadle pumps • Water cans	• Drum • Channels • Pipes	• Flooding • Direct application • Drip	• Drainage of water logging • Surface drainage channels
	Surface water	• Spate and flooding • Wetland • Diversion • Pumping • Micro dams	• Micro pumps (petrol, diesel) • Motorized pumps • Gravity	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels
	Ground water	• Spring protection • Hand dug wells • Shallow wells • Deep wells	• Gravity • Treadle pumps • Micro pumps (petrold, diesel) • Hand pumps • Motorized pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Recharge wells and galleries
Sub-basin, Basin	Surface water	• Large dams	• Gravity • Large scale motorized pumps	• Channels • Canals • Pipes (rigid, flexible)	• Flood & Furrow • Drip • Sprinkler	• Surface drainage channels • Drainage re-use

Source: UNECA (2011)

Figure 6: Agricultural water management along the spectrum from rainfed to irrigated



Source: FAO (2020)

Notes: Predominantly green boxes include water management practices by farmers reliant on rainfall but who may still apply some form of irrigation. Predominantly blue boxes refer to irrigation by farmers in purely irrigated settings, or farmers in rainfed areas with some access to irrigation.

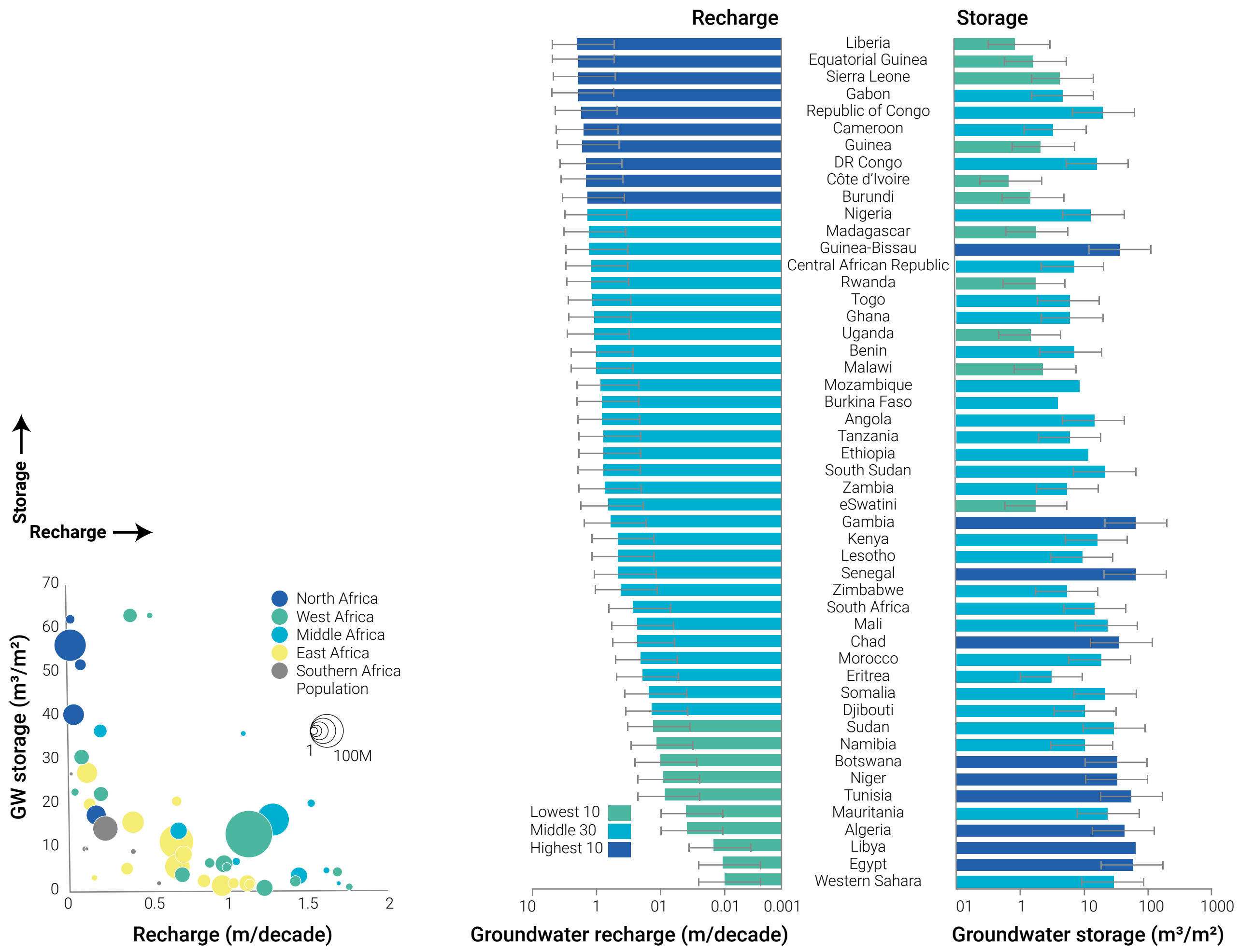
Africa's arid and semi-arid regions, as well as areas with limited water storage infrastructure, will benefit greatly from increased investment in water storage, which represents a key element for the continent's agenda on agriculture adaptation to climate change.[70] Techniques include storing groundwater during the rainy season, harvesting rainwater, and storing water in the ground through soil moisture conservation. These measures can be combined with more conventional surface storage systems for buffering variability, such as small farm ponds and large reservoirs. Effective agricultural adaptation also requires appropriate groundwater management measures in line with the storage versus recharge properties of aquifers.

At both 1.5°C and 3°C trajectories, impacts on net water availability will be concentrated in the northern and southern parts of Africa that are already the most arid: in the south, Botswana, Namibia, South Africa and Zimbabwe, and across the Mediterranean coast of Africa.[71] North African countries that receive little rainfall, including Algeria, Egypt, and Libya, have considerable groundwater storage but extremely low recharge rates, which makes them susceptible to long-term depletion of groundwater resources.

Countries with smaller groundwater storage capacity but heavier rainfall and a more reliable recharge rate such as Burundi, Côte d'Ivoire, and Liberia are more vulnerable to drought but more resilient to long-term depletion.[72]

Five countries in Africa are considered more water-secure than other countries on the continent, due to their groundwater storage and recharge rates that remain above the African average: Angola, the Democratic Republic of the Congo, Guinea-Bissau, Nigeria, and the Republic of the Congo. Net water availability in these countries is not expected to be heavily impacted by climate change, but heavy rainfall events and floods are likely to increase.[73] On the other end of the spectrum, countries like Eritrea, Eswatini, Lesotho, Zambia, and Zimbabwe are highly vulnerable to short-term climate hazards and long-term water resource depletion along both the 1.5°C and the 3°C scenarios, given their storage and recharge rates are below the African average. These countries require additional investments in monitoring and developing their groundwater resources (Figure 7).[74]

Figure 7: Storage and recharge rates of Africa's aquifers



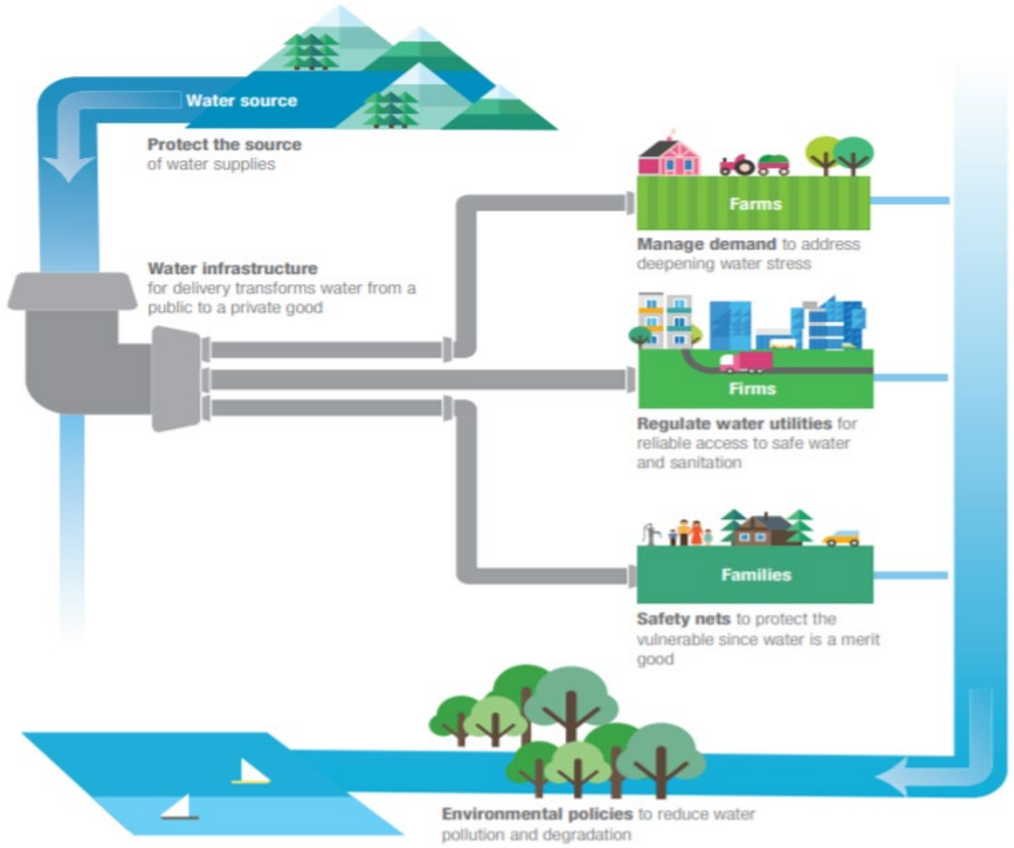
Source: MacDonald et al. (2021)

Nature-based solutions are fundamental to climate adaptation strategies in the agriculture sector, for purposes of water management as well as additional benefits such as biodiversity. Mangroves protect shorelines from storms, lakes store large water supplies, and floodplains absorb excess water runoff. While engineered innovative infrastructure and practices—such as precise application of irrigation water or measurement of plant moisture content using sensors—can contribute to water efficiency, working with natural infrastructure can optimize the performance and financial returns of engineered infrastructure.[75] If combined, nature-based solutions and engineered options can maximize ecosystem services such as clean water supply, soil and slope stability, air quality control, water storage, soil fertility and nutrient recycling, recreation and tourism, energy, biodiversity protection, water purification, food provision, groundwater recharge, flood control and disaster control. Mangrove restoration projects are ongoing in Kenya, Tanzania, Mozambique, Madagascar, Mauritius and Seychelles.[76]

Water security cannot be achieved by focusing on one single solution or by taking action in one sector only. Water is a fundamental input into all activities of the food system—from production, to processing, transportation, and distribution, to consumption—and engages different sectors across the chain: agriculture, energy, infrastructure, transport and trade. A warmer world, even under a 1.5°C scenario, calls for urgent collaboration and improved policy coherence and coordination across sectors, agriculture sub-sectors, and scales (Figure 8). Water management initiatives in one sector can have beneficial spillover effects on others by increasing the availability of water supply in the system. For example, wastewater recycling in urban areas or desalinization of water for the manufacturing sector may allow relocation of some of the water resources to other sectors of the economy, including agriculture. Sectoral collaboration also involves policy coherence, ensuring that initiatives in one sector do not create perverse effects on others, such as the case of subsidies or removal of trade barriers for water-intensive crops.

Similarly, policies and incentives need to complement investments in infrastructure and nature-based solutions to build long-term resilience, to ensure equitable access for the most vulnerable, and to address trade-offs in water system objectives. Water prices and quotas are essential for managing an increasing demand and for ensuring effective allocation of water resources across sectors. For vulnerable farming populations, weather risk insurance can provide a buffer against shocks and diminish long-term effects on livelihoods.[77] Policies that go beyond the agriculture sector, such as improving access to water for sanitation, are equally important.

Figure 8: The water policy cycle

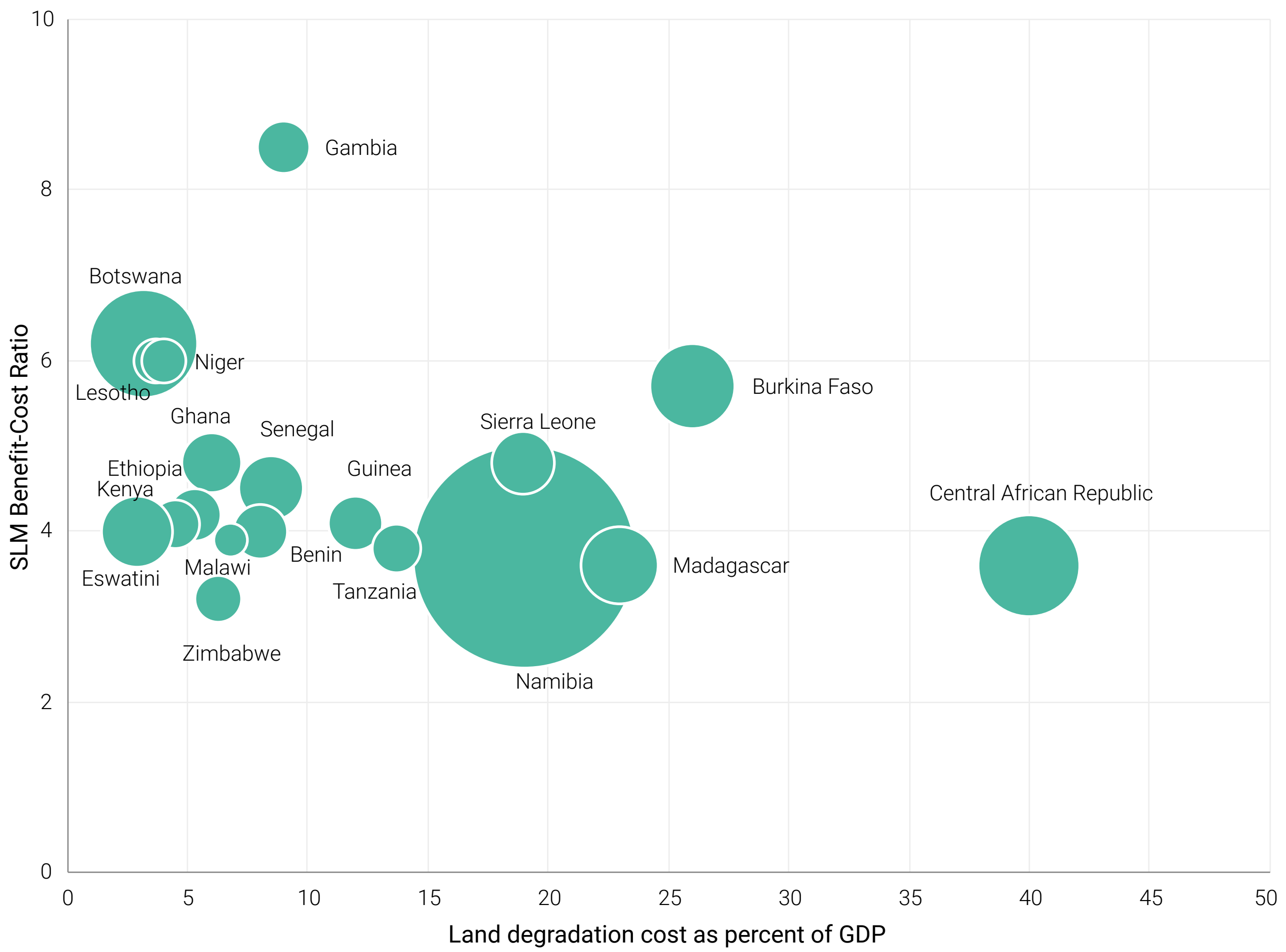


Source: World Bank (2017)

Restore degraded landscapes and practice sustainable land management. Land degradation interacting with climate change represents one of Africa's biggest and most urgent challenges. Land degradation costs about US$ 108 per person each year, or an average annual 12 percent GDP loss for 19 countries in Africa (Figure 9), through the loss of land's productive capacity due to a combination of human-induced factors such as soil erosion, acidification, nutrient leaching, and compaction. Land degradation reduces the effectiveness of adaptation options, yet these interactions have largely been omitted from adaptation planning.[78] Small-scale farmers suffer the most because poor soil conditions, climate and weather variability, land tenure insecurity, and limited access to markets pressure them to make short-term trade-offs that compromise long-term gains. Land degradation reduces options to meet both food demands and environmental needs sustainably. Agriculture is a dominant sector driving land degradation, forcing further global warming through the emission of greenhouse gases and reduced rates of carbon re-uptake and storage.

Land management options for climate adaptation include increasing soil organic matter, no-till farming, perennial crops, erosion control, dietary change, forest protection, sustainable forest management, controlled grazing, rangeland management, clean cooking, fuel and fire management, peatland restoration, regulating the management and conversion of peat soils, coastal restoration, mangrove conservation, long-term land use planning, vegetation management, afforestation and grazing land management.[79] For example, the African Forest Landscape Restoration Initiative (AFR100) is a global effort to restore 100 million hectares of degraded and deforested land in Africa by 2030. To date, 31 countries have made commitments to restoring country landscapes.

Figure 9: Relationship between land degradation cost as percent of GDP and benefit cost ratio of sustainable land management (SLM)



Source: Produced from data from Global Mechanism of the UNCCD (2018) and Nkonya et al. (2016)
Note: The width of the bubbles represents the annual cost of land degradation per capita

Scale up context-specific climate-smart soil management. Sustainable land management (afforestation, reforestation, agroforestry, and rangeland management) can help reduce the negative impacts of multiple stressors, including climate change, on ecosystems and societies. It can also contribute to mitigation and adaptation. Reducing and reversing land degradation, at scales from individual farms to entire watersheds, can provide cost-effective, immediate, and long-term benefits to communities and support several Sustainable Development Goals (SDGs) with co-benefits for adaptation and mitigation. Sustainable crop, grazing and forest systems can isolate substantial amounts of carbon from the atmosphere and store it in soils and vegetation. Sustainable soil and land management initiatives that build up soil organic matter can deliver co-benefits at all levels by contributing to climate change mitigation while maintaining soil-supported ecosystem services, thereby increasing agricultural ecosystems' resilience to climate change and other stressors. Specific technologies such as zaï, half-moons and stone bunds, when combined with an application of organic and inorganic nutrients, are promising climate-smart agricultural practices that small-scale farmers could practice widely.[80]

The Ethiopian government has spurred soil management with the extensive soil mapping under the EthioSIS[81] initiative. This has involved over 100,000 soil samples, machine learning to examine the full range of management options, and initiating public and private sector relationships to bring needed interventions to farmers. Other countries such as South Africa, Nigeria, Tanzania, and Ghana are also generating soil maps.

Improve livestock management. Livestock systems are impacted by climate change, both through direct impacts related to heat and through an array of indirect impacts on forage quantity and quality, water availability and disease spread. The main adaptation options available for different livestock systems are managerial, technical, behavioral and policy-related options. Managerial options include production adjustments and changes in labor allocation.[82] Examples of production adjustments include intensification, integration with crops, shifting from grazing to browsing species, multi-species herds, mobility, soil and nutrient management, water management, pasture management, corralling, feed and food storage, farm diversification and cooling systems. Examples of changes in labor allocation include diversifying livelihoods, shifting to irrigated farming, and labor flexibility. Technological options include breeding strategies and information technology research. Behavioral options include cultural patterns and encouraging social collaboration and reciprocity, such as livestock loans, communal planning, food exchanges, and information sharing.[83]

Locally adapted livestock species are an example of improving livestock for climate change, as disease risks, water availability and pasture quality change. For example, N'dama and West African Shorthorn goats have been bred to survive trypanosomiasis without drugs.[84] Samburu and Turkana Pastoralists in northern Kenya are increasing camel numbers to have more drought-resilient livestock. During drought periods, for example, pastoralists may shift from cattle to sheep and goat husbandry, as their feed requirements are lower, feeding habitats broader and reproduction rates higher. Taking up livestock production, usually poultry, or novel livestock such as cane rats and snails is an expanding adaptation practice in Africa.[85]

Monitor and manage new trends in pests and diseases. The ranges, intensity and frequency of pest and disease outbreaks are all likely to shift under climate change. Key adaptation options include climate and pest monitoring to predict and respond rapidly to emerging and existing pests, and pest prevention measures to discourage the establishment and development of pest populations. To support these direct measures, agroecosystem management can be applied to support ecosystem services and enhance the resilience of farms and landscapes to changes in climate and pest pressures.[86] Applying pest and disease models to analyze and predict yield losses is still challenging for the scientific community. The World Bank is funding the Regional Disease Surveillance Systems Enhancement (REDISSE) project to strengthen weak human health, animal health, and disaster response systems to improve the preparedness to handle future epidemics and minimize the national, regional, and potentially global effects of such disease outbreaks. It currently involves 16 West and Central African countries.[87] Another monitoring service is the Pest Risk Information Service (PRISE), currently being deployed in Ghana, Kenya and Zambia. The PRISE uses a novel combination of earth observation technology, real-time field observations, and plant-pest lifecycle to deliver a science-based pest risk information.

Promote diversification of crops and livestock. On-farm diversification is a promising strategy for farmers to adapt to climate change. Diversification can enhance biodiversity, pollination, pest control, nutrient cycling, soil fertility, and water regulation without compromising crop yields. Crop diversification may be spatial (simultaneous cultivation of species) and temporal (crop rotation).[88] Practices with proven adaptation functions include alternating cereal crops with legumes and broadleaf crops, introducing cover crops, and introducing poultry and small farm animals. Variability in responses and occurrence of trade-offs highlight the context-dependency of outcomes.[89]

Use climate-ready species, cultivars, and breeds. Recent breeding work has enabled several crops and animals to become better adapted to African climate risks, such as Drought Tolerant Maize for Africa (DTMA) varieties, heat-tolerant beans, and fat and thin-tailed ovines. Ten million small-scale farmers have benefitted from DTMA species resulting in increased yield and incomes. The use of adapted crops and varieties helps to reduce the negative impacts of climate change on agricultural systems while leading to stable agricultural production. Small-scale producers adopt climate-resilient crops and varieties to cope with abiotic stresses such as drought, heat, flooding and salinity. To maximize adoption, influencing factors such as availability and effectiveness of extension services, followed by education levels of heads of households, farmers' access to inputs and socioeconomic status of farming families, need to be dealt with.[90]

Incorporate perennial crops, including agroforestry. Trees outside forests substantively contribute to livelihood improvement while also enhancing biomass and carbon stocks. Agroforestry's resource management is proven to benefit livelihood benefits in provisioning, regulating, and supporting ecosystem services. Trees on arable land can support carbon sinks, contributing to adaptation and mitigation through carbon sequestration.[91] Agroforestry for climate adaptation at the farm level and enhanced resilience at the landscape level can take many forms. Agroforestry can reduce air pollution[92] and improve the atmosphere's warming and cooling, thus creating a more stable microclimate for crops and livestock. It also enhances water security through improved infiltration to soils and groundwater, protecting water catchments and watersheds.[93] The potential to improve soil properties and water availability to plants also make agroforestry practices suitable for landscape restoration. Moreover, trees provide several ecosystem services such as water regulation, climate buffering, soil fertility, erosion and flood control, food, fodder, medicine and wood. These are all important for resilience to climate change and reduced vulnerability of local people.[94] For instance, Côte d'Ivoire has committed to restoring forest cover to at least 20 percent of land area by 2030, and mixed cocoa agroforestry systems are a core component of the national strategy.


Photo: subman/iStock

FINANCING ADAPTATION OF AFRICA'S FOOD SYSTEMS TO CLIMATE CHANGE

Cost of action

Appropriate investments in the agriculture sector can help the food systems adapt by increasing productivity, resilience, and resource-use efficiency.

To generate the evidence base for policymakers, Sulser et al. (2021) assessed the cost of adaptation to climate change across a range of future climate scenarios and investment options (Table 3).

Table 3: Description of scenarios in the IMPACT model

Reference	With no climate change (NoCC; constant 2005 climate with various Shared Socioeconomic Pathways (SSPs))
	With climate change (CC; combinations of SSPs and Representative Concentration Pathways (RCPs) across a range of General Circulation Models (GCMs))
Agricultural R&D	Increased reserach and development (R&D) investment across the CGIAR portfolio plus faster and more eficient adoption of new technologies
Water Management	Expansion of irrigated area coupled with increased water use efficiency
	Improved soil water-holding capacity
Infrastructure	Infrastructure improvements to improve market efficiency through the reduction of transportation costs and marketing margins (rail, road, port, and electrification)

Source: Sulser et al. (2021).

Notes: The no climate change scenario is defined by Shared Socioeconomic Pathway 2 (SSP2), while the reference with climate change scenario is defined by the combination of SSP2 with RCP8.5 via the UK Met Office Hadley Centre Earth System Model (HGEM) General Circulation Model. Detailed descriptions of RCPs, GCMs, and SSPs are available from Moss et al. (2010), O'Neill et al. (2017), and Navarro-Racines et al. (2020)[95]

The assessment linking climate, crop, water, and economic models showed that climate change would slow progress toward eliminating hunger. An additional 78 million people are facing chronic hunger in 2050 relative to a no-climate-change future. More than half of the additional food-insecure people will be in Sub-Saharan Africa. The adaptation costs for Sub-Saharan Africa include annual public investments that already address resilience needs: that is, the reference scenario ($5.90 billion) and annual incremental investment costs ($9.58 billion) to offset climate change effects on hunger between 2015–2050 (Table 4).

The estimated cost of sustainable land management (Table 4) builds on an AFR100 initiative that seeks to restore 100 million of degraded land in Africa by 2030. For this report we raised the ambition to 175 million hectares of degraded land by 2050. At land restoration costs ranging from $500 per hectare for woodland to $5,000 per hectare for wetland, land restoration costs by 2050 were estimated at $187.21 billion or $6.24 billion per year for Sub-Saharan Africa. The estimated cost of Climate Information Services builds on a recent assessment on modernizing hydrometeorological services and early warning systems in Africa. Water investments (efficient irrigation systems, enhanced water use efficiency, and improved soil water holding capacity) dominate the reference scenario (59 percent) followed by agricultural research and extension to facilitate the adoption of climate-smart technologies (38 percent) and rural infrastructure to improve market access through the reduction of transportation costs and marketing margins such as rail, road, port, and electrification (3 percent). Additional investments to adapt to climate change impacts are dominated by sustainable land management (35 percent) followed by water (27 percent), infrastructure (20 percent), agricultural research (17 percent), and CIS (less than 1 percent). R&D-led adaptation is most effective in minimizing the impact of climate change on the food system,[96] delivering gains in food security by mitigating food price increases and enhancing environmental sustainability by slowing cropland expansion.

Table 4: Annual reference scenario and incremental investment costs for agricultural adaptation for Sub-Saharan Africa by 2050 ($ billion)

Scenarios	Research and extension		Water management		Infrastructure and market access	Sustainable land management	Climate information services	Total
	International agricultural research	National agricultural research	Efficient irrigation and increased water use efficiency	Improved soil water holding capacity				
Reference scenario ($billion)	1.11	1.11	3.11	0.39	0.18	-	-	5.90
Incremental costs ($billion)	1.66	-	1.42	1.20	1.90	3.35	0.053	9.58
Total	**2.77**	**1.11**	**4.53**	**1.59**	**2.08**	**3.35**	**0.053**	**15.48**

Sources: Sulser et al. (2021); World Bank (2021), and others' calculations

Notes: Sustainable land management includes vegetative measures such as agroforestry, tree planting, and natural tree regeneration, and structural measures such as terracing, flood control, cross slope barriers and other erosion control measures; CIS = Climate information services, including hydrometeorological observation and ICT equipment, Early Warning Systems and Services, Institutions, Regulatory Framework, and Training. Infrastructure includes road, rail, and electricity that help in linking rural communities to markets.

Cost of inaction

Financing adaptation to climate change will be more cost-effective than frequent disaster relief. For Sub-Saharan Africa, our estimates based on a synthesis of existing studies (Table 5) indicate that the annual agricultural adaptation cost is $15 billion (0.93 percent percent of regional GDP), but the cost of inaction could be more than $201 billion (12 percent of GDP). Note that there can be significant regional variations in the cost of inaction. For instance, West and East Africa could lose up to about 15 percent and Southern Africa up to about 10 percent of their GDP by 2050 if adaptation measures are not taken.[97] Also the five adaptation measures considered in this report will require different periods for their impacts to be felt. Public agricultural research undertaken today will begin to noticeably influence agricultural productivity and resilience in as little as three years and its impact could be felt for as long as 25–30 years. The report also assumes advances in international agricultural research to combine tolerances to drought and heat stresses in breeding programs for Sub-Saharan Africa and to rapidly scale up the adoption of these technologies.

With available financial resources and an adequate enabling environment, it can take between six to eight years to fully implement the 175 million ha target for land restoration targets. Different measures require different number of years to deliver adaptation benefits. For instance, structural erosion control measures can be completed within 18 months; grasslands require two years to reach maturity for natural regeneration or planting; natural tree regeneration at least three years; and planted trees about four to six years. On the other hand, once the necessary equipment and other infrastructure have been installed, CIS can provide real-time, personally relevant information that farmers can use to adapt to climate change. Furthermore, ecosystem services from sustainable land management deliver both private and public benefits. Our assessment indicates that provisioning ecosystem services account for only 33 percent of the ecosystem services, while the remaining 67 percent are mostly global environmental benefits. The public good nature of the ecosystem services from sustainable land management provides a compelling case to scale up payment for ecosystem services in Africa.

Adaptation to climate change would also benefit other development areas, such as resilience to pandemics, and boost growth, reduce inequalities, and sustain macroeconomic stability.[98]

Table 5: Annual agricultural adaptation costs and costs of inaction ($ billion)

	Research and extension	Water management	Infrastructure and market access	Sustainable Land Management	Climate information services	Total
Cost of action ($ billion)	3.88	6.12	2.08	3.35	0.053	**15.48**
Cost of inaction ($ billion)	71.21	90.67	12.56	26.76	0.488	**201.69**
Cost of action as proportion of cost of inaction (%)	5.44	6.75	16.56	12.51	10.86	**7.67**

Source: Based on Nkonya et al. (2016); Alene et al (2010); Fenta et al. (2020); Fuglie (2018); Nin Pratt (2021) Venton et al. (2019); Ludwig et al., (2016); and various calculations. See the Annexe on Methodology for more details.

As part of the analysis undertaken for this chapter, we find that deciduous forest is estimated to generate the largest ecosystem services value of $293 billion followed by wetland ($240 billion), while the least comes from woodland ($95 billion). Regulating services (e.g., carbon sequestration) account for 48 percent of ecosystem services provided by forests followed by provisioning services (food production, genetic resources, etc.). Regulating services (regulation of water flows, waste treatment, erosion prevention, etc.) also dominate the ecosystem services generated by wetland (68 percent), followed by cultural services such as recreation (16 percent). Habitat services dominate the ecosystem services provided by woodland (80 percent), while provisioning services dominate the ecosystem services provided by cropland. Provisioning services account for only 33 percent of the ecosystem services, while the remaining 67 percent are mostly global environmental benefits that beneficiaries other than local land managers enjoy. This provides justification for designing payment for ecosystem services schemes to encourage sustainable land management practices.

Economic activity in a month can shrink by one percent when the average temperature is 0.5°C above normal. This impact is 60 percent larger than the average for emerging market and developing economies in other regions, reflecting Sub-Saharan Africa's agricultural dependence and the temperature sensitivity of its agricultural sector. Climate-induced natural disasters, especially droughts, have a long-lasting impact on agroecosystems and people depending on them, reflecting the prolonged nature of the disasters. For example, medium-term annual economic growth in Africa can decline by one percentage point with one additional drought. This impact is about eight times that in emerging markets and developing economies in other regions.

Challenges to economic growth are compounded by widening fiscal and current account deficits and corresponding pressures on public debt and international reserves after a natural disaster. Reduced economic activity translates into lower tax revenues, while spending needs accelerate with the demands of post-disaster relief and humanitarian support and rebuilding damaged infrastructure. Post-disaster foreign financial assistance or remittances seldom fully offset strains on external positions from reduced agricultural exports and increased imports for reconstruction. Financial system stability can also be affected by rapid increases in non-performing loans and deposit withdrawals for banks and deteriorated balance sheets for insurance companies. More broadly, assets stranded because of weather-related disasters could lower collateral values and hurt the stability of financial institutions.

“

I call on all global leaders to ensure adaptation finance and technology reach the small-scale farmers and rural communities.”

Gilbert F. Houngbo, President, International Fund for Agricultural Development

Photo: pixdeluxe/iStock

Financing opportunities

The agricultural financing gap in many African countries surpasses government budgets and available donor funding. The financing gap for climate adaptation is at risk of widening in the future due to fiscal drain on resources from the coronavirus pandemic. Low-income countries are especially hard-hit as they bear a disproportionate weight of climate disasters. At the same time, their fiscal space is more limited, their credit ratings more at risk, and their borrowing capacity more constrained.

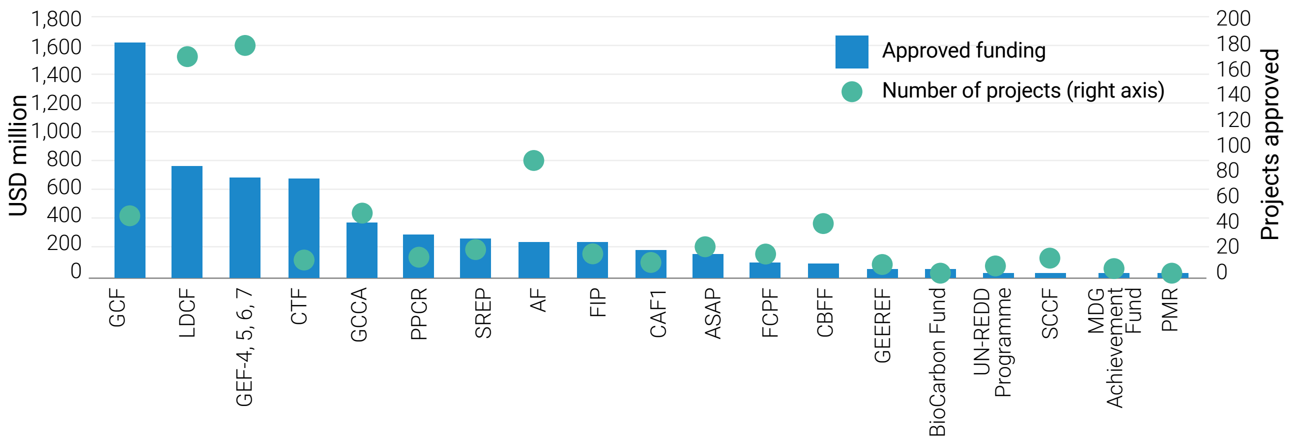
Globally, climate finance for agriculture, forestry, and land use totaled an average of $20 billion per year in 2017/2018, representing just 3 percent of the total global climate finance for the period.[99] On the other hand, climate finance targeting energy efficiency and renewable energy generation averaged $370 billion per year (about 64 percent), and low-emission transport received an average of $140 billion (24 percent) of the total climate finance tracked. Out of the total climate finance tracked, a total of $10 billion was channeled to bring benefits to small-scale agriculture actors, which is equivalent to only 1.7 percent of the total climate finance tracked.[100] Most commitments ($8.1 billion) consist of projects developed in the agricultural sector, forestry, land use, and other natural resource management.

Some 49 percent of the tracked small-scale agriculture climate finance was for climate adaptation projects, of which projects addressing both mitigation and adaptation objectives received 29 percent. In comparison, mitigation-only projects were targeted by 21 percent of the finance. The largest percentage directed towards adaptation is aligned with the increased vulnerability of small-scale agricultural actors to climate change. Low-carbon and climate-resilient infrastructure received the largest share of funding (36 percent), followed by investments to improve agricultural productivity and resilience at farm level and support for enhancing livelihood resilience of rural communities in general (each 14 percent).

Increasing financing for climate-smart agriculture requires addressing the set of market failures which hold back private investments. These include: (i) building technical and institutional capacity for the identification, appraisal and management of climate-smart agriculture investments; (ii) designing financing mechanisms which are operated on a commercial, transparent and sustainable basis and support the mobilization of additional commercial resources; and (iii) identifying and promoting climate-smart agricultural technologies that are commercially viable and deliver significant environmental benefits.

Between 2003 and 2020, multilateral climate funds investments to support low-carbon development and climate adaptation in Sub-Saharan Africa amounted to $5.9 billion. The largest sources of approved funding for adaptation projects are the Green Climate Fund (GCF), the Least Developed Countries Fund (LDCF) administered by the Global Environmental Facility (GEF), the Pilot Program for Climate Resilience (PPCR) of the World Bank's Climate Investment Funds (CIFs) and the Adaptation Fund (AF). Some 37 percent of the multilateral climate finance into Sub-Saharan Africa are adaptation flows, 33 percent support mitigation, 17 percent are multiple foci, and 13 percent support REDD+ [101] activities.[102]

Figure 10: Multilateral Climate Funds flow into Sub-Saharan Africa, 2003-2020

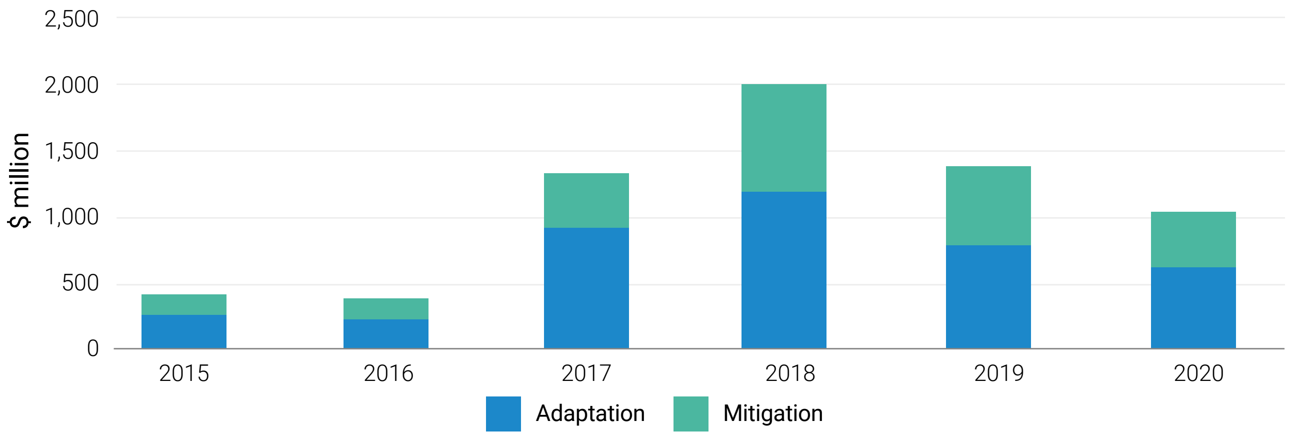


Source: Watson and Schalatek (2021)

For more than a decade, Multilateral Development Banks have been tracking climate finance flows in their operations across sectors through an agreed joint methodology for adaptation and mitigation. Figure 11 shows that climate finance flow to the agriculture sector in Sub-Saharan Africa increased from $433 million in 2015 to $2 billion in 2018 and then declined to just over $1 billion in 2020. Adaptation flows are consistently higher than mitigation flows, ranging from 58 percent in 2019 to 69 percent in 2017. This again reflects the priorities of African countries to address the agriculture sector's climate vulnerability and increase resilience. The increase in mitigation financing in the last four years suggest that countries are increasingly paying attention to the vast potential for African agriculture to reduce agricultural emissions through climate-smart practices. This is plausible as both adaptation and mitigation share the ultimate purpose of minimizing climate impacts.

Photo: Maria Schiffer/iStock

Figure 11: Multilateral development banks' climate finance flow to agriculture and land use in Sub-Saharan Africa, 2015–2020 ($ million)



Source: Data compiled from the MDB joint reports on climate finance by African Development Bank (AfDB), the Asian Development Bank (ADB), the Asian Infrastructure Investment Bank (AIIB), the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Inter-American Development Bank Group (IDBG), the Islamic Development Bank (IsDB) and the World Bank Group (WBG)

Maximizing finance will require a range of public policy actions including increasing the space for private sector activity, improving the policy and regulatory environment, and using public financing to help crowd-in private sector investments to optimize the use of scarce public resources.[103]

Significantly increasing the amount of capital available for climate-smart investments in agriculture is critical to achieving adaptation objectives. This will require designing new financing mechanisms and overcoming longstanding technical and institutional barriers. The critical barriers to closing the financing gap for agriculture include an inadequate enabling environment, limited capacity to manage production, marketing and price risks, and high transaction costs of lending to farmers.

Photo: Afrimages/iStock

Targeting finance to benefit small-scale producers

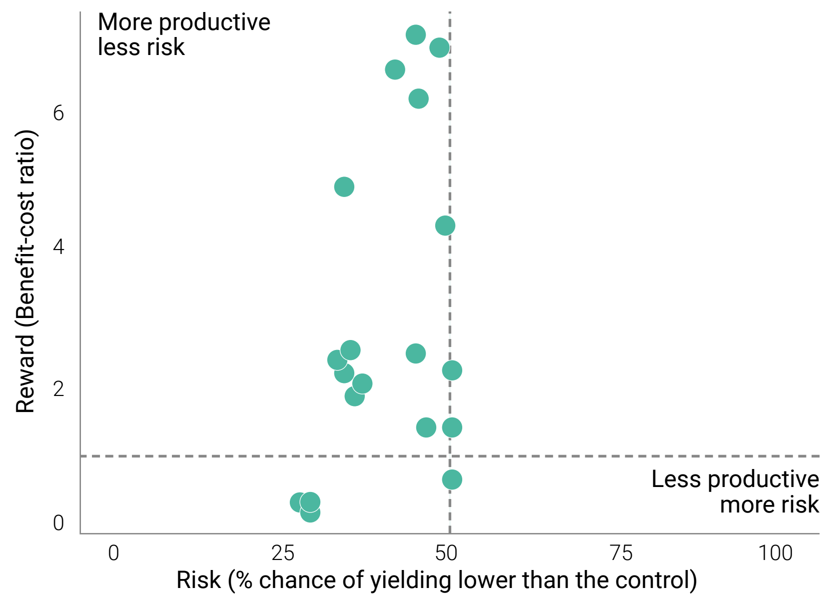
Small-scale producers—farmers, livestock keepers, fishers and small rural enterprises—are a key target for finance if Africa is to achieve sustained resilience to climate change. However, globally, small-scale agriculture continues to receive a low share (40 percent) of total climate finance for the Agriculture, Forestry and Other Land Use (AFOLU) sector. Between 2017 and 2018, Sub-Saharan Africa was the largest recipient of climate finance to small-scale producers, amounting to $3.6 billion, or 36 percent of the total climate finance committed worldwide to small-scale agricultural producers.[104]

The price tag for food system adaptation in Africa can make it easy to lose sight of the millions of financial decisions small-scale producers must make to transform agriculture. Evidence shows that adopting simple farming techniques—such as covering the soil with crop residues to conserve soil moisture,[105] planting trees to reduce ambient temperature,[106] among many others—may buffer against future climate hazards. But barriers to changing farming practices including costs and risks can be high, if not prohibitive, for many small-scale producers, as they need to invest new financial, knowledge, or human capital and the benefits are uncertain.[107]

Farmer investment in improved crop, soil, nutrient management, and agroforestry options reduce risk, helping farmers adapt. Yields are greater than business-as-usual for most options, though risks grow along with rewards (Figure 12). Nevertheless, the potential benefits typically far exceed costs, with expected returns up to seven times greater. Investments present an opportunity to capture benefits in relation to the level of risk incurred by the investment. Many resource-poor farmers may not be able to accept even the lowest level of risk, especially when the investment has an extended payback period or high upfront costs. Complementary strategies including insurance, credit, and access to weather information can further mitigate risk and catalyze changes in farming techniques, amplifying the adaptative capacity of small-scale producers.

Public sources of finance can be used to increase the flows of capital to small-scale food producers in Africa and de-risk investment in three main ways. The first is by developing an enabling environment that enhances farmers' access to tailored and demand-driven financial services. The second is by building the capacity of financial institutions to manage exposure to specific agricultural risks. The last is by supporting financial institutions in reducing transaction costs, for instance through branchless banking and mobile financial services. Better understanding of small-scale farmers' individual adaptation investment decisions, as described above, provides a critical foundation to increase and improve the flows of adaptation capital to them.

Figure 12: Potential trade-offs between rewards and risks for small-scale producers when investing in improved farming practices.



Note: Rewards were calculated as the benefit-cost ratio. Risk considers crop yields over time, given varying weather conditions, and represents the possibility of yielding lower than the average yield when not using the improved farming technique. Data were derived from farm budgets estimated during research trials in Kenya and Malawi and compiled as part of the Evidence for Resilient Agriculture (ERA) v1.0.[108]

POLICY RECOMMENDATIONS

To avert catastrophic impacts on food security, adaptation of agriculture and food systems is an imperative, not a choice, for African countries in this decade and in coming decades. All indications are that financing adaptation to climate change will be more cost-effective than financing increasingly frequent and severe crisis responses, disaster relief, and recovery pathways. For Sub-Saharan Africa, the cost of action works out to a tenth of the cost of inaction. Furthermore, there is tremendous synergy between adaptation actions and the development agendas enshrined in the Sustainable Development Goals and the Malabo Declaration of 2014.

Priority actions for African governments to enable adaptation of food systems encompass both policy interventions and public financial investments. For the policy interventions, the financial costs are relatively low, but political effort is needed. Key areas for attention are reduction in trade barriers, repurposing of existing agricultural subsidies, and addressing distortions that slow down adaptation, such as women's unequal legal access to productive assets. Other actions carry higher public sector investment costs, but deliver substantial benefits to adaptation, with compelling impacts on food security as well as co-benefits to climate mitigation.

"All the science is showing we are closer and closer and closer to a tipping point and so we have to find a way bring everybody together and agree to come on action. I am afraid I don't have a silver bullet idea for it. We just have to get it all done. We have to give equal weight to adaptation and mitigation, bring the developing and developed worldviews together to fight climate change. We have no choice."

Lee White, Minister of Forests, Oceans, Environment and Climate Change, Gabon
High-Level Dialogue "An adaptation acceleration imperative for COP26", September, 2021

Five key areas identified for such investment are: research and extension services, water management, climate-resilient infrastructure, sustainable land management, and climate information services. For all of these, there is a sound evidence base from which to build a business case for climate finance and private finance. There is also substantial practical experience to draw on for implementation, both from African contexts and globally.

In summary, climate adaptation of the agriculture and food systems is an urgent, impactful and achievable agenda for African countries.

Photo: Bartosz Hadyniak/iStock

Photo: WBG - Arbegona woreda land certification

Sustainable Land Management in Ethiopia

Geography: Ethiopia's highland regional states: Amhara, Oromia, Tigray, SNNP, Beneshangul/Gumuz, and Gambela.

Adaptation measures: This series of investment projects, and most recently, a results-based financing program, have been building resilience and addressing land degradation by establishing community and kebele[109]-level watershed management teams, developing and implementing participatory watershed management plans and building local capacity in sustainable land management (SLM). Investments to support the implementation of participatory watershed management plans include those for introducing and expanding climate-smart agriculture, grazing ex-closures to allow regeneration of vegetation on steep slopes, biophysical soil and water conservation measures – such as terracing, afforestation and participatory forest management, treatment of erosion gullies, small-scale irrigation and water harvesting systems. These investments are complemented by activities that help sustain these practices whilst also diversifying livelihoods, developing value chains for key crops and improving fodder supply and quality. The program also provides support for land titling and land registration in woredas to improve land tenure security and to incentivize farmer-level investment in sustainable land management practices. The CALM program takes these investments to transformative scale, by providing results-based financing in support of expanding the number of major watersheds under participatory watershed planning and management and for land certification and the establishment of woreda-level land registries.

Key outcomes: Targeting land degradation: Vegetation cover in the project area increased by 9 percent (as measured with remote sensing data) and soil carbon by 0.3 percent in the 2009–2013 period,[110] indicating a reduction in land degradation as a result of SLM practices. Although the extent of yield increases was not measured directly as part of the project, SLM has made measurable contributions with regards to reducing soil erosion and runoff, which has enabled farmers to get better return on their investments in productivity enhancements. (e.g., fertilizer and improved seeds).[111] Early results from support for land titling show that farmers are willing to use land certificates as collateral for microfinance loans, therefore increasing investment in SLM practices and business development.

Partners and funding: SLMP 1 and SLMP 2 (US$29 million and US$102 million, respectively from International Development Association, Government of Ethiopia and GEF 2008–2018); RLLP (US$129 million from IDA, GoE, Canada and Norway) 2018-2024; RLLP 2 (US$178 million from GCF and PROGREEN). 2018–2024; CALM (US$500m from IDA) 2019-2024.

PROJECT SUMMARY

Mean temperatures in Ethiopia have been increasing by an average of 0.25°C per decade, while the number of hot nights and days increased by 37.5 percent and 20 percent respectively between 1960 and 2003.[112] The trend is expected to continue up to a 3.7°C increase in mean temperature and a 26–69 percent increase in the number of hot days by the end of the century under a high-emission scenario, increasing the intensity of heat-waves and evapotranspiration demand and driving droughts.[113]

While the country's climate features a large amount of inter-annual variability, end-of-century trend data indicate a 20 percent rainfall reduction (baseline 1986) in spring and summer in the central, northern and southern regions, leading to increased water stress.[114] Drought impacts over the last century (from 1900 to 2020) have led to more than 400,000 deaths and nearly 80 million people affected,[115] with economic losses amounting to US$1.5 billion.[116,117]

About 79 percent of Ethiopians live in rural areas that largely depend on agriculture, a sector responsible for 48 percent of the country's GDP and 85 percent of export earnings.[118] Agricultural production is dominated by rainfed small-scale farms, which are highly dependent on healthy soils, water, forests and biodiversity. All of these are currently threatened by the impacts of land degradation, which is affecting some 80 percent of the country, with 27 million ha significantly eroded and two million ha beyond reclamation.[119] Losses from land degradation currently are estimated to cost 2–3 percent of GDP.

Community-based watershed management is a country priority for scaling SLM practices, and recent efforts have focused on integrating landscape approaches and climate adaptation needs. This approach has been used in the two phases of the Sustainable Land Management Project (SLMP) and its successors, the Resilient Landscapes and Livelihood Projects (RLLP 1 and 2) which are both ongoing, and most recently, the Climate Action through Landscape Management (CALM) Program for Results. In total, around 250 'major' watersheds are being supported by ongoing investment projects, an additional 5,000 microwatersheds by the CALM program; and around 380 districts are receiving land administration support.

Lessons learned from previous SLM interventions across other countries in the Sahel and West Africa region have informed the programmatic approach to supporting the GoE's SLM Program. For instance, previous projects often lacked ownership among communities or failed to create incentives through early benefit flows, rendering them unsustainable or quickly reversed. The SLMP and RLLP projects promoted SLM supported by the issuance of landholding certificates to smallholders and institutional capacity development to enhance communities' participation and investments. So far, the investment projects (SLMP 1, 2 and RLLP) have led to the establishment of 980 community-level watershed user associations with 125 multiyear management plans for major watersheds currently under implementation. CSA and conservation measures are now being implemented over 400,000 ha within these major watersheds. Bylaws were developed and applied across 500 micro-watersheds to improve the governance of communal lands and over 700,000 land certificates have been issued to households, of which over 500,000 have been issued to women, either individually or jointly with a man. Over 20,000 land certificates have been issued to previously landless youth. Whilst the RLLP and RLLP 2 projects are ongoing, and will continue under

Photo: WBG - Ethiopia, Tigray region, Kola District. As part of the World Bank funded SLMP, the community planting local species of trees

Photo: WBG - World Bank financed RLLP Farm land rehabilitation, Arbegona woreda, Sidama region, Ethiopia

implementation until 2024, the CALM Program is scaling this support still further, aiming to bring 2.5 million ha under watershed management plans and sustainable land management practices by 2024. It also aims to put in place modern land registration systems in 280 woredas and support issuance of nearly 19 million land certificates.

Typical SLM interventions under these projects and programs include the construction of physical soil and water conservation infrastructure (e.g. stone terraces, soil bunds, check-dams and trenches); tree planting and area closures to rehabilitate degraded communal lands (hillsides and pastures jointly held by the community for grazing and other needs); and soil and water conservation, water harvesting, agroforestry and improved seeds and agronomic practices on individual farmlands (land held and cultivated privately by smallholder farmers).

These projects and programs also benefit and enhance the inclusion of landless families, youth and women through the introduction of small ruminant livestock, poultry and bees. The building of livelihood resilience was supported through integrated fodder planting or poultry/sheep/goat and through infrastructure improvements like building of roads/feeder roads. Tens of thousands of farmers have been trained on income generating activities and nearly 100,000 people now take part in income generation activities under support from RLLP alone. Over 900 'common interest groups' have been established to support income generation and other livelihood activities under SLMPs 1 and 2 and the RLLP. In the long term, these interventions are expected to increase diversification of livelihoods, improve resilience, reduce vulnerability to climate shocks and reduce greenhouse gas emissions.[120]

Households' vulnerability to climate shocks was evaluated based on changes in food and water security and out-migration, with about that two thirds of the participating households showing reduced vulnerability to droughts after the SLMP 2 project was completed. Improved food security was highest in areas suffering from severe land degradation, which also saw reduced out-migration, and in drought-prone areas, where small-scale irrigation was the key enabler for increased yields and reduced exposure to droughts. Commercial agroforestry and sustainable charcoal production, which were promoted to help diversify communities' sources of income, also reduced vulnerability in some communities through income growth. However, the poorest and landless households and those without access to irrigation perceived relatively diminished benefits through activities like poultry, livestock production, beekeeping and harvesting of grass from communal lands.

The projects demonstrated greater success in abating land degradation than in improving livelihoods and reducing vulnerability, highlighting that addressing degradation alone is not sufficient to reduce vulnerability to climate shocks. For this reason, the RLLP projects have a stronger focus on improving livelihoods. The lessons learned from these projects also point to the importance of encouraging proactive local participation, having demonstrable and upfront economic benefits to incentivize smallholder farmers to maintain the SLM practices introduced as part of the projects and implementing market-oriented agroforestry interventions that can bring sustainable income for smallholder farmers.

Improvements in ongoing and future World Bank-financed projects (RLLP and RLLP II respectively) aim to strengthen the establishment of formal water organizations and the support revenue models through value chains, public-private partnerships or community linkages, enhanced capacity building and improved returns by increasing climate smart agriculture (CSA) and other practices to enhance productivity. The strong commitment of the Government of Ethiopia to the SLM agenda and the development of proven models for addressing land degradation have also enabled a transition from project to results-based financing and this now offers very promising prospects for achieving a transformational scale-up of support for SLM across Ethiopia's highlands.

Photo: AFD

Agroecology Program for West Africa – A solution for family farms of the Economic Community of West African States to climate change risks

Geography: Member states of the CEDEAO (Burkina Faso, Côte d'Ivoire, Mali, Senegal and Togo and to be expanded across 15 countries in West Africa).

Adaptation measures: The program aims to minimize projected climate change-related agricultural yield reductions and build resilience through an agroecological transition for sustainable intensification.

Key outcomes (expected): The project anticipates a 5 percent annual reduction in the number of people who are structurally vulnerable to climate risks, food and nutrition insecurity in the covered area.

Its goals include: 50 percent of agricultural family farms participating in collective organizations for agroecology; 10 percent of agricultural lands in project areas under agroecological practices; 15 mechanisms operational (three per country) to remove barriers to agroecology in the context of the National Plans for Agricultural Investment, Food Security and Nutrition (PNIASAN); a 5 percent annual increase in the number of people trained in agroecology (12,000 farmers, of whom 10 percent should be young people and 30 percent women); and at least 12 training centers with capacities in agroecology operating.

Partners and funding: European Union and French Development Agency (AFD). 2018-2024. 16.2 million euros.

PROJECT SUMMARY

West Africa is experiencing relatively rapid changes in climate, with warming across the region[121] and increased precipitation and climate extremes. Although future precipitation trends are uncertain, the western Sahel region (west of 0°E) shows drier scenarios combined with a 2-4°C warming in average temperatures by the end of the century.[122]

Despite uncertain future scenarios with regards to monsoon rainfall, projected crop yield losses have been identified as a common threat to livelihoods in rural West Africa. Studies show a consensus on expected yield reductions of 11 percent in West Africa, with corn being the crop most affected. Yield losses will be driven by the effects of higher temperatures on crop cycle duration and increased evapotranspiration demand, despite changes in rainfall.[123]

Scaling agroecological production is a crucial opportunity for sustainable development in West Africa. It will not only improve the productivity of agriculture but also its resilience to climate change, thus helping to contain food and nutritional insecurity in the region. Adequate public policy is needed to support the scaling of agroecological systems, backing agroecological intensification with complementary approaches (e.g. trainings, demonstration plots, expert consultation, alternative marketing systems) that promote the emergence, adoption and dissemination of environmentally intensive agricultural practices in family farming. This project has a double objective: to develop field projects to support groups of farmers and herdsmen who commit to changing their practices and to encourage experience sharing and contribute to the development of public policy.

The program is implemented by a commission of CEDEAO through the Regional Agency for Food and Agriculture (ARAA). Agroecological principles aim at promoting practices that are locally contextualized, add value to local resources, improve biodiversity and minimize dependence on external inputs. Within the context of African farming systems, practices that enhance soil quality, improve water management, adapt cropping systems (through modified sowing practices and crop/cultivar selection), and improve livestock management (mainly forage management, food supplements and grazing-free areas) are crucial to building resilience.[124] These practices contribute to livelihood adaptation by minimizing the impacts of reduced precipitation and increased rainfall variability and temperatures. They do so by improving the resilience of livestock and cropping systems, often using a combination of several practices.[125]

The project strategy is based on developing local participation and ownership, integration of communities and the agricultural industry, co-production of innovations, addressing adoption needs, strengthening of capacity building centers and diffusion of technological innovations, inclusion of women and youth, systematization of lessons learned (including applied research) and support of public policies towards agroecology.

Local implementation has been driven by 15 field projects, six of which had started by the end of 2020. Efforts in capacity building and dissemination of technologies are being rolled out based on diagnostic assessments of 12 training centers, agricultural schools and professional and research organizations. Farm level implementation of adaptation practices is framed under participatory landscape management plans that drive agroecological intensification at the farm level through community level processes supported by the training of technical staff and field schools for farmers. Finally, the projects will seek to add value and introduce agroecologically intensified products across the region.


Photo: Lance Hadley/Shutterstock

Better Beans for Africa

Geography: Pan-Africa

Adaptation measures: The project promotes resilience building across the value chain of bean production in Africa. It provides farmers with access to iron-biofortified beans, a climate-smart and resilient crop with enhanced nutritional content. To improve the uptake of the beans, the initiative works to develop the capacity of smallholder farmers and to improve nutrition education and awareness. It promotes diversification of meals among African households, with a focus on bean-based products, and fosters partnerships with the private sector to improve the market access of bean-based products.

Key outcomes: The program has developed more than 536 varieties of iron-biofortified beans and made them available to more than 300 million households. The bean crops produced are climate resilient, early maturing and have enhanced protection against pests and diseases. In Rwanda, iron bean yields were 20 percent higher than other available varieties, providing US$ 58-78 profit per hectare for smallholder farmers. In addition to improving nutrition security when introduced into the diets of local communities, beans help in alleviating iron deficiency among women and children.

Partners and funding: Consortium Group on International Agricultural Research, Alliance of Bioversity International, HarvestPlus, Agriculture for Nutrition and Health, International Center for Tropical Agriculture, Global Affairs Canada, Swiss Agency for Development and Cooperation (SDC), United States Agency for International Development (USAID), UK Foreign, Commonwealth and Development Office, The Rockefeller Foundation, Alliance for Green Revolution in Africa, KirkHouse Trust, Bill & Melinda Gates Foundation and other national and local-level stakeholders. 1996-present.

PROJECT SUMMARY

Despite growing efforts to fight hunger and malnutrition, the number of hunger-stricken people in Africa has increased by 47.9 million since 2014, reaching 250.3 million (or one fifth of the total population of the continent) in 2020. In West Africa, nearly 17 million people needed immediate food assistance in 2020 due to a combination of drought, poverty, high food import prices, environmental degradation, displacement, poor trade integration, and conflict–a set of interlinked threats. Almost 94 percent of the undernourished population resides in Sub-Saharan Africa.[126] Economic recession due to COVID-19 is expected to push additional 25 to 42 million to the brink of undernourishment.[127]

The African Union's most recent Biennial Review shows that only four of 49 member states are on track to achieve the goals and targets of the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods by 2025 (AU 2020). This means that Africa is lagging on progress to achieve Sustainable Development Goal 2, which calls for ending hunger in all forms by 2030, and Sustainable Development Goal 13 on taking action to combat climate change and its impacts.

African agriculture and food systems are already suffering from the impacts of climate change. Already, visible effects include changes to the start and end dates of growing seasons and the frequency and intensity of dry spells and heavy rainfall events. Evidence shows that climate change has stalled productivity growth in the continent's foremost staple crop, corn.[128] Overall, Sub-Saharan Africa has experienced about a 1.4 percent reduction in food calories per year from key food security crops (corn, cassava, sugarcane, sorghum, rice) due to climate change.[129] Precipitation is also likely to decrease over northern Africa and southwestern parts of South Africa by the end of the century, while the overall frequency and intensity of heavy precipitation events are projected to increase elsewhere on the continent.[130] These climatic changes are likely to have negative impact on agricultural production and food security. Food insecurity ncreases temporarily by 5-20 percent in the affected area after with each flood or drought.[131]

Studies have predicted that by 2050 calorie availability is likely to decline throughout the developing world, resulting in an additional 24 million undernourished children ages 0-5, almost half of whom will be living in Sub-Saharan Africa. This is 21 percent higher than the projection with no climate change.[132] This is particularly alarming since the adverse consequences of undernutrition in the first years of life are often irreversible.[133] The importance of improving diets, particularly for children, and having more complete nutrition in each meal has been recognized throughout the continent.

In light of this situation, beans have been identified as one key resource to combat undernutrition in Africa because of their high protein content, and generous amounts of fiber, complex carbohydrates and other dietary necessities. Beans also supply 25-30 percent of the recommended daily levels of iron and meet 25 percent of the daily requirement for magnesium and copper, as well as 15 percent of potassium and zinc.[134] Common beans are a staple across eastern, central and southern Africa, where about 6.3 Mha of land is used to grow beans every year. Per capita bean consumption in eastern Africa is the highest in the world–in western Kenya, Rwanda and Burundi, people eat around 50-60 kg of beans every year. Beans are also quickly gaining importance in countries such as Cameroon and Guinea in central and western Africa. However, the impacts of climate change are likely to negatively affect common bean production across Africa. Reduced precipitation will impact common bean production in southeastern Africa by 2050. The iron content in common beans is also expected to significantly decline under climate change-induced drought stress.[135]

The introduction of iron-biofortified beans in the African agricultural systems and diets offers an effective way to adapt the existing bean production and reduce food insecurity and undernutrition on the continent. The effort to mainstream these "better beans" was led by the Pan Africa Bean Research Alliance (PABRA), a collaborative, multi-stakeholder platform for research to facilitate rural transformation, which has worked to develop incomes, resilience to climate change and gender equality for improved rural and urban livelihoods in 32 African countries.

PABRA's resilience building interventions take place across the entire value chain from bean production to consumption. Specific areas of intervention include research development, wherein PABRA and its associated breeding program carry out biofortification of beans to increase their iron and zinc content, and working with communities to impart nutrition education and awareness. The project also works to improve the diets of smallholder farmers by encouraging them to consume their own crops; shares bean recipes and preparation skills with households to improve the quantity and frequency of bean consumption in household diets; and promotes dietary diversification through a food basket approach consisting of locally available fruits, vegetables, meats, roots and tubers, along with beans, to provide a well-rounded, diversified and nutritious diet. Additionally, it promotes the cultivation of community kitchen gardens and builds partnerships with the private sector to give an impetus to the commercialization of nutritious value-added bean products (e.g., bean-based porridge flour for use in school feeding programs), as well as working with cottage industry players like food vendors and local restaurants to develop bean-based snack foods. The iron-biofortification of beans is also carried out in response to farmer and market demands, with the improved varieties being early maturing, high in iron and zinc, drought and heat-resistant and protected against pests and diseases.

PABRA scales its efforts through multistakeholder partnerships in different countries. For example, in Burundi, PABRA partnered with the private sector and Institut des Sciences Agronomiques du Burundi to scale up the production of composite bean flour for infants and new mothers. In Rwanda, one of the early adopters of iron-biofortified beans, where about one in five women and four in 10 children suffer from anemia, PABRA–with support from CGIAR's HarvestPlus Program, Alliance of Biodiversity International, CIAT and the Rwandan Agriculture Board–has released ten iron-biofortified bean varieties to date. By 2018, an estimated 20 percent of the beans produced were high-iron varieties, consumed by 15 percent of the population (1.8 million people). Iron bean yields are about 20 percent higher than other available varieties, providing an additional US$ 57–78 in profit per hectare for smallholder farmers. To ensure sustained biofortification delivery, in 2019 the entire iron bean program was handed over to the Rwanda Bean Alliance, which includes representation from actors across the value chain and engages in activities from research to consumer education.[136]

To date, PABRA has released 536 varieties of beans, which have been distributed to more than 30 million households. Early evidence from Rwanda shows the increase in the physical work efficiency of women attributed to decreased iron deficiency through mainstreaming fortified beans in their diets.[137] Survey results from Tanzania also reveal the positive impact of fortified beans on the food security status of bean growers in the southern highland zone and reiterate the importance of policies that promote and facilitate access to fortified beans–such as education and programs to improve wealth status and market access–as central to alleviating food insecurity.[138]

MoA-INFO – Digital Solutions for Agriculture

Geography: Kenya

Adaptation Measures: The project delivers free digital agricultural extension and advisory services via SMS to smallholder farmers throughout Kenya. Topics include scientifically validated and reviewed agronomic practices to support the cultivation of 11 crops (corn, beans, Irish potatoes, sweet potatoes, mung beans, bulb onions, cabbage, sorghum, bananas, tomatoes and pigeon peas), agronomic information, climate-smart advisory, weather information, optimal input use, organic input use, monitoring of prices of agricultural inputs and extension services. MoA-INFO also designed and delivered "decision-support tools" to farmers via their mobile phones, which they can use to make better-informed decisions regarding monitoring for and managing fall armyworm infestations, selecting the most appropriate seeds based on local conditions, and fertilizer use.

Key outcomes: The project helps to boost agriculture yields by providing customized and farm-relevant advisory, the provision of timely and locally-relevant weather information to enable more informed cropping decisions, and optimal and informed use of agricultural inputs.

Partners and funding: Precision Development (PxD); Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MoALFC); the International Fund for Agricultural Development (IFAD); Center for Agriculture and Biosciences International (CABI).

PROJECT SUMMARY

Kenya has the largest economy in East Africa, and with a population of more than 52 million as of 2019, it serves as the region's financial, trade, and communications hub. Agriculture forms the backbone of the Kenyan economy, contributing more than 33 percent to the country's GDP. The majority of the agricultural production is rainfed (98 percent) and is led by smallholder enterprises, employing more than 40 percent of the total population and 70 percent of the rural population.[139] Agricultural productivity, however, has stagnated in recent years, despite continuous population growth. Only 20 percent of the land in Kenya is suitable for agriculture; however, maximum yields have yet to be achieved, leaving considerable potential for increases in productivity.[140] The current productivity losses arise from lack of access to basic agricultural inputs, updated technology and adequate finance and extension services. These issues will further be exacerbated by the growing impacts of climate change.[141]

Kenya not only faces increasing inter-seasonal variability in precipitation patterns but also a greater likelihood of extreme events like droughts and sea level rise along its coastline. Warming in Kenya is expected to be around 1.2–2.2°C by 2050, with the greatest temperature increases in the west. Projections also point to an increase in the duration (nine to 30 more days) of heatwaves. Precipitation patterns are expected to remain highly variable and uncertain; however, average rainfall is expected to increase by 2050, particularly during October and December.[142] Climate extremes, particularly floods and droughts, are also expected to become more frequent and severe. Climate disasters in the recent past have already caused severe economic losses. Droughts from 2008 to 2011, for instance, caused losses amounting to US$10.2 billion (compared to a loss of US$ 2.8 billion during the 1998-2000 drought) in livestock and crop production.[143,144]

Given the importance of agriculture to Kenyan economy and society, it is essential for adaptation options to help embed climate information better into cropping decisions to make the agricultural systems more resilient. Many disruptive agricultural technologies (DAT) are helping address not only threats posed by climate change but also several other challenges that impede agricultural growth, including: lack of market access for smallholder farmers; limited access to inputs like seeds, fertilizer and machinery; limited information about variables like weather patterns, soil characteristics, future market demand; inequalities among farmer groups and gender inequality.[145]

Precision Development (PxD) makes use of these disruptive technologies to alleviate challenges faced by smallholder farmers. The organization provides digital climate-informed advisory services, including decision-support tools, services, platforms and activities that can help disseminate climate information, enabling individuals and organizations to make climate-resilient decisions and adapt to climate variability. In Kenya, PxD started in 2016 with a pilot project that provided SMS-based advisory service to around 1,900 smallholder corn farmers, giving tailored recommendations based on local soil tests. Building on this approach, in 2017 PxD expanded the dissemination of its advisories through phone calls and e-extension systems in addition to SMS, reaching more than 5,900 farmers.[146] The advisories resulted in increasing the yields of sugarcane farmers by 11.5 percent.[147] Agricultural advisories also emboldened farmers and encouraged changes in behaviour and farming practices; e.g., making them 10-24 percent more likely to experiment with farm inputs to combat local soil acidity.[148] The initiative also strives for financial inclusivity by providing farmers with low-cost, accessible and relevant mobile agronomic advice that is customized to boost yields.

To bring the digital solutions to scale, PxD collaborated with Kenya's Ministry of Agriculture, Livestock, Fisheries and Co-operatives in 2018 to launch the MoA-INFO SMS platform to issue advisories to combat the spread of the fall armyworm. The advisories were co-produced with inputs from counterparts in the Ministry of Agriculture, CABI, and experts in the field, ultimately providing a decision-support tool for farmers to gain knowledge about armyworms, monitor the costs of pesticides and make informed and cost-effective decisions about their use.


Source: Precision Development


Source: Precision Development

The service, which provides free agricultural recommendations to farmers via SMS, can be accessed with any type of phone and currently has more than 650,000 registered users across Kenya. Initially, the platform was focused on advice around fall armyworms but has since expanded to include recommendations for growing 11 crops. The recommendations are customized based on the user's location, which is collected at the ward level, and are offered in either Swahili or English. The advisory messages are based on recommendations that were jointly developed with and approved by the MoALFC (including KALRO). The service allows farmers to pull up content when they are looking for information about crop production or pest control and to receive push messages with farming advisories that are timed to the crop calendars in different parts of the country. Lastly, the platform also includes multiple decision support tools (DSTs) that allow farmers to receive customized advice about seed varieties, fertilizer types, pests and diseases control measures.

PxD developed its own in-house platform (Paddy) to run MoA-INFO on behalf of the MoALFC. The platform allows for greater customization of advisories and can send content over SMS, voice messaging, WhatsApp and Telegram. Paddy is now being used in multiple countries where PxD works. Overall, PxD serves more than 5 million farmers in ten countries, five of which—Ethiopia, Kenya, Rwanda, Uganda, and Nigeria—are in Africa.

Supporting smallholder agriculture

Photo: IFAD

IFAD'S GROWING ROLE IN ADAPTATION

Smallholder and poor farmers in the developing world are heavily reliant on natural resources, which were already degrading before climate-related changes such as increasing temperatures, erratic rainfall, pest infestations, rising sea levels, and extreme events such as floods, droughts, landslides, and heatwaves presented further threats to smallholder habitats and livelihoods.

In response, the share of IFAD's resources allocated to climate change has been rising. During 2019-2021, 42 percent of IFAD's financing in eastern and southern Africa supported climate change actions. The equivalent figure for eastern and southern Africa was 34 percent. Up to 90 percent of IFAD's spending on climate change is for adaptation.[149]

IFAD's Adaptation for Smallholder Agriculture Programme (ASAP), first launched in 2012 with a second phase starting in 2018, is the world's largest climate adaptation program dedicated to supporting smallholder farmers.

ASAP aims to reach out to eight million people, including four million women and girls, to:

- Improve land management and gender-sensitive climate-resilient agricultural practices and technologies
- Increase availability of water and efficiency of water use for smallholder agriculture production and processing
- Increase human capacity to manage short- and long-term climate risks and reduce losses from weather-related disasters
- Make rural infrastructure climate-resilient
- Document and disseminate knowledge on climate-smart smallholder agriculture

An ASAP Trust Fund of US$ 316 million, supported by 11 donors, has so far committed US$ 292.6 million to 42 projects. Grants provided under the Programme are mainstreamed into larger IFAD projects, to increase the climate resilience of IFAD's approximately US$ 1 billion per year of new investments.

ASAP grants have supported adaptation tools; climate risk analyses; agroecological interventions that enhance resilience; food loss and waste reduction; climate-smart irrigation; climate information services; stakeholder engagement; and social protection. A brief snapshot of ASAP activities in Africa follows.

Adaptation toolbox

As part of ASAP, IFAD has developed a toolbox that includes the Climate Adaptation in Rural Development (CARD) Assessment Tool and the Adaptation Framework.

CARD enables the integration of climate-related risks into investments and strategies, food security studies, and rural development policies. Designed for non-expert public and private investors and decision-makers, it currently provides data for 17 major crops in nearly all African countries. CARD can be used to provide estimates of how climate variability and change will impact yields and value chains. It can also inform decisions to shift from one crop that may be more vulnerable to climate impacts, to another.

For example, Figure 1, generated by CARD, shows the impact of climate change on rainfed agricultural yields (without irrigation) in Mali. Cereals, tubers, and pulses, which are important crops for smallholder farmers in Sub-Saharan Africa, will be heavily impacted, with wheat yields in Mali, for instance, going down well below 40 percent by 2050.

The Adaptation Framework tool is a repository of adaptation actions for small-scale agriculture, including livestock, forestry, and fisheries, that can be used in project design.[150] Project design teams can consider cost-benefit, climate risk relevance, farmer capacities, mitigation co-benefits, and biodiversity support.

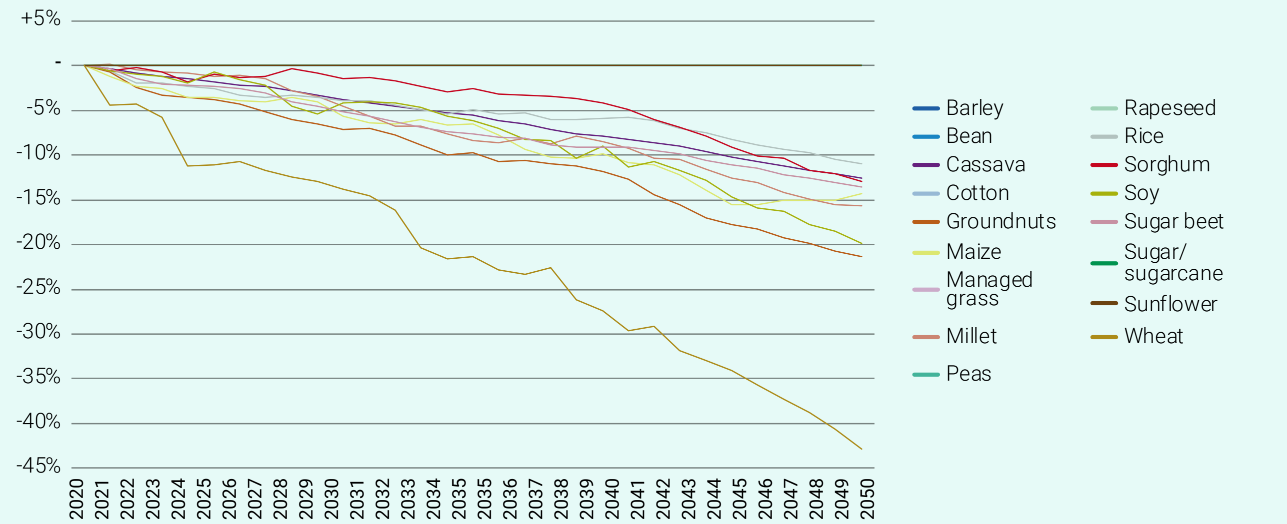
Climate risk analyses

ASAP also funds climate risk analyses (often conducted by regional and national institutions) to support the integration of climate information and improved knowledge of climate-related risks to smallholder farmers in country strategies and programming. For instance, a 2020 risk analysis by the University of Cape Town on the future suitability of crops in Zimbabwe found that increasing temperatures, increasing delays or inconsistencies in the onset of rainfall, and an overall decrease in annual and seasonal precipitation will result in negative impacts on all the crops assessed. Lost production of maize, one of the most climate-vulnerable of Zimbabwe's staples, is predicted to cost the country US$ 88.8 million per year.[151]

Agroecological interventions

Agroecology – the application of ecological principles to agriculture, where diversity, recycling, and effective use of resources in farming systems is central – has a strong potential contribution to farming system resilience against climate change impacts, to the conservation of biodiversity, and to reversing land degradation trends. IFAD defines agroecology not just as a set of agricultural practices, but also as changing social relations, empowering farmers, adding value locally, and privileging short value chains.

Figure 1: Impact of climate change on rainfed agricultural yields in Mali, without irrigation



An ASAP grant of US$ 4.9 million was integrated into the US$ 45 million Pro-poor Value Chain Project in the Maputo and Limpopo Corridors (PROSUL) project in Mozambique, implemented over 2012-2020. The ASAP grant amount financed smallholder adaptation to climate change in the three southern provinces of Gaza, Inhambane, and Maputo, where rural poverty is particularly high. The ASAP grant funded the installation of robust and efficient water management infrastructure; improvement of the weather stations network; and the introduction of sustainable agriculture techniques that are more resilient to climate shocks, such as intensified cassava production systems that integrate mixed cropping and improve household food security.

Drought tolerant varieties of casava were introduced, along with agroecological practices such as minimum tillage and mulching. Climate information services were delivered through mobile phones, and credit and saving groups were set up, where most of the members were women (80 percent). As a result, cassava yields went up from six tons per hectare to 20 tons per hectare, with positive impacts on income and food security (Figure 2).[152]

Reduction in food loss

Food loss in Sub-Saharan Africa is estimated to be 13.5 percent for grains, and as high as 50 percent for fruit and vegetables.[153] Over the 2014-2020 period, IFAD, partly through ASAP, funded the Climate-resilient Post-harvest and Agribusiness Support Project (PASP) in Rwanda, where average losses were estimated at 30 percent for key agricultural produce like maize, beans, potato, cassava, and dairy. The losses were found to be due to limited knowledge and skills in post-harvest handling and on-farm storage, and limited access to appropriate post-harvest equipment and drying, storage, and cooling infrastructure.

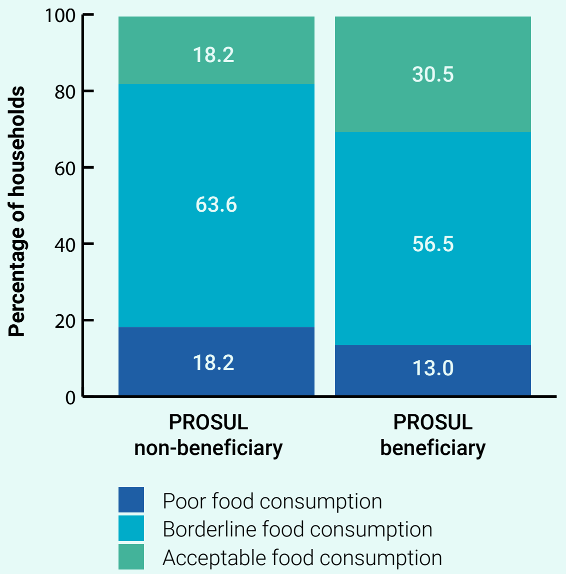
PASP focused on the creation and strengthening of hubs – multifunctional business centres where primary produce is aggregated. The hubs identified under the project (cooperatives, farmers' organizations, and small and medium-sized enterprises with a proven potential to develop inclusive business activities that benefit poor smallholder farmers) were assisted with investments in climate-smart technologies for drying, processing, value addition, packaging, storage, logistics, and distribution.

Around 44,000 smallholder households gained access to new climate-smart post-harvest technologies through PASP. In addition to a 20 percent reduction in the level of post-harvest losses over the baseline, the project contributed to improved food security, the creation of new employment opportunities, and an average income increase of at least 10 percent for project beneficiaries.[154]

Climate-smart irrigation

The frequency of severe droughts has increased in Sub-Saharan Africa in previous decades, particularly in the Sahel strip and the Horn of Africa. In the past, techniques such as small-scale irrigation and water harvesting have been used to counter the effect of droughts. While these techniques remain relevant, new solutions are needed to deal with the continuous change in climate. Moreover, measures promoted earlier to increase incomes during the dry season, such as horticulture using small irrigation systems, are now failing because of rising temperatures and unpredictable rains.[155]

Figure 2: Impact on household food consumption levels through the PROSUL project



Source: IFAD (2020). Pro-Poor Value Chain Development in the Maputo and Limpopo Corridors Project Completion Report.

In response, IFAD is promoting 'climate-smart irrigation' – a mix of hard and soft techniques that maximise water use efficiency for agriculture.[156] For instance, under Phase II of the Participatory Small-scale Irrigation Development Programme (PASIDP II, 2016-2021), ASAP grant funds sought, among other things, to protect US$ 80 million worth of infrastructure from extreme weather events; train 15,000 people in sustainable farming practices and technologies; help 80,000 households in vulnerable areas to receive increased water availability for agriculture; and improve water management over 60,000 hectares.[157]

In Madagascar and Burundi, IFAD promotes the System of Rice Intensification (SRI), where rice fields are kept alternately dry or wet instead of constantly flooded, and less water and fewer seeds are needed to produce the same quantity of rice.[158]

Climate information services

While the technical capacities for climate information services already exist in Africa, including frameworks to collect satellite-based and terrestrial data in regions such as the Sahel and the Horn of Africa, last mile information services lag behind.[159] IFAD supports tailored climate information services in various countries, by establishing networks (between, for instance, meteorological agencies, extension services providers, mobile phone companies, and farmer organizations), and creating links with weather insurance.

In Rwanda, Madagascar, Nigeria, Kenya and Mozambique, the focus is on sharing information on planting and irrigation dates with small-scale farmers. In Rwanda, for instance, more than 6,000 farmers receive advice on planting dates for maize.[160] In Kenya, weather advisory services are provided as part of an e-voucher based insurance scheme in eight arid and semi-arid counties (see below). The farmers that benefit from the scheme receive advice on planting dates and good practices to cope with dry spells.

Stakeholder engagement

The continuous engagement of not only primary beneficiaries (smallholder and poor farmers, including in particular women and youth), but also of local governments, research institutions, NGOs, and other actors is critical to keep adaptation interventions in the agriculture sector locally-relevant and effective.

Photo: IFAD

In Sudan, ASAP has supported the creation of inclusive local institutions to manage dry forests, rangeland, and water sources through the Butana Integrated Rural Development Project (BIRDP). The Natural Resource Governance Framework of Butana enabled communities to protect their customary rights on forests and rangeland, and has now been scaled up nationally to enable community dialogues between various groups of users, including the private sector, in a manner that avoid conflicts.[161]

Social protection

In contexts where poverty is high and natural resource depletion is extreme, social protection schemes are necessary to enhance resilience and adaptation capacities. IFAD has piloted a e-voucher system in Kenya, where smallholder farmers are provided with a debit card that comes with e-vouchers to access benefits such as agricultural inputs, insurance, and conservation agriculture services at a subsidized rate, with a decreasing level of subsidy over three planting seasons. The level of subsidy and lists of inputs are tailored to the county context in consultation with the Kenya Agricultural and Livestock Research Organization. Farmers must provide the rest of the cost as a deposit on their bank account. The e-voucher service is provided by two banks in Kenya, and also helps the farmers access formal banking systems. In total 114,000 farmers were supported by the e-voucher system, which has now been replicated beyond the IFAD-financed project.[162]

AfDB's work on agriculture and food security

Photo: AfDB

Transforming the agriculture sector in Africa can have a vital impact on inclusive growth on the continent. As of 2021, the AfDB's agriculture and food security portfolio included 170 active projects with an investment of approximately US$ 4.8 billion.

The AfDB is currently implementing its Feed Africa Strategy (2016-2025) which aims to develop the untapped potential of agriculture in Africa; drive inclusive gains to sustainably transform the lives of all, including the poorest and most vulnerable; and to empower smallholder farmers and youth.[163] The Strategy recognizes the crucial roles of the public and private sector in promoting sustainable agriculture, and the need for new technologies to modernize value chains and replicate success. Within the framework of the Strategy, AfDB has invested over US$ 40 million over the last three years towards productivity enhancement using best practice technologies. This has leveraged over US$ 450 million in terms of impact.

An additional US$ 245 million has been invested in ten projects to strengthen climate resilience of African food systems, complemented by an additional US$ 38 million for climate information services and agriculture disaster risk financing solutions.

Several innovative programs have been launched, including the Climate Smart Agriculture (CSA) Initiative and Technologies for African Agricultural Transformation (TAAT). Under CSA, which can contribute significant adaptation and mitigation co-benefits for Africa, AfDB is working with the GCA to provide at least 30 million farmers Climate Smart Digital Technologies for Agriculture and Food Security by 2025. This program will establish a dedicated Digital Agriculture Financing Facility to support public and private sector actors to work together, and put in place enablers to scale up the adoption of climate smart digital technologies for African food systems.

TAAT, meanwhile, aims to raise Africa's food output by 100 million tons and lift 40 million people out of poverty by 2025 by harnessing high-impact, proven technologies that boost agricultural productivity and mitigate climate risks to food security. TAAT's overall objective is to mitigate risks and promote diversification and processing in 18 agricultural value chains within eight priority intervention areas. The program deploys technologies at scale in nine commodity value chains: maize, rice, wheat, high-iron bean, cassava, orange-fleshed sweet potato, sorghum/millet, livestock, and aquaculture. Launched in 2018, the program has been successful in the deployment of drought-resistant maize, heat-resistant wheat, and pest-resistant crops, enabling farmers to increase yields and improve their livelihoods.

Photo: AfDB

Photo: AfDB

The US$ 257 million Programme to Build Resilience to Food and Nutrition Insecurity in the Sahel is an example of a multinational project being implemented by AfDB. The Sahel faces repeated food and nutrition crises due to a convergence of the impacts of climate change and variability, environmental degradation, weak governance, and limited infrastructure. The AfDB Programme is currently being implemented in Burkina Faso, Chad, The Gambia, Mali, Niger, Senegal, and Mauritania to target 180,000 farms and small and medium-sized enterprises; and to reach 1.43 million direct beneficiaries and 3.03 million indirect beneficiaries. It employs an integrated approach to build resilience, by optimizing available resources, mitigating the impact of shocks related to climate hazards, optimizing the agricultural calendar, and improving agricultural practices.

Photo: AfDB

Photo: AfDB

Digital Climate Advisory Services in Africa

Photo: iStock/guentergunt

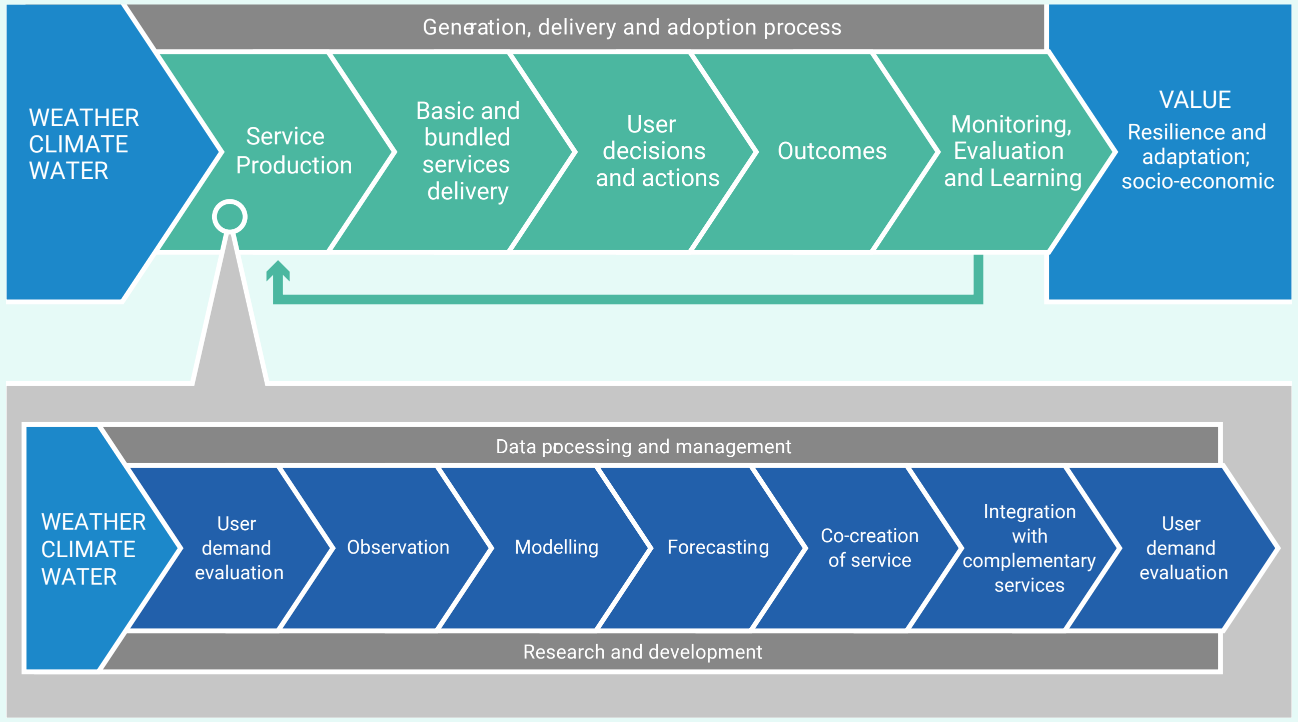
Digital climate-informed advisory services (DCAS) are tools, platforms or activities that disseminate climate information and help individuals or organizations make climate-resilient decisions and adapt to climate variability and change.

These services can be provided via mobile apps, radio and online platforms that disseminate advisories in different formats (e.g., bulletins) tailored to extension services, agri-business, and farmers, depending on the target audience's access to digital technologies and digital literacy. Moreover, these services are meant to support rather than replace person-to-person communication channels and strong agricultural extension services (Figure 1).

The growth of mobile technologies and internet access in Africa over the last two decades offers an opportunity to integrate farmers and Agri-SMEs into a digitally enabled agri-food system. More than 400 digital agriculture solutions provided by governments, the private sector and development organisations (including financial services, market linkages, supply-chain management, advisory and information services, and business intelligence) have helped an estimated 32 million African farmers increase their yields by 40-70 percent (Figure 2).[164]

Digital climate-informed advisory services offer a significant opportunity to build the resilience of farmers to the impacts of an increasingly variable climate. Effectively designed and timely transmitted advisory services—ranging from seasonal forecasts to pest advisories, planting calendars to early warning systems—can help farmers to adapt to climate shocks and plan for production in a changed climate. Decisions related to climate change adaptation may include switching to crops with greater tolerance for emerging climate change stressors and modifying land-use or cropping systems or supplementing rainfed production with irrigation as dry spells increase in frequency and length. Additionally, data and analytics can be used to improve pest and disease surveillance and the development of early warning systems. Digital soil maps are also critical for farmers to understand the local soil conditions and respond using locally specific advisories. Mobile platforms provide a digital identity and credit profile, making it easier for farmers to access markets and financial services, such as insurance, and thus to transfer or manage climate risks.

Figure 1: Process of producing and delivering DCAS



Source: DCAS investment blueprint[165]

Figure 2: DCAS investment opportunities in Africa

Sub-Saharan Africa

90% of the market for digital services that support African smallholders remains untapped

400 different digital agriculture solutions with 33 million registered farmers

Growth of **40%** per year for the number of registered farmers and number of digital solutions

The Digitalisation for agriculture market likely to reach the majority of the region's farmers by **2030** (CTA & Dahlberg Advisors, 2019)

Photo: iStock/hadynyah

However, there are currently multiple gaps that need to be addressed in investments for digitally enabled value chains supporting the adaptation of smallholder farmers to climate challenges:

- Available digital solutions are currently outpacing the readiness to adopt them, and the agriculture sector lacks an important layer of enabling middleware infrastructure namely, agriculture specific data, hardware, and software infrastructure that digital agriculture solutions rely on to source information and deliver services to farmers and other agriculture intermediaries.
- There are gaps in the availability of and access to climate and weather data for the development of digital applications for advisory services.
- The majority of current digital solutions in the agriculture sector are used by commercial players, leaving smallholder farmers behind.
- Most of digital agriculture technologies used by farmers in Sub-Saharan Africa have been implemented at a small scale, dependent on donor funding, and remain at pilot stage.
- Agricultural technology companies—many of which are headed by young entrepreneurs—have yet to find a commercially viable business model to deliver digital solutions to smallholders and agri-SMEs at scale.

Figure 3: DCAS design principles

Source: DCAS investment blueprint

Moving forward, digital climate advisory services ought to enhance and facilitate farmers' adaptation through adoption and exchange of new technologies and adaptation practices and by promoting long-term, sustainable, equitable outcomes and design principles (Figure 3) to ensure impacts on the decision-making of farmers.

DCAS offer crucial opportunities to build the resilience of small-scale producers in the face of climate change, particularly when bundled with complementary services (e.g. financing, input supply, market access and insurance). Evidence indicates that appropriately designed and implemented DCAS—especially those that are bundled with financial and other services—can increase agricultural productivity and household income by as much as 57 percent.[166] The bundling of services has been found to be cost-effective and to foster uptake by farmers. Furthermore, it offers an opportunity to create unified and interoperable data platforms that permit the development of a wide range of services to respond to the interconnected challenges that farmers face. Governments have a central role to play in enabling conditions, for example, putting in place the middleware infrastructure. Private sector involvement in DCAS is essential to ensure innovation, scaling and sustained provision of services.