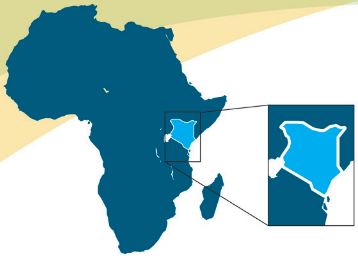

Climate-Smart Agriculture in Kenya

Climate-smart agriculture (CSA) considerations

- P Kenya agriculture is characterized by both very small landholdings (0.3–3 ha) and extremely limited irrigation (less than 0.16% of arable land). This poses the greatest challenge on sustainably intensifying agricultural productivity. However, intensive agriculture using sustainable land management (SLM) practices with basic irrigation presents an opportunity for redressing this issue.
- P A While continuing to rely on traditional practices, Kenyan farmers are also embracing new and improved technologies, as evident in dairy and horticulture production systems. These value chains have the potential to generate enough revenue to enable farmers to invest in promising CSA interventions, such as the use of forage (improved feeding systems) and irrigation (water management practices).
- P A M Declining productivity of many staples (particularly wheat and maize) is alarming. However, there is also great potential to redress this through investing in CSA interventions that would increase productivity and mitigate climate change risks, such as new improved seeds, drought-resistant seeds, alley cropping, coupled with small-scale irrigation or production diversification.
- P A M Targeted CSA interventions, such as the inclusion of agroforestry in the cultivation of fruit trees and vegetables or keeping small ruminants and poultry, have the potential to reduce the prevalence of undernourishment from the current rate (24%).
- P M Investments in improved pastoral livestock-keeping practices are essential for achieving reductions in methane emissions from agriculture. Introducing improving breed and feeding regimes, the use of biodigestors for biogas production have the potential to reduce greenhouse gas (GHG) emissions, particularly in key areas such as the Arid and Semi-arid Lands (ASALs).
- A M P Effective, widespread implementation of CSA policies and practices requires an integrated landscape management strategy, broader gender mainstreaming approaches when designing interventions for promoting financial or land ownership, as well as adequate institutions and financing mechanisms to address tradeoffs and/or synergies between productivity, adaptation, and mitigation goals.
- A M P Kenya has several innovative platforms that offer opportunities for increased productivity, adaptation, and mitigation across production systems. In particular, the Kenya Climate-Smart Agriculture Programme (2015–2030) will be crucial for coordinating domestic and international CSA interventions.
- Devolution of agriculture decision-making to county governments creates valuable opportunities for accelerating the implementation of policies that incentivize CSA adoption on the field, for targeted investments in rural infrastructure, but also for the delivery of timely information to farmers (early warning systems, agricultural extension services, etc.). This requires examining and building capacity of county governments to spearhead agricultural development needs.

A Adaptation M Mitigation P Productivity
Institutions $ Finance

The climate-smart agriculture (CSA) concept reflects an ambition to further integrate agricultural development and climate responsiveness. CSA aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and minimize greenhouse gas (GHGs) emissions. Increased planning is vital in order to address tradeoffs and synergies between the three pillars: **productivity, adaptation,** and **mitigation** [1]. By addressing challenges in environmental, social, and economic dimensions across productive landscapes, CSA practices coordinate the priorities of multiple countries and stakeholders in order to achieve more efficient, effective, and equitable food systems. While the concept is new and still evolving, many of the practices that make up CSA already exist worldwide and are currently used by farmers to cope with various production risks [2]. Mainstreaming CSA requires a critical mapping of successfully completed, on-going practices and future institutional and financial enablers. This country profile provides a snapshot of a developing baseline created to initiate discussion at both the national and global level about entry points for investing in CSA at scale.

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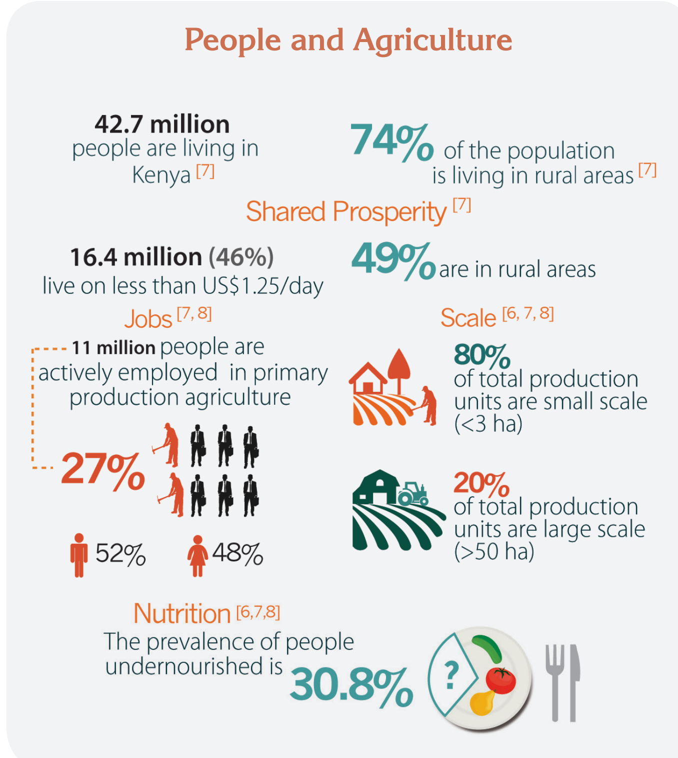
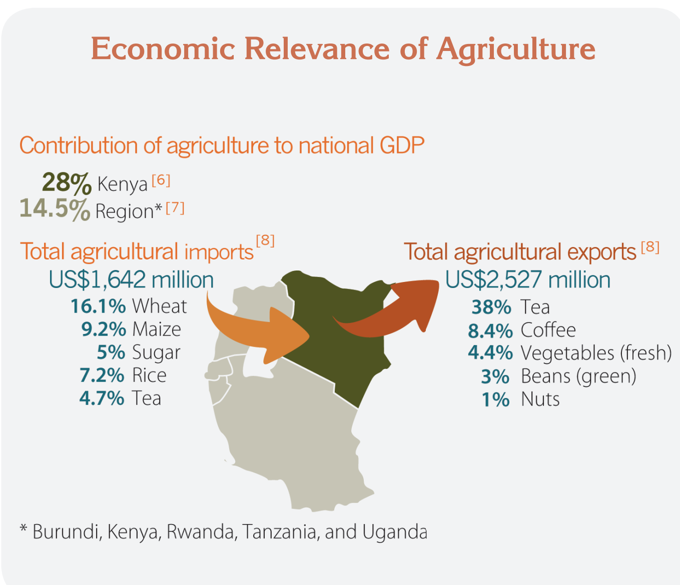
National context:
Key facts on agriculture and climate change

Economic relevance of agriculture

In the past three decades, agriculture has remained central to Kenya's economic development, constituting 28% to the country's gross domestic product (GDP) and accounting for 65% of Kenya's total exports earnings. The crop, livestock, and fishery sub-sectors contribute approximately 78%, 20%, and 2% to the agricultural GDP, respectively [3] (Annex II). The country's reliance on agriculture and dependence on imports (especially of wheat, maize, and rice, among others) underscores the need for sustainable, resilient increases in agricultural productivity for food security and economic growth through CSA promotion.

The agricultural sector employs more than 80% of Kenya's rural workforce and provides about 18% of total formal employment. While official figures are not available, it is estimated that women represent between 48% [4][1] and more than 80% [5] of the total agricultural labour force.





Land use

Kenya's agricultural area extends over 48% of total land-use area in the country. While 78% of this land is categorized as meadows and pastures, the remaining 22% is dedicated to agriculture made up of arable land (21%) and permanent crops (1%) (2007–2011 averages) [8]. The most important agricultural regions are located in the Central, Western, and Rift Valley areas. The great majority of Kenyan farming systems are rainfed and small scale, with farmers owning an averaging of 0.2 to 3 ha of land [9]. Small-scale farming, typically characterized by mixed crop–livestock systems and partial commercial production, occupies approximately one-third of the country's land area [10]. Conversely, large-scale farming systems occupy the majority of Kenya's land area and generally take one of two forms: (1) privately-owned or state-held ranches that are technologically equipped for commercial production, or (2) extensive, low-technology production using communal grazing systems [11].

An increase in crop cultivation (especially cereal and pulses) has been observed over the past years, as a response to increased demand for food and a growing human population (Annex II). Consequently, livestock mobility[2] and grazing land have been reduced and altered, resulting in heavy losses (estimated at US$8,395) for the cattle industry, with potential implications for the configuration of land in Kenya [12].

Agricultural production systems

Kenya's agricultural sector is predominated by small-scale production systems; however, the scale of farming systems varies across agro-ecological zones. Small-scale production systems (between 0.2 and 3 ha) account for 78% of total

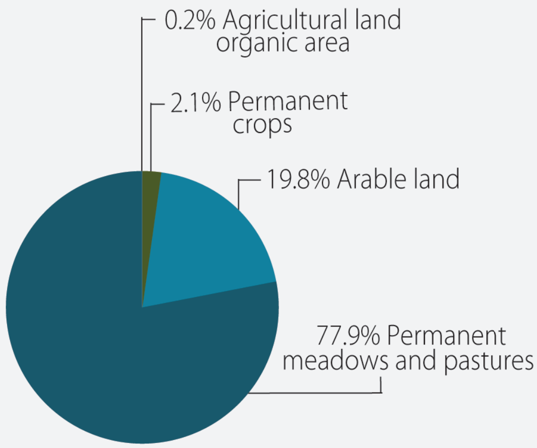
1 Women make up 43% of the agricultural labour force in developing countries, ranging from 20% in Latin America to 50% in Eastern Asia and sub-Saharan Africa [4].

2 Livestock mobility maximizes the use of seasonal spatial forage resources in the Arid and Semi-Arid Lands (ASAL).

Land Use

Land Use [8]

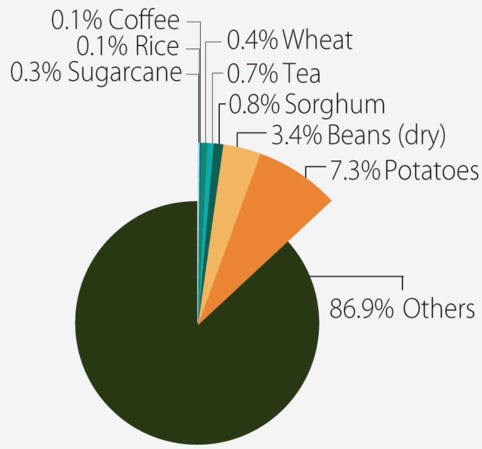
% of total land



Agricultural area is **48%** of total land area [8]

Main Crops [8]

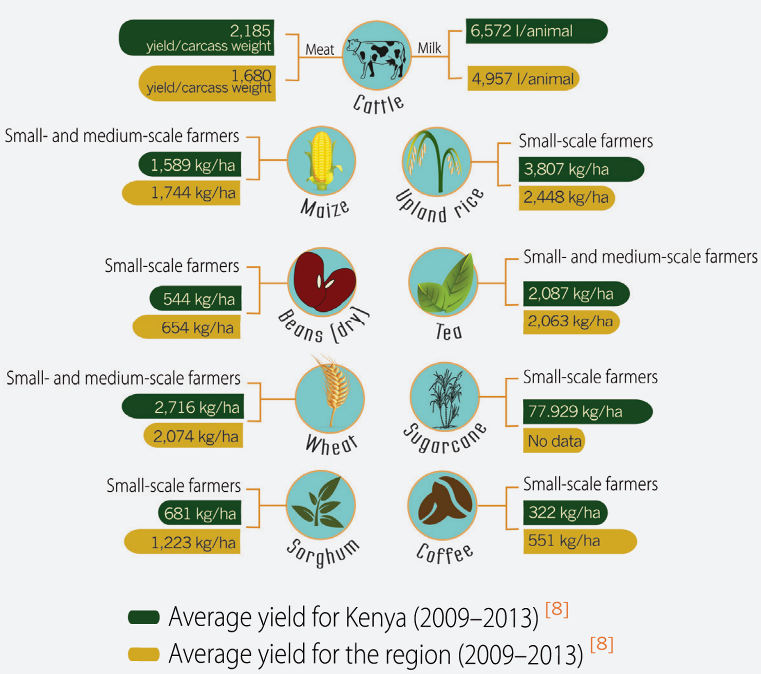
% of total harvested area



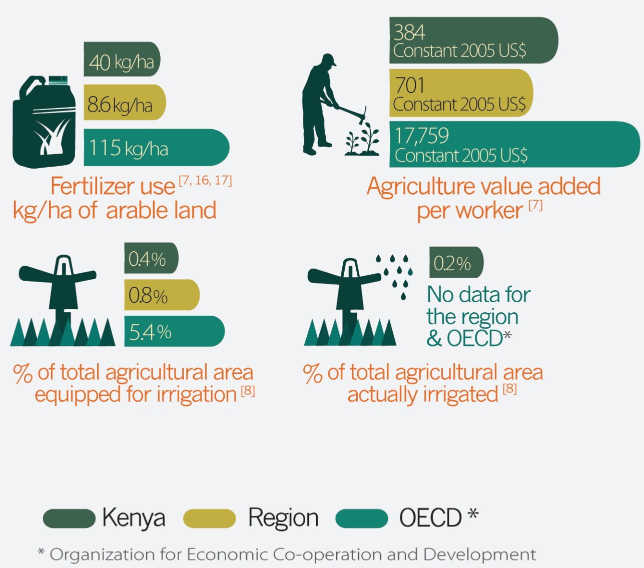
* Calculations based on sum of FAO estimates of areas under (a) arable land (b) permanent crops, and (c) permanent meadows and pastures, not taking into account bodies of water.

agricultural production and 70% of commercial production [13]. The majority of Kenya's maize (70%), coffee (65%), tea (50%), milk (80%), fish (85%), and beef (70%) products are produced by small-scale farmers. These production systems use limited improved inputs and modern production practices, such as hybrid seeds, concentrated feeds and fertilizer, pesticides, machinery, and irrigation.

Important Agricultural Production Systems



Productivity Indicators



Medium-scale production systems (3 to 49 ha) are generally associated with commercial crops, namely tea, coffee, pyrethrum, and vegetables. These production systems are characterized by the greater adoption of technological practices and inputs, and farmers are more likely to invest in production and marketing or take out loans for farm development. Large-scale production systems (50+ hectares for crops or 30,000+ hectares for livestock) are responsible for 30% of the nation's commercial production, focusing on tea, coffee, maize, and wheat). For large-scale producers, the use of improved technologies, such as terracing and zai pits for improved farmland management, often results in markedly higher productivity [14]. Intensive agricultural production is most common in high rainfall areas (See Annex III).

Despite the growing prevalence of intensive agriculture, irrigation remains uncommon. In 2012, only 0.16% of arable land received irrigation [6] [15]. The use of fertilizers remains low compared to global figures, but higher than the average in sub-Saharan Africa [16] (Annex IV). Therefore, intensive agriculture using sustainable land management (SLM) practices and small-scale irrigation offers promising potential for increasing agricultural productivity in Kenya.

Agricultural greenhouse gas emissions

The role of livestock in GHG emissions cannot be understated. The agricultural sector is the largest source (58.6%) of total GHG emissions in Kenya, and livestock-related emissions account for the overwhelming majority (96.2%) of those emissions. The contribution of other sectors to national GHG emissions are as follows: energy (25.3%), industry (3.2%), and waste management (1.2%) [18].

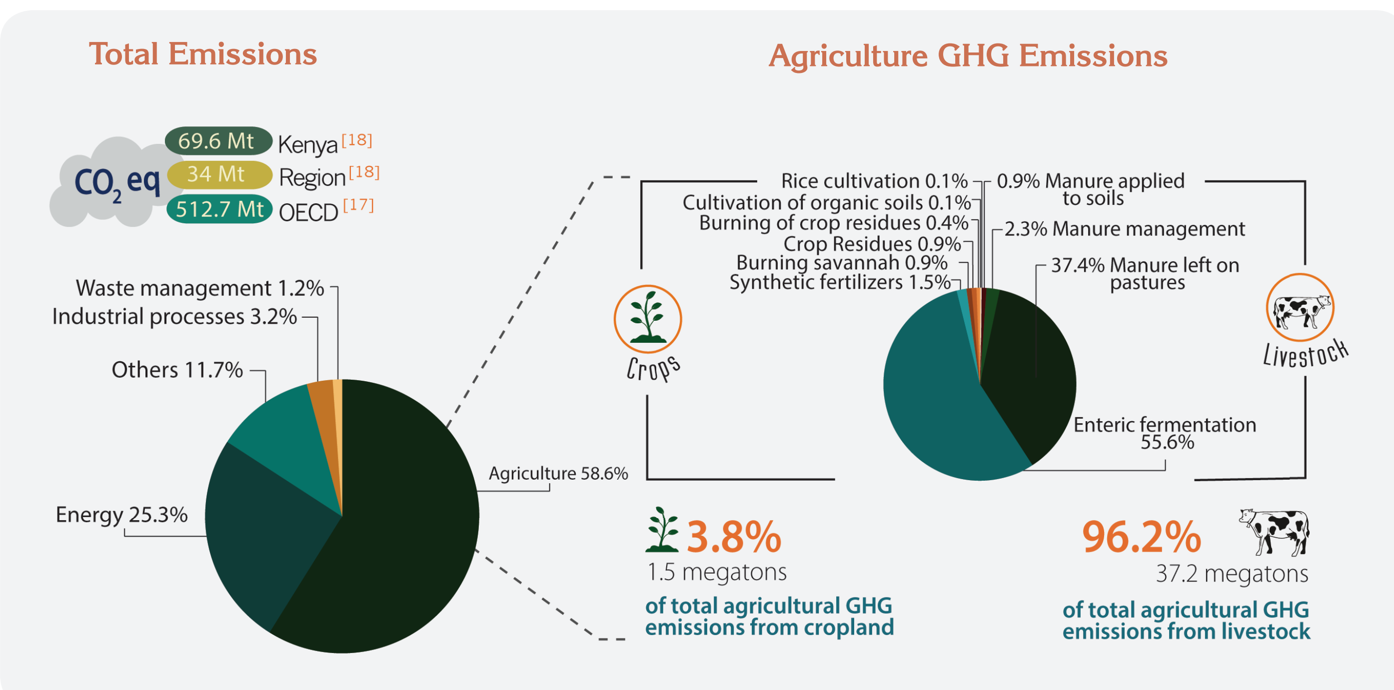
Agricultural emissions are projected to increase from 20 mega tonnes CO_2 equivalent (Mt CO_2 eq) in 2010 to 27 Mt CO_2 eq in 2030, driven in large part by livestock methane emissions [19]. However, there is great potential to reduce methane emissions by improving pastoral livestock-keeping practices, such as the use of improved breeds and feeding regimes. Similarly, agroforestry systems could play an important role in sequestering carbon in soil and trees on farms, contributing to mitigation efforts in the agriculture sector.

Challenges for the agricultural sector

Kenyan agriculture faces productivity and food security challenges tied to a lack of inputs and irrigation, limited access to markets, market information and training/extension services, all of which thwart agricultural investments and create further gender inequalities and inequities.

In 2011, about 3.5 million people were declared food insecure in Kenya, with significant numbers facing catastrophic conditions after consecutive years of below-average rainfall that have resulted in one of the driest years since 1950 [25].

The limited use of inputs, whose costs are often beyond the reach of small-scale farmers, is often compounded by climate-related events (such as low and unreliable



rainfall), hampering productivity nationwide. As a result, the productivity of many staple crops (maize, wheat) remains below world and regional averages. For example, 2013 maize yields were 1.1 tonnes/ha, as compared to the sub-Saharan African average (1.43 tonnes/ha) and global average (4.9 tonnes/ha) [8]. In other staple crops, productivity may actually be decreasing. Researchers observed steadily decreasing maize production between 2009 and 2014, with general yields ranging from 0.5 to 5.0 tonnes/ha and an annual maize yield of less than 1.5 tonnes/ha in 26 out of the 59 districts [20]. While declines in productivity of these staple crops are alarming, they also represent an opportunity to invest in CSA practices that boost yields and mitigate climate-related risks.

Available arable land is often not used for commodity crop production, remaining mostly unexploited across certain high potential agro-ecological zones. For example, the Kenyan ASAL regions receive rainfall below 500 mm per year, yet farmers continue to grow maize rather than drought-tolerant crops, such as sorghum or millet, which are better equipped to match low rainfall levels [21].

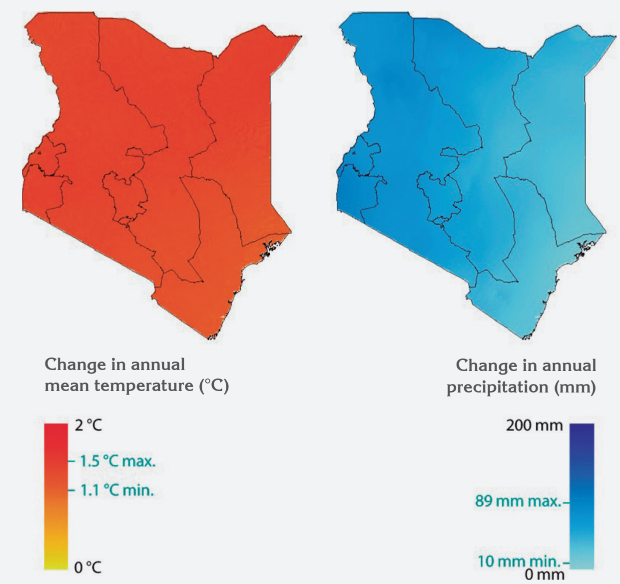
Accelerated population growth and an average annual growth rate of 2.59% from 2008 to 2014 has led to a growing demand for food and natural resources. At the same time, rural migration and adverse climate conditions have led to lower agricultural productivity and a shift towards non-farm income generating activities. Rural population, the major providers of agricultural labour force, decreased by 3.2% from 2008 to 2014 [8].

The underperformance of the agriculture sector, together with limited market access, scarce value-added activities and increased anthropocentric pressure on natural resources, is tied to natural resource depletion, conflicts, and poverty. Currently, nearly half of Kenya's population lives in poverty with concomitant food insecurity and dependency on external food aid [22] [23] [24]. In 2011, about 3.5 million Kenyans were food insecure, as compared to one million in 2009 [25].

Agriculture and climate change

Kenya's average annual temperatures increased by 1 °C between 1960 and 2003 [26] [27],[3] and by 1.5 °C in the nation's drier regions in the same time period [19]. The central, south-eastern, northern, north-eastern and eastern regions of Kenya have seen temperature increases between 0.1 °C and 1.3 °C, while the west coast demonstrates a

Projected Change in Temperature and Precipitation in Kenya by 2030



declining temperature trend [19] [28] (Osumba and Rioux, 2014). Meanwhile, seasonal rainfall trends vary greatly across agro-ecological regions and are less prescriptive given limited data availability. Statistics indicate increases in total annual precipitation by about 0.2 to 0.4% per year [29]. Additionally, extreme climate events have become increasingly frequent, with direct consequence to annual production rates (Annex V).

Uncertain climate patterns have several implications for the rural populations who derive their livelihoods from farming and related enterprises [9]. Agriculture in Kenya is largely (98%) rainfed and thus extremely vulnerable to increasing temperatures, droughts, and floods [13]. Smallholder farmers are especially hard hit by these changes, often confronted with livestock losses, crop failures, and related income and livelihood losses. Two noteworthy extreme climate events are the 1998 El Nino and the 2009 drought, which resulted in a combined total cost of US$2.8 billion (about 7% of the 2010 GDP equivalent), with crops and livestock bearing the brunt of the losses [30].

Projections based on RCP 4.5 emissions scenario [31] and downscaled using the Delta Method [32] show increases in mean annual temperature of 1 °C to 1.5 °C by 2030. Relatedly, changes in rainfall distribution and more frequent extreme events, such as prolonged drought and flooding,

3 Kenya's average annual temperatures have increased by 1 °C between 1960 and 2003, while temperatures in western Kenya rose by 0.5 °C between 1981 and 2004. For the drier parts of Kenya, temperatures went up by 1.5 °C during the same period [26] [27].

are predicted to result in more frequent water shortages[4] [33]. Rainfall increases are expected to be concentrated from the Lake Victoria region to the central highlands east of the Rift Valley. The eastern and northern arid and semi-arid lands (ASAL) are expected to see an overall decrease in precipitation due to climate change [34]. Such weather patterns, manifested through longer and more frequent dry periods interspersed with intense but shorter and unpredictable periods of rainfall, are likely to deplete water and pasture resources, leading to natural resource scarcity [3]. This affects crop production, since the effect of daily, seasonal, and annual variations in rainfall, and the effect of micro-variability in rainfall patterns are important in the development of incremental adaptation technologies.

Maize, which is the preferred crop in many farming systems in Kenya, is not well adapted for current climatic conditions, nor is it well-suited under the predicted future climate conditions. Studies show that climate change will likely have major implications for maize production, with losses estimated at US$100–200 million annually by 2050 [35]. Moreover, the staple crops' yield growth rate is expected to decrease between 12% and 23%, while food prices will increase by 75% to 90% by 2055 [13]. Coping with such changes will require significant investments in water management techniques (irrigation and water storage structures). However, more positively, such climate change projections suggest that, in some places, opportunities for crop diversification and intensification may emerge, including options for expanding into places where cultivation is not currently possible. In other places, particularly in low rainfall areas, households are likely to experience increased food insecurity and higher poverty rates.

CSA technologies and practices

CSA practices present opportunities for addressing climate change challenges, while simultaneously supporting economic growth and development of the agriculture sector. For this profile, practices are considered CSA if they maintain or achieve increases in productivity as well as at least one of the other objectives of the CSA (adaptation and mitigation). Hundreds of technologies and approaches around the world fall under the heading of CSA [2].

CSA is gaining momentum in Kenya. This is attributed to the fact that agriculture is recognized as a sector with great potential for contributing to the achievement of a range of development goals related to food security, nutrition, poverty reduction, and climate change adaptation and mitigation. The Kenya Climate Change Action Plan (2013–2017) recognises critical CSA practices such as agroforestry, conservation tillage, the limited use of fire in agricultural areas, cultivation of drought-tolerant crops, water harvesting, and integrated soil fertility management, among others.

Apart from traditional agricultural techniques, Kenyan farmers have started adopting new, improved technologies, as evident in both crop and livestock production. Some examples include biogas production using biodigestors (especially applied in intensive dairy production), and improved pastures management in agrosilvopastoral systems in the highlands and sub-humid areas, as well as in intensive and extensive dairy production[5] (mostly through grass–legume associations), among others. For crop production, Kenyan farmers practice terracing and contour bunds for maize, beans, coffee production, use water-efficient irrigation techniques in rice cultivation (mostly in the East), adopt drought-tolerant crop varieties for cereals and legumes (beans, pigeon peas, cowpeas) in semi-arid areas. Many of these practices help build system's resistance to pests and diseases, such as the case of drought-tolerant varieties for crop and livestock production.

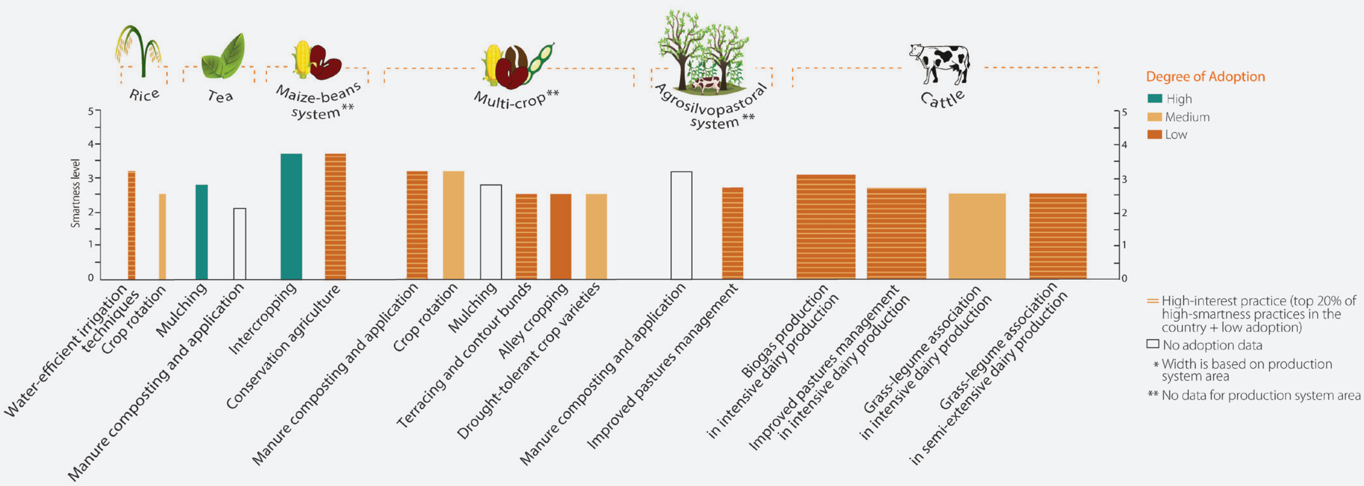
Although CSA practices are used in many agro-ecological zones, few have high adoption rates (such as maize–beans intercropping or mulching in tea production system). Low and medium-adoption rates for practices scoring high climate-smartness levels, such as conservation agriculture in maize–bean systems in the West and the East, manure application and composting in multi-crop systems (maize and sorghum), irrigation techniques in rice cultivation, crop rotations or the use of biodigestors in intensive dairy production, are linked with infrastructural, institutional, and financial challenges for both farmers and other stakeholders in the agriculture value chain. Moreover, weak enforcement and non-systematic policies and legislation, limited institutional capacity to guarantee resource user rights (especially land tenure regimes) and to deliver services, such as weather agro-advisories, climate information systems, research and development (R&D), and extension services have greatly impacted adoption levels of CSA practices. Many of these practices are knowledge intensive, and promoting their adoption will require well-designed, inclusive, and innovative knowledge management systems that facilitate information-sharing techniques for and among farmers and support local and indigenous knowledge.

4 However, the variability is not a new phenomenon, and the long term pattern or trend is still not yet certain[33].

5 Intensive dairy production systems are common in central and western regions of the country, while extensive dairy production is mostly found in the semi-arid, eastern regions.

Likewise, programmatic barriers to CSA adoption can be overcome by building capacity among farmers and supporting the sharing of knowledge and experience, creating incentives through social, legal,[6] institutional, or financial and market mechanisms, long-term strategic investments in agricultural infrastructure, improved productive capacity, and product quality, as well as innovative public-private partnerships that offer risk management instruments such as agricultural insurance to vulnerable farmers.[7]

Selected Practices for Each Production System with High Climate Smartness



This graph displays a selection of CSA practices for each of the key production systems in Kenya (Annex VII). Practices of high interest for further investigation or scaling-out are visualized. The assessment of a practice's climate smartness uses the average of the rankings for each of the six smartness categories: weather, water, carbon, nitrogen, energy, and knowledge. Smartness categories emphasize the integrated components related to achieving increased adaptation, mitigation, and productivity. Climate smartness is ranked from 1 (very low positive impact) to 5 (very high positive impact).

Table 1. Detailed smartness assessment for top ongoing CSA practices by production system as implemented in Kenya

The assessment of a practice's climate smartness uses the average of the rankings for each of the six smartness categories: weather, water, carbon, nitrogen, energy, and knowledge. Smartness categories emphasize the integrated components related to achieving increased adaptation, mitigation, and productivity.

	CSA Practice	Climate Smartness	Adaptation	Mitigation	Productivity
Rice (0.1% of harvested area)	Crop rotation (Eastern Kenya) Medium adoption (30–60%)		Helps maximize soil nutrients. Reduces pest and disease risks. Improves soil fertility.	Maintains or improves soil carbon stocks and soil organic matter content.	Improves yields and income.
	Water-efficient irrigation techniques (Eastern Kenya) Low adoption (<30%)		Reduces water use.	Alternate Wetting and Drying (AWD) can reduce methane emissions.	Ensures greater yield stability during dry seasons. Contributes to increased yield per unit area.

6 Land ownership and use is a pre-requisite for CSA adoption. It determines user rights and access to financing for adoption of CSA innovations and technologies.

7 At present, such instruments are of limited availability in Kenya and usually remain in pilot phase.

	CSA Practice	Climate Smartness	Adaptation	Mitigation	Productivity
Tea (0.7% of harvested area)	Mulching (Kericho, central regions) ■ High adoption (>60%)		Promotes soil and water conservation. Increases soil nutrients upon decomposition. Prevents erosion.	Maintains or improves soil carbon stocks and soil organic matter content	Improves yields and income.
	Manure composting and application (Kericho, central regions)		Improves soil nutrients and yields per unit area. Promotes soil conservation, reduces soil salinity, and improves water retention.	Reduces methane emissions and can lead to a reduction in the amount of inorganic fertilizers required.	Improves yields and income.
Maize/beans	Intercropping (Western and Eastern Kenya) ■ High adoption (>60%)		Improves soil quality (physical and chemical). Increases efficiency in water and soil use.	Nitrogen fixation through leguminous plants reduces nitrogen fertilizer requirements. Contributes to increases of soil organic matter, maintaining soil carbon stock.	Increases yields and income. Reduces economic vulnerability by diversifying production.
	Conservation agriculture (Western and Eastern Kenya) ■ Low adoption (<30%)		Promotes soil and water conservation. Helps avoid crop losses during dry periods.	Facilitates carbon sinks in soils. Reduces nitrogen loss.	Increased yields and income.
Multi-crops	Manure composting and application ■ Low adoption (<30%)		Improves physical and chemical soil characteristics, which contribute to improved yields per unit area.	Contributes to reduced methane emissions upon aerobic composting.	Increases productivity as a result of enhanced soil health and fertility.
	Crop rotation (Maize/beans, cowpeas, pigeon peas, cotton, sunflower, soybean, groundnuts) (Coastal, Central, Western, and Eastern regions, as well as Kisii highlands and Uasin Gishu and Kericho counties) ■ Medium adoption (30–60%)		Maximizes the use of soil nutrients. Reduces pest and disease risks. Improves soil fertility. Helps manage pests and diseases.	Maintains and/or improves soil carbon stocks. Reduces the need for nitrogen fertilizers application when leguminous crops are introduced.	Contributes to product diversification and increases yields in certain contexts.

	CSA Practice	Climate Smartness	Adaptation	Mitigation	Productivity
Agrosilvopsatoral	Manure composting and application		Soil structure is improved alleviating compaction and erosion. Improves water retention capacity of the soil.	Contributes to reduced methane emissions upon aerobic composting.	Improves yields and income.
	Improved pastures management ■ (Low adoption <30%)		Increased feed quality and quantity for livestock. Promotes soil and water conservation.	Feed quality (among other forage characteristics) can reduce methane emissions related to enteric fermentation.	Increases yields and income.
Cattle (78% of total land use area)	Use of biodigestors in intensive dairy production (Central, western regions) ■ (Low adoption <30%)		Contributes to reductions of on-farm organic waste and odors. Facilitates the elimination of pathogens. Can provide alternative on-farm heating sources.	Reduces methane emissions from manure. Provides an alternative on-farm energy source.	Increases income.
	Improved pastures management in intensive dairy production (Central, western regions) ■ (Low adoption <30%)		Increases feed quality and quantity for livestock. Promotes soil and water conservation.	Feed quality (among other forage characteristics) can reduce methane emissions related to enteric fermentation	Increases yields and income.
	Grass–legume association in intensive dairy production (Central, western regions) ■ (Medium adoption 30–60%)		Improves quality and quantity of the feeds. Increases productivity per unit area. Promotes soil and water conservation.	Improved feed quality reduces methane emissions. Nitrogen fixation through leguminous plants reduces nitrogen fertilizer requirements.	Increases productivity and income through increased product quality.
	Grass–legume association in semi-extensive dairy production (Semi-arid, Eastern Kenya) ■ (Low adoption <30%)		Improves quality and quantity of the feeds. Increases productivity per unit area. Promotes soil and water conservation.	Improves foliar biomass. Increases carbon sequestration.	Increases income.

Calculations based on qualitative ranking, where positive change was noted as 5=very high; 4=high; 3=moderate; 2=low; 1=very low; 0=no change, not applicable, and no data.

Case study of CSA in Kenya:
Climate-smart villages in Lower Nyando, Kisumu

The Lower Nyando climate-smart village (CSV) is one of the 15 villages established in 2011 by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). A CSV is an experimental plot aimed to enhance farmer's resilience through improved agricultural productivity, income levels and mitigation of greenhouse gases from agriculture.

Smallholder farmers in Lower Nyando are confronted with variable weather patterns that have caused crop failures, undermining livelihoods and threatening local food security. At the same time, common farming practices have been a significant contributor to agricultural GHG emissions, further intensifying the impacts of climate change. Furthermore, the region is also facing problems related to soil erosion, declining soil fertility, high poverty rates, low farm labour productivity, and a growing human population.

In response to these challenges, CCAFS initiated the CSV in 2011 in an attempt to adapt agricultural activities to changing climate conditions and to ensure a stable and improving food supply with additional mitigation benefits. CSVs are community driven, participatory, and inclusive. Stakeholders test climate-smart services, such as tailored weather agro-advisories for farm planning and management, allowing for continued improvement. These services are delivered through ICT mobile telephony, enabling farmers to buy index-based insurance to protect them in the event of extreme weather.

As a result, about 22 tree nurseries have been established to supply over 50,000 high-quality tree seedlings with a 75% tree survival rate. Women own more than half of these nurseries and sell seedlings for extra income, allowing them to send their children to school and buy more nutritious food for their family. More than 11,000 households in the CSV have joined self-help groups, of which about 70 to 85% of the active members are women. Farmers have discovered the value of agroforestry, with alleys of maize, sorghum and other crops sandwiched between rows of multi-purpose trees that stabilize and enrich the soil. Peer learning, where certain farmers host neighbours on their farms for knowledge-sharing events, has promoted cross-fertilization of ideas in the region.

Even though several opportunities exist with the CSVs, CSA technologies are knowledge intensive, and farmers have limited exposure to agricultural innovations. Similarly, pest and disease management is poor, slowing the uptake of improved livestock management practices. To maximize available opportunities, links between farmers and the private sector and markets need to be created, via sustainable initiatives such as microfinance.

An agroforestry field, Kisumu, Kenya
Photography: P. Casier (CGIAR)

Institutions and policies for CSA

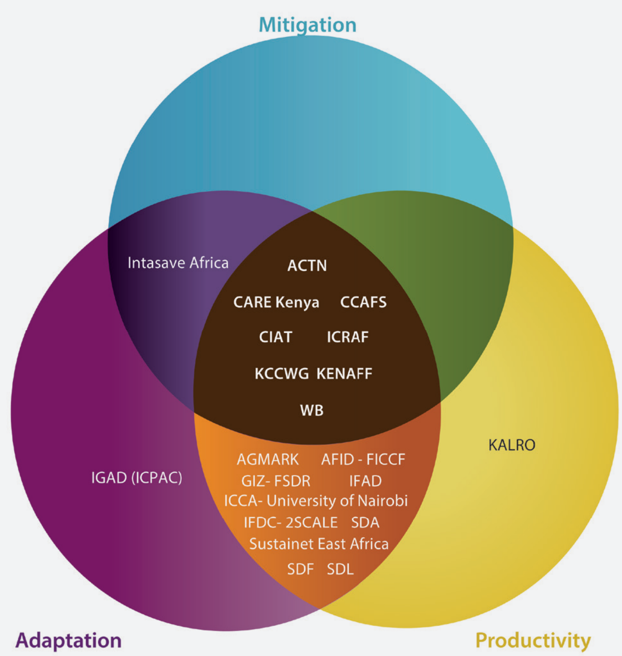
Internationally, Kenya has been actively engaged in conversations on mainstreaming climate change into agricultural policies, plans, and actions. The country is a signatory to the United Nations Conventions on Combating Desertification (UNCCD), Climate Change (UNFCCC) and Conservation of Biodiversity (UNCBD). Kenya has submitted two national communications to the UNFCCC and has on-going integrated policies and strategies and operational plans for climate change. Regionally, Kenya is implementing the Comprehensive Africa Agriculture Development Programme (CAADP) Framework (2010) and the East African Community Climate Change Policy (EACCCP). Both of these frameworks emphasize sustainable land and water management for improved agricultural productivity through research, technology adoption and dissemination, and agricultural GHG emissions reduction and, if harmonized, have the potential to deliver important on-the-ground results regarding CSA.

A number of institutions support CSA in Kenya, by providing financing, facilitating knowledge and information management, promoting index insurance for farmers, and advancing technology development. At governmental level, CSA roles and responsibilities fall under three ministries – the Ministry of Agriculture, Livestock, and Fisheries (MLF), Ministry of Environment and Natural Resources (MENR), and the Ministry of Water and Irrigation (MWI). Despite the different legal frameworks, policies, and strategies that each of these ministries have developed throughout the years, mechanisms and frameworks for work coordination among these ministries are essential for successful implementation of CSA interventions. In this sense, the operational document Kenya Climate-Smart Agriculture Programme (2015–2030) provides a good opportunity for coordinating CSA interventions in the country.

Less than half of the institutions identified work on integrating productivity, mitigation, and adaptation goals into their programmes and actions. These institutions refer to research programmes and centers such as the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the World Agroforestry Centre (ICRAF), NGOs (CARE Kenya), multilateral institutions (World Bank [WB]), the network of civil society organizations Kenya Climate Change Working Group (KCCWG), and the private sector (Kenya National Farmers' Federation [KENF], Africa Conservation Tillage Network [ACTN]). These institutions provide cooperation opportunities that involve research, agricultural technologies, and innovations, risk insurance, emissions reduction, conservation, education, gender, and adaptation systems. Half of the institutions identified in this study focus on improving agricultural productivity and adaptation.[8] On one hand, this overall picture indicates a need for stronger public and private-sector readiness and capacity to address tradeoffs and synergies between the three CSA pillars, especially through improved knowledge management systems that can enable the adoption of knowledge-intensive CSA practices on the field. On the other hand, this situation reaffirms the importance of strengthening integration and complementarity among international, regional, national, and local institutions that carry out CSA-related activities in Kenya, in such a way to add value to existing efforts to promote CSA.

The Constitution of Kenya devolves key agriculture sub-sectors (including crop and animal husbandry, plant and

Primary Focus of Institutions Engaged in CSA



8 They include: Agricultural Markets (AGMARK), the German Development Cooperation Agency - Food Security and Drought Resilience Programme (GIZ-FSDR), the International Fund for Agricultural Development (IFAD), the Institute of Climate Change and Adaptation (ICCA) of the University of Nairobi, the International Fertilizer Development Centre Programme Towards Sustainable Clusters in Agribusiness through Learning in Entrepreneurship (IFDC-2SCALE), the State Department of Agriculture (SDA), the State Department of Livestock, the State Department of Fisheries, and Sustainet East Africa.

animal disease control and fisheries) to sub-national (local) levels. This creates valuable opportunities for accelerating the formulation and implementation of policies and action plans that incentivize CSA adoption on the field, but also for the delivery of knowledge and timely information to farmers (through, for instance, agricultural extension services). Better understanding and seizing this opportunity requires examining and building capacity of county governments to spearhead agricultural development needs.

The National Development Plan, Kenya Vision 2030, recognizes the importance of agricultural activities for achieving an average GDP growth rate of 10% per year up to the year 2030, thus contributing to hunger and poverty reduction.[9] Additionally, the National Climate Change Action Plan (NCCAP) emphasizes a low-carbon, climate-resilient development pathway for the economy. It highlights the priority actions for planning in key climate-sensitive sectors, including agriculture. These CSA priorities include agroforestry, conservation tillage, and agricultural waste management. For livestock, it prioritizes improved management of grazing systems, biogas, livestock diversification, and improved breeding of animals. The adaptation actions include drought-tolerant crops, water harvesting, integrated soil fertility management, insurance schemes, and price stabilization schemes for livestock, strategic food reserves, and mainstreaming climate change into agricultural extension services.

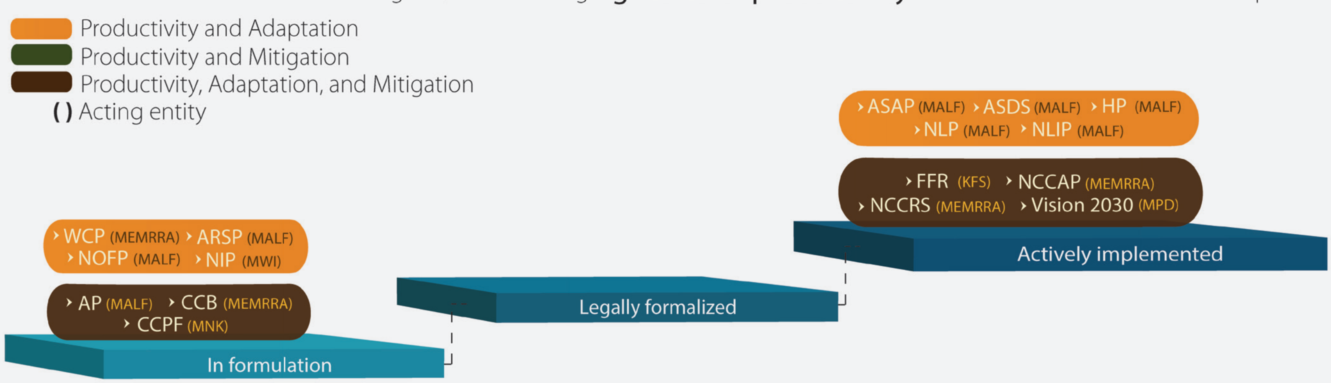
The Agricultural Sector Development Strategy (ASDS) recognizes the need to transform smallholder agriculture from low-productivity subsistence activities to a more innovative agribusiness enterprise operationalized through five-year Medium-Term Plans (MTPs). CSA is implicitly integrated in this vision, which prioritizes investment in both adaptation- and mitigation-related practices and technologies: weather information systems, research on drought-tolerant crop varieties, soil and water conservation, water harvesting, and strengthening integrated pest management systems (adaptation), as well as agricultural waste management, organic farming, mulching, agroforestry, and biotechnology (mitigation).

Among other legislative frameworks and policy initiatives in Kenya, the Arid and Semi-Arid Lands (ASALs) Policy aims to revitalize ASALs by harnessing livelihood opportunities in the drylands. The policy acknowledges pastoralism as a legitimate and productive livelihood and aims to develop the ASALs coherently by providing basic services (health, education, and infrastructure) and decentralizing the planning of livelihood diversification, community participation and early warning systems, which constitute important enablers for CSA adoption in these regions.

The Farm Forestry Rules play an important role in ensuring synergies between agricultural activities and natural resource protection. Accordingly, farmers are required to establish and maintain farm forestry (e.g., woodlots or trees

Enabling Policy Environment for CSA

Policies listed are related to maintaining and/or enhancing **agricultural productivity** and at least one of the other CSA pillars:



AP Agriculture Policy (2009) **ARSP** Agriculture Research System Policy (2014) **ASAP** Arid and Semi-Arid Policy (2008) **ASDS** Agricultural Sector Development Strategy (2010-2020) (2009) **CCB** Climate Change Bill (2014) **CCPF** Climate Change Policy Framework (2007) **FFR** Farm Forestry Rules (2009) **HP** Horticulture Policy (2012) **NCCAP** National Climate Change Action Plan (2013) **NCCRS** Kenya National Climate Change Response Strategy (2012) **NIP** National Irrigation Policy (2009) **NLIP** National Livestock Policy (2008) **NLP** National Land Policy (2009) **NOFP** Kenya National Oceans and Fisheries Policy (2008) **WCP** Water Catchment Policy (2012)

9 According to Vision 2030, key areas of investment in agriculture include: (i) productivity of agricultural enterprises; ii) policies for land use and natural resources management (e.g., expansion of irrigated land for agriculture); (iii) market access and improved supply chains; and (iv) added value of agricultural exports.

on farms) on at least 10% of every agricultural landholding. Likewise, species of trees or varieties planted must not have adverse effects on water sources, crops, livestock, soil fertility, and the neighbourhood, and must not be of invasive nature. Moreover, agriculture authorities at the district (now county) level are required to identify land at risk of degradation and establish measures necessary for ensuring its conservation, including planting of trees.

Other notable policy efforts include: the Crops Act (2013), which establishes sustainable and environmentally friendly production as the standard for all land cultivation, outlining the role of county governments in implementing national policies and laws, including the responsibility for soil and water conservation, as well as the duties of the Agriculture, Fisheries and Food Authority; the National Livestock Policy, which creates implicit opportunities for CSA promotion and scale-out through breeding programmes, improvement and conservation of feed and animal genetic resources, among others; the Draft National Irrigation Policy, where the main objectives are to expand land under irrigation; increase agricultural water harvesting and storage capacities; promote water harvesting, use of waste water, and exploitation of groundwater for irrigation; build capacity for generation and utilization of irrigation research, innovation, and technology the Environmental Management and Co-ordination Act, which requires, among others, hillside management to prevent soil erosion and biodiversity loss; the Environmental Management and Co-ordination Act, which requires, among others, hillside management to prevent soil erosion and biodiversity loss;[10] and the National Agricultural Research System Policy (2012) aimed at establishing an integrated national agricultural research system that guides and supports the development of an innovative, commercially oriented, and modern agricultural sector (Annex VIII).

Last, but not the least, there is a strong link between CSA and the national agenda on forest protection and reduction of emissions from deforestation and forest degradation. Kenya is currently drafting its national REDD+ Strategy. Providing agricultural inputs to poor and vulnerable, forest-adjacent communities, in line with the Government's National Accelerated Agricultural Inputs Access Program (NAAIAP), essential for tapping into the country's mitigation potential.

While these are noteworthy examples of the country's progress towards mainstreaming climate change in agriculture investments, it is important to establish effective mechanisms for policy enforcement and to emphasize the need to establish effective mechanisms for enforcement and to enhance institutional integration and coordination, to make CSA a reality on the field and better target vulnerable small-scale farmers. As seen in the previous section, the majority of the practices with high climate smartness scores present low- and medium-adoption rates and are more common among medium- and large-scale farmers.

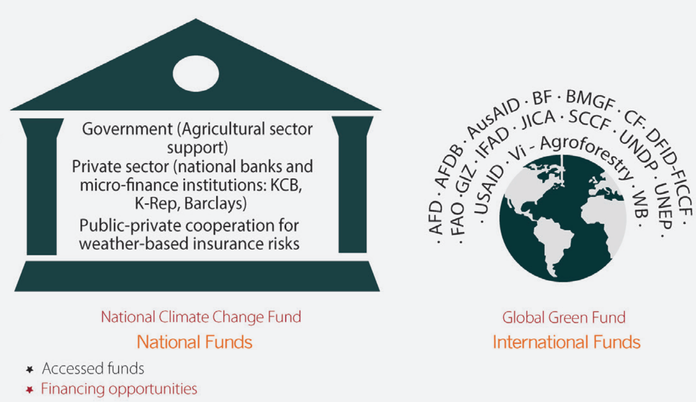
Financing CSA

National finance

At present, the Government of Kenya has not earmarked any money for CSA through its agriculture budget support, but is in the process of creating a National Climate Change Fund (NCCF) through its Climate Change Bill that will support CSA. In addition, the Kenyan Climate-Smart Agriculture Programme (2015–2030) is in place as an operational document that provides a good opportunity for coordinating CSA interventions in Kenya.

Funds for Agriculture and Climate Change

AFD French Agency for Development **AFDB** African Development Bank **AusAID** Australian Agency for International Development **BF** Biocarbon Fund **BMGF** Bill & Melinda Gates Foundation **CF** The Clinton Foundation **DFID** UK Department for International Development **FAO** Food and Agriculture Organization of the United Nations **FICCF** Finance Innovation for Climate Change Fund **GIZ** German Agency for International Cooperation **IFAD** International Fund for Agricultural Development **JICA** Japan International Cooperation Agency **KCB** Kenya Commercial Bank Group **SCCF** Special Climate Change Fund **UNDP** United Nations Development Programme **UNEP** United Nations Environmental Programme **USAID** United States Agency for International Development **WB** The World Bank



10 The National Environment Management Authority (NEMA) issued rules on soil erosion prevention and management to avoid soil fertility loss (ie., salinisation from over-irrigation).

Complementary to this, in response to the drought risks to agricultural production identified through the Agricultural Risk Assessment Report (2015), Kenya is developing the crop and livestock weather index-based insurance frameworks, which could help offset losses due to drought exacerbated by climate change and support farmers to maintain/increase productivity and incomes. Several commercial banks, such as the Kenya Commercial Bank (KCB), the K-Rep Bank, and Barclays offer various insurance, credit, and loans schemes to farmers, but their reach to resource-poor farmers throughout the country is still limited. This is partly due to limited knowledge and awareness of such products, among both extension service providers and the intended beneficiaries. Furthermore, private-public partnerships are at very early stages; actors continue working in isolation, leading to duplication of efforts and waste of valuable resources.

Potential finance

Apart from the proposed NCCF, which can add significant value to national efforts to support CSA interventions, there is a high potential for strengthening existing cooperation with regional and international actors, making sure that their investments reflect an integrated vision of the three CSA pillars. Likewise, Kenya has piloted various financing mechanisms, including the Carbon Finance (Vi Agroforestry), Finance Innovation and Climate Change Fund, Payment for Ecosystem Services (PES), among others. Given their positive results, these efforts could be up scaled to enable wider adoption of CSA practices, technologies, and services throughout the country.

Outlook

Enhancing food security while preserving the natural resource base and vital ecosystem services requires the transition to agricultural production systems that are more productive, use inputs more efficiently, have greater stability in their outputs, and are more resilient to climate risks, shocks, and long-term variability. Climate-smart agriculture requires a major shift in the way land, water, soil nutrients, and genetic resources are managed to ensure that these resources are used more efficiently. Making this shift requires considerable changes in technical approaches and financial mechanisms and also improved access to markets.

At the national level, Kenya has emphasized the need to transform its agriculture sector in order to meet the demand for its growing population through sustainable land and water management practices that ensure environmentally sound agricultural practices. This includes drought-tolerant crops and livestock in the ASALs, devolution of agriculture to county governments and increased export of cash crops, such as tea, coffee, and horticultural crops. However, climate finance has failed to adequately integrate agriculture, though it has great potential for adaptation and mitigation.

Enormous opportunities exist to create synergy amongst public and private institutions in agriculture and climate change. Existing frameworks such as the NCCAP, Agricultural Policy (in process), and the INDC are central for CSA as they enhance the adaptation of small-scale farmers, providing incentives for low-carbon agricultural activities (conservation agriculture, alley farming, and hay making) and promoting integrated land and water management (mixed farming, crop rotation, agroforestry, and contour farming). Furthermore, scaling up promising CSA practices and innovations requires institutional coordination between private and public agriculture and climate-related institutions at national, regional, and international levels, not excluding development partners.

Works Cited

[1] FAO. 2010. "Climate-Smart" Agriculture. Policies, practices and financing for food security, adaptation and mitigation. Rome: Food and Agriculture Organization of the United Nations (FAO).

[2] FAO. 2013. Climate-Smart Agriculture Sourcebook. Rome: FAO.

[3] GoK. 2007. Kenya Vision 2030. Nairobi: Ministry of Finance and Planning.

[4] WB. 2009. Kenya – Agricultural Carbon Project. Washington, DC: The World Bank (WB).

[5] FAO. 2011. The role of women in agriculture. ESA Working Paper No. 11-02. Rome: Agricultural Development Economic Division of the Food and Agriculture Organization of the United Nations (FAO).

[6] KNBS. 2013. Economic Survey Report. Nairobi: Kenya National Bureau of Statistics. (Available at: www.knbs.or.ke/).

[7] WB. 2015. World Development Indicators. Washington, DC: The World Bank (WB). (Available at: http://data.worldbank.org/data-catalog/world-development-indicators).

[8] FAO. 2015. FAOSTAT Database. Rome: Food and Agriculture Organization of the United Nations (FAO) (Available at: www.faostat.org/).

[9] GoK. 2010. Agricultural Sector Development Strategy Medium-Term Investment Plan: 2010–2015. Nairobi, Kenya: Government of Kenya (GoK).

[10] GoK. 2012. The National Climate Change Action Plan (NCCAP), 2013–2017. Nairobi, Kenya: Ministry of Environment and Natural Resources (MENR).

[11] GoK. 2012. National policy for the sustainable development of Northern Kenya and other arid lands. Sessional Paper Number 8 of 2012. Nairobi, Kenya: GoK.

[12] Fitzgibbon C. 2012. Economics of Resilience Study – Kenya Country Report. Nairobi, Kenya: Ministry of Environment and Natural Resources (MENR).

[13] FICCF. 2013. A review of climate-smart agriculture initiatives in non-ASAL areas of Kenya. Nairobi, Kenya: Finance Innovation and Climate Change Fund (FICCF).

[14] Amwata DA; Omingo PO. 2013. Sustainable adoption of Climate Services for Climate-Resilient Food Production: Lessons Learnt from Climate Change Adaptation in Africa Programme. Nairobi, Kenya: International Development Research Centre.

[15] FAO. 2012. FAO Country profiles: Kenya. Rome: FAO.

[16] IFIA. 2014. Fertilizer use in sub-Saharan Africa. International Fertilizer Industry Association (IFIA) (Available at: www.fertilizer.org).

[17] OECD. 2015. OECD data. Organization of Economic Cooperation and Development (OECD) (Available at: https://data.oecd.org/).

[18] WRI. 2014. CAIT - Country Greenhouse Gas Emissions Data. (Available at: http://www.wri.org/resources/data-sets/cait-country-greenhouse-gas-emissions-data/).

[19] Osumba J; Rioux J. 2014. Scoping study of climate-smart agriculture in Kenya. Smallholder integrated crop livestock farming systems. Rome: FAO.

[20] KALRO. 2014. Food Crops Research Programme. Kenya Agricultural & Livestock Research Organization (KALRO).

[21] Nyariki DM; Amwata DA; Ikutwa C. 2015. Analysis of sorghum value chain in Kenya: Case studies of Tharaka Nithi, Meru, Makueni, and Kitui Counties. Nairobi, Kenya: Africa Harvest.

[22] Nyariki DM; Wiggins SL; Imungi JK. 2002. Levels and causes of household food and nutrition insecurity in dryland Kenya. Ecology of Food and Nutrition 41(2):155–167.

[23] Amwata DA. 2005. Effects of communal and individual land tenure systems on land-use and food security in Kajiado District, Kenya. MSc Thesis, Kenya.

[24] Amwata DA. 2013. Influence of climate variability and change on land-use and livelihoods in the southern rangelands of Kenya. PhD Thesis. Nairobi: University of Nairobi, Kenya.

[25] Amwata DA; Nyariki DM; Musimba NKR. 2015. Factors influencing pastoral and agropastoral household vulnerability to food insecurity in the drylands of Kenya. A case study of Kajiado and Makueni counties, Journal of International Development. DOI: 10.1002/jid.3123.

[26] Jaetzold R; Schmidt H. 2009. Farm Management Handbook of Kenya. Vol. II. Nairobi, Kenya: Ministry of Agriculture and German Agricultural Team (GTZ).

[27] UNEP. 2009. Kenya: Atlas of Our Changing Environment. Nairobi, Kenya: United Nations Environment Programme (UNEP).

[28] Thornton PK; Jones PG; Owiyo T; Kruska RL; Herrero M; Kristjanson P; Notenbaert A; Bekele N; Omolo A, with contributions from Orindi V; Ochieng A; Otiende B; Bhadwal S; Anantram K; Nair S; Kumar V; Kelkar U. 2006. Mapping climate vulnerability and poverty in Africa. Report to the UK Department for International Development, ILRI, Nairobi, Kenya, 200 pp. (Available at: http://www.dfid.gov.uk/research/mapping-climate.pdf).

[29] ILRI. 2011. Predicted impacts of climate change on Kenya: Definitely hotter – expect less productive cropping, more livestock herding. Nairobi, Kenya: International Livestock Research Institute (ILRI).

[30] MENR. 2009. Economics of climate change in Kenya. Nairobi, Kenya: Ministry of Environment and Natural Resources (MENR).

[31] Collins M; Knutti R; Arblaster J; Dufresne JL; Fichefet T; Friedlingstein P; Gao X; Gutowski WJ; Johns T; Krinner G; Shongwe M; Tebaldi C; Weaver AJ; Wehner M. 2013. Long-term Climate Change: Projections, Commitments and Irreversibility. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker TF; Qin D; Plattner GK; Tignor M; Allen SK; Boschung J; Nauels A; Xia Y; Bex V; Midgley PM. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1029–1136. DOI: 10.1017/CBO9781107415324.024.

[32] Ramírez-Villegas J; Jarvis A. 2008. High-Resolution Statistically Downscaled Future Climate Surfaces International Center for Tropical Agriculture (CIAT); CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Cali, Colombia.

[33] Luedeling E. 2011. Climate change impacts on crop production in Busia and Homa Bay Counties, Kenya. Nairobi, Kenya: World Agroforestry Centre.

[34] Ojwang' GO; Agatsiva J; Situma C. 2010. Analysis of climate change and variability risks in the Smallholder sector: Case studies of the Laikipia and Narok Districts representing major agro-ecological zones in Kenya. FAO, Rome, Italy.

35] Herrero M; Thornton PK; Notenbaert AM; Wood S; Msangi S; Freeman HA; Bossio D; Dixon J; Peters M; van de Steeg J; Lynam J; Rao PP; Macmillan S; Gerard B; McDermott J; Seré C; Rosegrant M. 2010. Smart Investments in Sustainable Food Production: Revisiting Mixed Crop–Livestock Systems. Science 327:822–825.

For further information and online versions of the Annexes, visit: http://dapa.ciat.cgiar.org/csa-profiles/

Annex I: Acronyms
Annex II: Agriculture sub-sectors in Kenya
Annex III: Kenya's farming systems
Annex IV: Fertilizer consumption in Kenya
Annex V: Climate change impacts on agriculture
Annex VI: Selection of important production systems in Kenya
Annex VII: CSA practices in Kenya
Annex VIII: Legislative frameworks and policies in Kenya

This publication is a product of the collaborative effort between the International Center for Tropical Agriculture (CIAT) – lead Center of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) – and the World Bank to identify country-specific baselines on CSA in Africa (Kenya and Rwanda), Asia (Sri Lanka) and Latin America and the Caribbean (Nicaragua and Uruguay).

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