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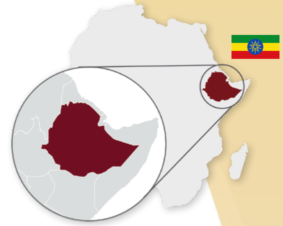

Climate-Smart Agriculture in Ethiopia

Climate-smart agriculture (CSA) considerations

A P The agriculture sector is the backbone of Ethiopia's economy and livelihoods. Yet, heavy reliance on rain-fed systems has made the sector particularly vulnerable to variability in rainfall and temperature. Climate change may decrease national gross domestic product (GDP) by 8–10% by 2050, but adaptation action in agriculture could cut climate shock-related losses by half.

A P Climate risk management interventions and long-term adaptation actions need to match localized vulnerabilities and impacts. The drought-prone highland areas are likely to experience more intense and irregular rainfall, affecting yields of slow maturing, long-cycle crops; however, the higher altitude moisture-sufficient parts of the highlands where cereal production is dominant are expected to increase in suitability and productivity of some cereals. Increased temperatures and extended drought periods are likely to negatively affect the lowlands, posing particular challenges to already vulnerable pastoral and agropastoral populations.

A P M Smallholder farmers produce over 90% of the agricultural output in Ethiopia. Despite high usage of traditional production methods, there is evidence of increased use of organic fertilizers, adoption of crop varieties with higher resistance/tolerance to drought, pests, and diseases, and improved livestock feeding practices, as attempts to increase productivity and resilience, but also with co-benefits in terms of reducing agricultural greenhouse gas (GHG) emissions.

$ M Given the country's poverty and food insecurity challenges, priorities for economic growth and increased resilience have pushed mitigation efforts backstage. Less than one-fifth of the climate finance is directed to mitigation efforts, mostly through renewable energy. Increased investments in agricultural practices that bring about mitigation co-benefits would bring out agriculture's role as a lead sector in low-emissions development.

I A large proportion of the country's land area is undergoing some form of soil erosion or land degradation, hence CSA-related efforts have been focused on restoring degraded lands through soil and water conservation measures, agroforestry, farmer-managed natural regeneration (FMNR), area closures, and dissemination of improved varieties. Such CSA practices and technologies are largely supported by the government and its development partners, through research and development, rural extension and advisory services as well as direct implementation. Many of these practices are implemented within the framework of the integrated watershed management approach through projects such as the Sustainable Land Management Programme (SLMP).

$ I Adoption levels of some CSA practices and technologies, such as conservation agriculture and agroforestry, among smallholder farmers remain low. Increased public and private support to enable access to improved inputs, equipment, credit and insurance schemes is needed to boost farmers' ability to manage risks and invest in long-term climate actions.

$ I Highly fragmented land units are not suited for effective implementation of some CSA practices, while land tenure regimes can significantly hinder credit access for smallholders. Ethiopia has made great effort to issue land certificates to smallholder farmers, and such programmes should be accompanied by sensitization of farmers and microfinance providers on the costs and benefits of investing in on-farm climate-smart and sustainable land management practices.

I $ Through an ambitious policy framework built largely on the Climate Resilient Green Economy (CRGE) Strategy and an enabling institutional infrastructure, Ethiopia has taken major steps towards mainstreaming climate change into agricultural planning. To demonstrate its unwavering commitments to green growth and food security and operationalize strategies and plans, additional national and international resources need to be mobilized over the next years, to fill existing financial gaps.

A Adaptation **M** Mitigation **P** Productivity **I** Institutions **$** Finance

The climate-smart agriculture (CSA) concept reflects an ambition to improve the integration of agriculture development and climate responsiveness. It 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 reduce/remove greenhouse gases (GHGs), and require planning to address trade-offs and synergies between these three pillars: **productivity, adaptation,** and **mitigation** [1].

The priorities of different countries and stakeholders are reflected to achieve more efficient, effective, and equitable food systems that address challenges in environmental, social, and economic dimensions across productive landscapes. While the concept is new, and still evolving, many of the practices that make up CSA already exist worldwide and are used by farmers to cope with various production risks [2]. Mainstreaming CSA requires critical stocktaking of ongoing and promising practices for the future, and of institutional and financial enablers for CSA adoption. This country profile provides a snapshot of a developing baseline created to initiate discussion, both within countries and globally, about entry points for investing in CSA at scale.

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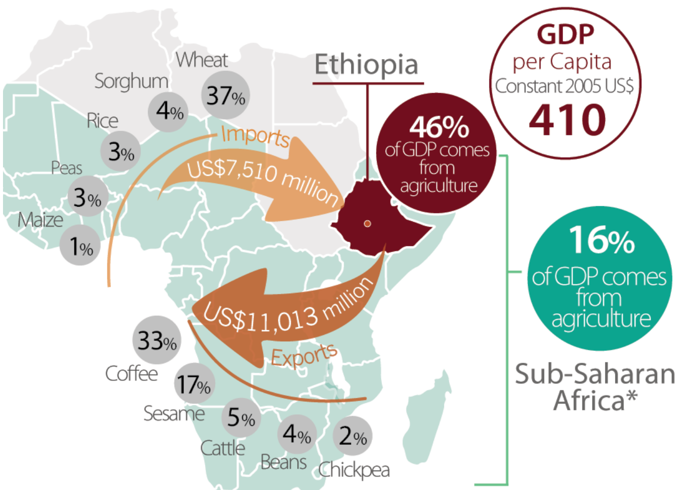
National context

Economic relevance of agriculture

Agriculture is the mainstay of Ethiopia's economy and the primary source of employment for its population. The agriculture sector has contributed approximately 44% to the gross domestic product (GDP) over the past 5 years[1] [3] and employed more than three quarters of the economically active population [4]. The livestock sector, one of the largest in the world in terms of animal heads, contributes 16–20% to the national GDP and represents a key subsistence source for some 10 million pastoralists [5]. Roughly 90% of total exports earnings [4] come from agriculture, especially through the commercialization of coffee, livestock products (hides, skins), and seeds and pulses. Cereal production is mostly for subsistence, with any excess sold to cater for other household needs such as education and healthcare.

Economic relevance of agriculture in Ethiopia [3, 6]



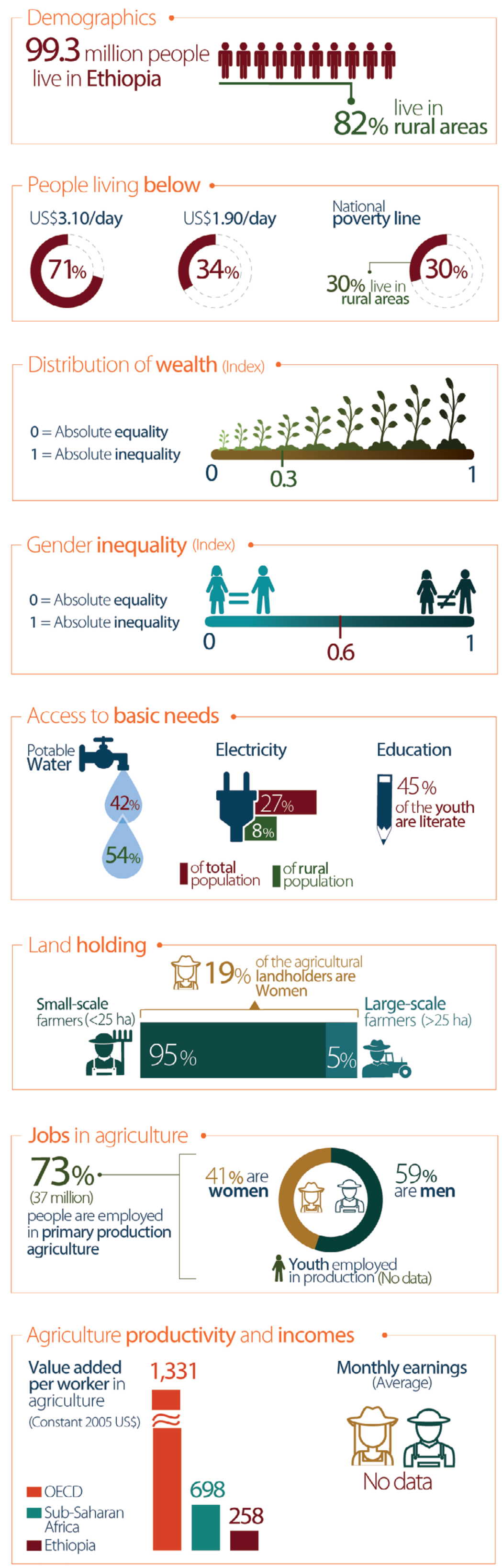
*Sub-Saharan Africa: Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzaville), Congo (Democratic Republic), Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Western Sahara, Zambia, Zimbabwe

People, agriculture, and livelihoods

Ethiopia's population has been increasing rapidly over the past four decades, from 35 million in the 1980s to 99.4 million in 2015 [3]. The large majority of the population (82%) lives in rural areas, in the country's highlands. The lowlands are mostly populated by pastoralists and agropastoralists.

Poverty rates in the country have decreased from 45% in 1995 to 29.6% in 2010 [3]. However, access to basic resources remains tight. Roughly 65% of all households and 54% of rural households have access to improved water resources; the rest of the population relies on water from ponds, streams and rivers. Almost half (48%) of all women in the country have no formal education, while 28% of men are without a formal education [4]. Illiteracy levels among farmers are high at 55% [4].

People, agriculture and livelihoods in Ethiopia [3, 4, 6, 7, 8, 9, 10]



1 Taking into account 2011-2015 averages. It is worthwhile noting that agricultural GDP has been declining since 2012, from 48% to 40% in 2015.

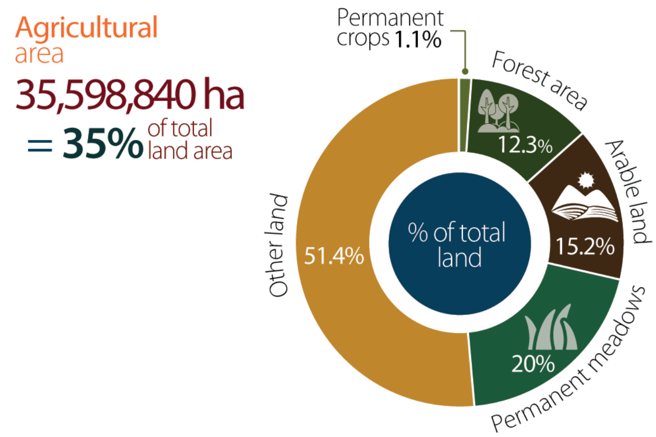
Land use

Ethiopia's land area totals 1.1 million square kilometers (km^2). Agricultural area occupies around 35% of total land area. Through the Constitution, the State owns all rural land and farmers have land-use rights.

There are approximately 17.5 million agricultural land holders[2] in the country, occupying 18 million hectares of land. Women represent only 19% of total agricultural land holders. Most farm holders are smallholder (farm sizes less than two hectares [ha])[3] and they produce the large majority (over 90%) of the gross agricultural outputs in the country [4]. As land has been fragmented to satisfy the needs of new generations, most smallholder farms are between 0.5 and 2 hectares in size. The small plot sizes in the country are often insufficient to enable household food security or adequate income to invest in improved farming methods [5]. Large, commercial farms (over 10 ha) are not widespread; extending over 1.2% of the total agricultural land area and contributing less than 5% of gross agricultural output [11].

There has been a steady increase in area under grain crops (cereals, pulses, oilseeds) over the past decades, from 10 million hectares in 2005/2006, to 12.4 million hectares in 2014/2015 [4]. Agricultural expansion has been carried out at the expense of natural resources availability and quality (particularly forests, water and soils). For example, in the highlands, where most Ethiopians live, over 40% of the land area is said to be undergoing some form of soil erosion, causing topsoil losses of over 1,493 million t/year and affecting regional and national crop production [12]. Unsustainable open grazing practices have also led to pasture degradation.

Land use in Ethiopia [3, 6]



Forests occupy approximately 12.3% of total land area, and some evidence shows between 1990 and 2005 deforestation rates averaged 140,000 hectares per year [13]. The decrease in vegetation cover and disturbance of the natural ecosystem have caused widespread soil degradation, contributing to decline in soil organic matter (SOM) and nutrient stocks [14]. In the lowlands[4] and midlands, over 19 million ha of fertile and uncultivated land is estimated to be available for agricultural investments [15].

Agricultural production systems

Ethiopia's proximity to the equator and its wide range of altitudes reflect distinct climate and agro-ecological conditions that favor the production of a diversity of agricultural goods, while at the same time posing challenges for technology development and targeting, mechanization and agricultural input (e.g. fertilizer) recommendations. The most commonly used categorization of Ethiopia's agricultural production systems refers to five main agro-ecological zones (AEZs), namely, "moisture reliable cereal-based highlands" (where the majority of the farmers live), "moisture reliable enset-based highlands," "drought-prone highlands," "humid lowlands," and "pastoralist areas" [16], Annex 1.

Cereals such as barley, maize, sorghum, wheat, and teff extend over three quarters of the country's cultivated land area and constitute the main source of food and income for the majority of smallholder farmers. Being a staple food for Ethiopians, teff accounts for 28% of the total cultivated area; it has traditionally been cultivated in the highlands, but it is quite adaptable to lower elevations and a variety of moisture, temperature and soil conditions. Maize is also grown by a large majority of farmers for food, fodder and sales; with its production volume being the highest among all crops. Sorghum and wheat each occupy around 17% of the grain-cultivated land. Sorghum has high tolerance to drought and high temperatures, but is less suitable for Ethiopia's high-altitude areas due to the cold temperatures, which are not favourable for the crop. Cultivated areas higher than 2,500 m.a.s.l. are almost exclusively dedicated to barley and wheat, which represent key components of the country's diet, and grown using many local varieties [17].

Faba beans are the most widely produced legumes across the country, representing an important protein source for rural populations. Chickpea production follows close behind, accounting for nearly 46% of the continent's production, the highest in Africa [18]. Potatoes are a high-potential staple root crop, and while production averages are currently low, the crop remains a large contributor to food security. Coffee is an important cash crop, contributing an average of 33% of the country's agricultural exports by value between 2009 and 2013 [6].

The majority of rural households (around 88%) hold livestock, especially local and indigenous cattle breeds [19]. Cattle heads are estimated at 53.9 million [20], while other livestock types amount to over 100 million heads [21], making the country home to one of the largest livestock populations on the continent. Half of the country's cattle stocks and a quarter of other livestock are owned by approximately 10 million pastoralists that occupy the lowland peripheral areas [5]. Cattle rely greatly on natural pastures as livestock feed [22], although in the highlands crop residues are a main source of livestock feed. Livestock are crucial in Ethiopia as a source of draught power, social protection, and food and nutrition security (meat, milk and eggs), while leather and leather products from cattle, goat and sheep hides comprise major import revenue earners for the country.

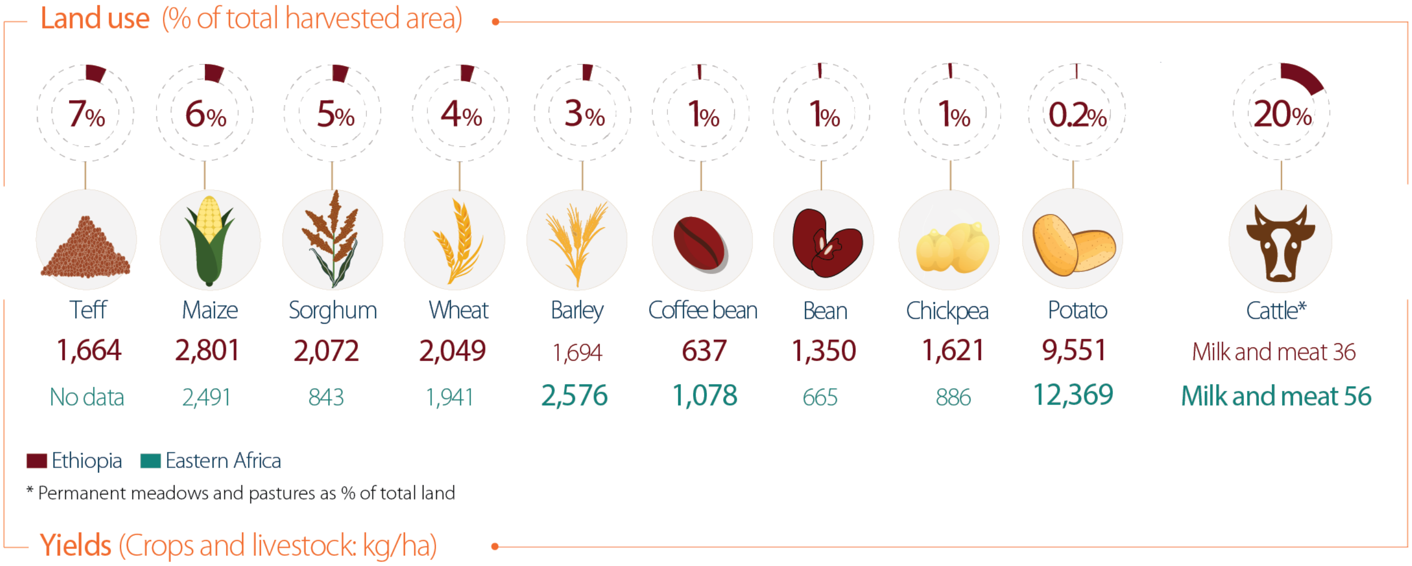
The following infographic shows a selection of agriculture production systems key for Ethiopia's food security. The importance is based on the system's contribution to economic, productivity and nutrition quality indicators. For more information on the methodology for the production system selection, consult Annex 2.

2 "Holder" here is defined by the capacity to manage and make decisions over agricultural land [4].

3 Official statistics report 14.5–15 million farmers holding less than 2 hectares during the main season 2015/16 [4].

4 Lowlands are normally stated as lying between 500 m and 1,500 m.a.s.l., the midlands are said to be between approximately 1,600 and 2,000 m.a.s.l.

Production systems key for food security in Ethiopia [3, 6, 23]

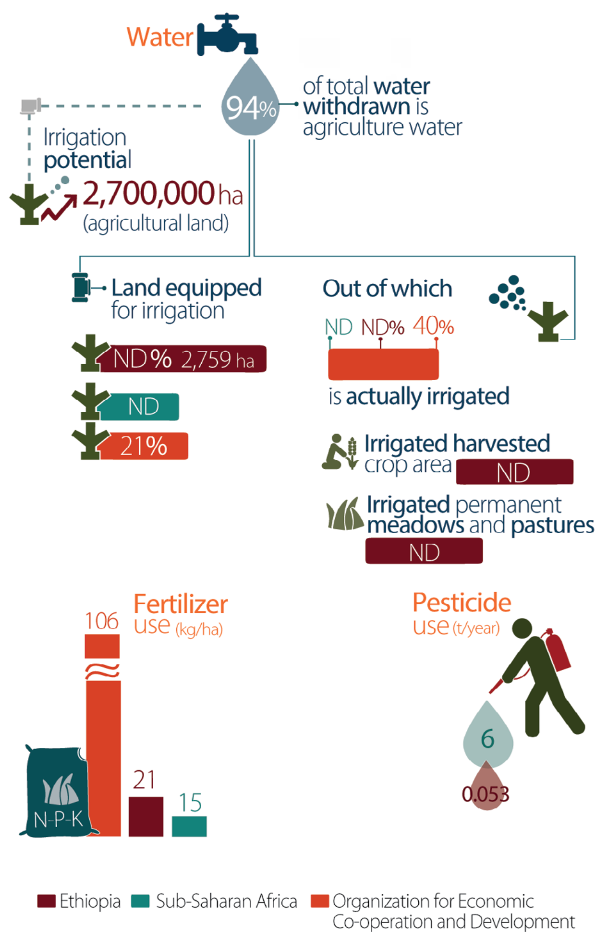


Fertilizers (organic and inorganic), supplied mainly by parastatals, traders and private organizations, among others, were used over a half of the cultivated area in the 2015/16 season. Almost 70% of the fertilizers used were inorganic,[5] and were applied for cereals; with high organic and inorganic fertilizer use being recorded for teff, wheat and maize [4]. Overall Ethiopia's average fertilizer use stands at approximately 21 kg per hectare, above the sub-Saharan average of 15 kg per hectare.

Although improved seeds of most cereals and pulses are available to smallholders, use of purchased improved seed is quite uncommon among smallholder farmers; in the 2015/16 season, improved seed area accounted for only 10.7% of the total cereal growing area, and this was mostly (83%) related to maize production [4].

Agricultural systems are almost exclusively rain-fed. Of an irrigation potential of approximately 2.7 million hectares of land, only 2–3% of the cropland is currently irrigated [5, 24]. In 2015/16, roughly 1.4 million farmers (180,000 ha of cultivated land) used irrigation for crop cultivation, mainly from rivers and natural ponds, and, to lesser extents, through installed water harvesting systems. Most of this irrigated area was for maize, sorghum and coffee production, [4] while sugarcane, potato and vegetables, such as onions and tomatoes, are also among the commonly irrigated crops. However, the country is endowed with huge water resources (springs and rivers), and their irrigation potential is highly underused.

Agricultural input use in Ethiopia [3, 6]



5 Urea; DAP – Diamonium Phosphate; and NSP – superphosphate.

Food security, nutrition and health

Vulnerability to poverty and food insecurity varies across Ethiopia's regions and is related to factors such as distance to input and output markets; access to productive assets; size, quality and productivity of land; household education levels and climatic factors. Households headed by women are particularly vulnerable, since, compared to men, they are less likely to own land and receive education. The moisture-reliable lowlands, pastoral areas and drought-prone highlands are among the regions most vulnerable to food poverty. Although it may seem counterintuitive that the moisture-reliable lowlands are vulnerable to food poverty, the region is classified as having the greatest proportion of poor people in the country [25]. In the pastoral and drought-prone highlands, in addition to poverty, lack of assets and low education; exposure to climate shocks is also high.

Pervasive poverty and food insecurity in rural households has also triggered a relatively high dependence on emergency food aid, in order to increase domestic food supply. Ethiopia is still one of the largest recipients of food aid in Africa, with a 2014 estimate indicating that the country receives around 27% of the global food aid given to sub-Saharan Africa [26]. Most of the food aid has been channeled to the country's north and less so to the south and south-east areas [27]. Household surveys have however shown, that the share of food in total expenditures is declining (fell from 60% in 1996 to 48% in 2011), while the quantities consumed (per adult equivalent) have increased by 55% [28].

In response to high poverty and vulnerability in the country, the Government of Ethiopia has implemented the Productive Safety Net Programme (PSNP), a component of the Government's Food Security program (FSP)[6] to support between 7 and 12 million people every year [29]. The programme is regarded as the largest social protection programme in Africa and is based on a cash or food for work principle. The programme has had some positive effects, with poverty rates having fallen significantly and the Global Hunger Index (GHI) score reduced from 43 in 2008 to 33 in 2016.[7] However, undernourishment rates remain high (at 32%) and 27% of children under five are underweight. Roughly 57% of childhood deaths are associated with malnutrition [30]. Ethiopia ranks 98th among the 113 countries in the Food Security Index (FSI),[8] with a score that has not changed significantly over the past 5 years. Recent efforts have also been made to integrate climate-smart agriculture into the PSNP.

On the positive side, as of 2015, Ethiopia was one of 12 African countries that had achieved the Millennium Development Goal (MDG) 1C target of halving the proportion of undernourished between 1990/92 and 2015, as well as making some progress to achieving the World Food Summit (WFS) target of halving the total number of chronically undernourished [31]. Despite making progress towards ending hunger, malnutrition and poverty, as of 2011, 44% of children under five were still stunted and 29 percent were underweight. From a nutrition quality perspective, the diets of rural households are composed mainly of cereals and tubers. Despite a large livestock population, consumption of livestock products is low in rural areas, except for the pastoral areas, where milk is a major component of the diet.[9]

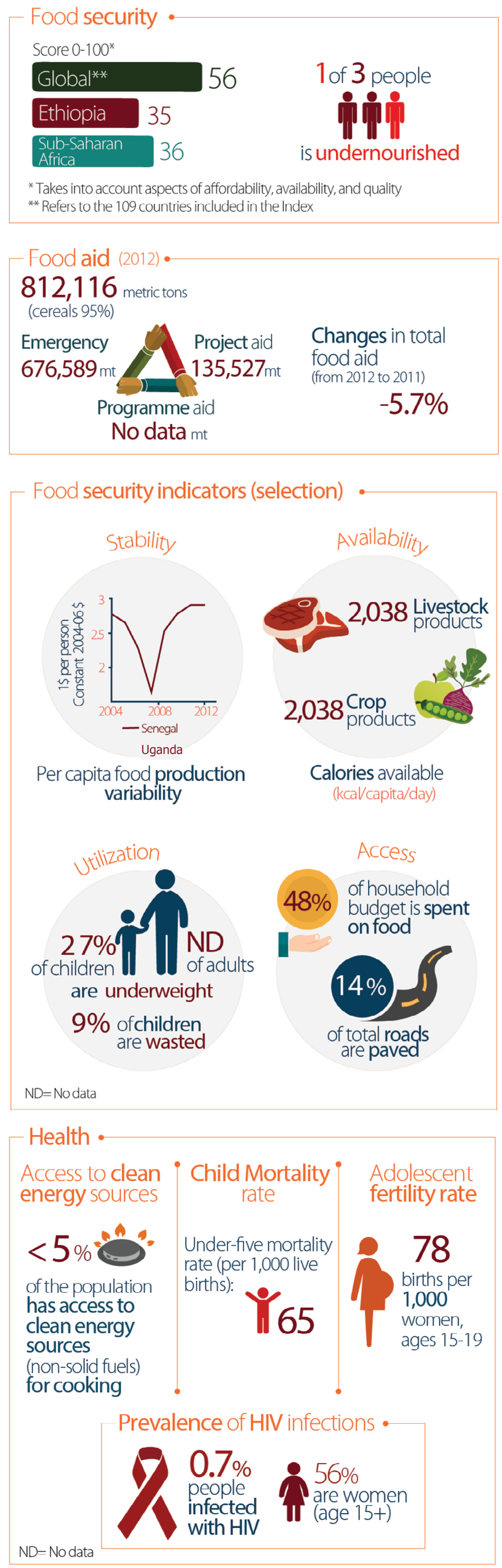
6 The PSNP was launched in 2005 and it's now in its fourth Phase. It targets three main AEZs, namely enset lowlands, drought-prone highlands, and pastoral areas and covers approximately 7.9 million individuals.

7 The GHI score takes into account undernourishment rates of the entire population and stunting, wasting and death rates among children under the age of five. The higher the GHI score, the higher the level of hunger.

8 The FSI takes into account aspects of food availability, affordability, quality and safety of food.

9 FAO Nutrition Country Profile for Ethiopia http://bit.ly/2AmOZmy

Food security, nutrition, and health in Ethiopia [3, 6, 32, 33, 34, 35]

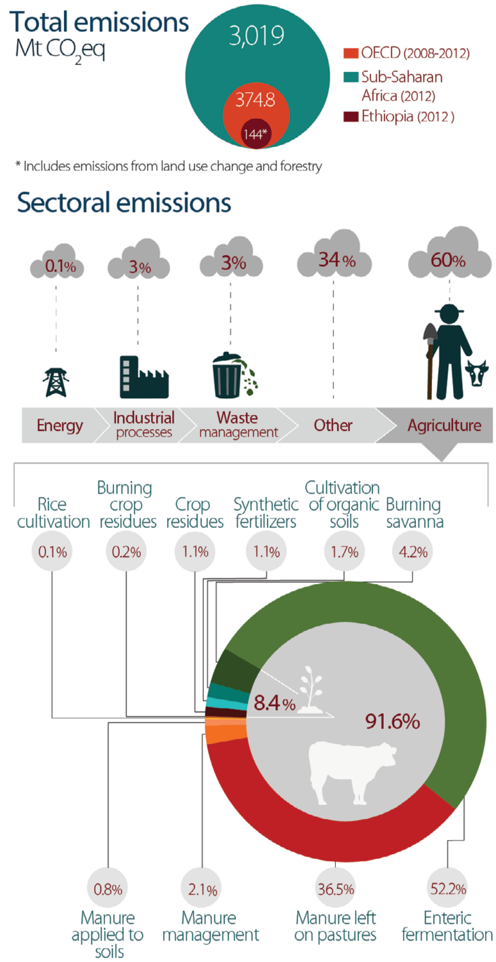


Greenhouse gas emissions

Total annual emissions in Ethiopia amount to 144 Mt CO_2eq,[10] the equivalent of approximately 0.3% of global emissions, while per capita emissions are similarly low, amounting to 2 tons of CO_2eq annually. The agricultural sector in the country is a major contributor to national emissions, accounting for approximately 60% of total emissions. Given that Ethiopia has the largest livestock population in Africa and has one of the largest livestock herds in the world [11], most of the agricultural GHG emissions emanate from livestock-related activities (methane and nitrous oxide emissions from enteric fermentation and manure left on pastures respectively), which account for almost 92% of agricultural emissions. Crop-related emissions are associated primarily with burning of natural vegetation, cultivation of organic soils and the use of synthetic fertilizer. Most emissions from the forest sector are associated with deforestation for the expansion of agricultural land [6, 15, 36].

In 2011, in response to the need to reduce emissions, develop a green economy and build greater resilience to climate change, the Government of Ethiopia developed the Climate Resilient Green Economy (CRGE) Strategy. One of the CRGE's main objectives is to reduce per capita emissions by a third by 2030, along the larger goal of advancing the economy and bringing Ethiopia to a middle-income status country [15]. Furthermore, according to the Intended Nationally Determined Contribution (INDC) prepared and submitted to the UNFCCC Secretariat in 2015, the country plans to reduce its annual level of emissions by 64% by 2030 compared to the business-as-usual scenario projection for 400 Mt CO_2eq; a significant portion of this being from the agriculture (90 Mt CO_2eq reduction) and forestry (130 Mt CO_2eq reduction) sectors [37].

Greenhouse gas emissions in Ethiopia [3, 6]



Challenges for the agricultural sector

The agricultural sector in Ethiopia is faced by a number of challenges, centered largely on increased pressure over natural resources (driven by a rapidly growing population and demand for food), which has led to land degradation on over 40 million hectares of land [21], declines in soil fertility and high rates of soil erosion, particularly in the highlands.

In addition, low agricultural yields have been associated with unfavorable climate conditions in some parts of the country (including climate shocks such as droughts and floods), which have had adverse effects on the natural resource base (e.g. soil erosion caused by intense rains) as well as on the livelihoods of rural populations who have limited resources ability to invest in resilience building and adaptation strategies.

Asked about the causes of crop damage in the 2015/16 crop survey, most farmers reported shortage of rain (57% of all farmers reporting crop damage), diseases and pests (18%), frost or floods (9%), weeds (7%), hailstone (7%), excessive rain (5%), wild animals (5%), and other factors (20%) as the main contributors to crop damage and even loss. Shortage of rain mostly affected cereals [4] but is also a significant factor in livestock production; affecting the availability of water, fodder and pasture with impacts on animal health and the nutrition and food security of pastoralists and agropastoralists.

Low uptake of technologies is not only driven by a lack of financial resources for initial investments and/or maintenance, but also by the existing land tenure system. Farmers find few incentives and opportunities to invest in improved management practices on land that is insecure,[11] whose area is constantly diminishing and fragmenting as a result of continuous population growth [38]. Some farming practices, such as agroforestry, may not be suitable for implementation on small pieces of land as farmers aim to maximize land under cultivation of the main crop. Additionally, small plot sizes often impede credit access and at times may act as a disincentive for the use of improved seeds and fertilizer [39]. Small land sizes also place a constraint on mechanization; smallholder investments in mechanization and uptake of technological innovations therefore being low and insufficient to improve farm efficiency, and increase productivity and profitability.

Food losses, which contribute to decreased availability of food in households and in markets, also result from inadequate storage facilities, pests and climate hazards. Some reports have indicated post-harvest losses for horticultural crops of as high as 40% [40], posing a threat to food security, incomes and profitability of producers.

10 This includes emissions from Land-Use Change and Forestry (LUCF) sectors.

11 In Ethiopia, land tenure insecurity is reflected by the Government's ownership of the land resources and the subsequent distribution to farmers, without any contractual arrangements. However, over the past years, land-use certificates have commenced to be issued.

Agriculture and climate change

Temperature and rainfall vary across the main regions of Ethiopia. There is a trend of decreasing temperatures and increasing rainfall from the lowlands in the south- and north-east to the central and upper highlands; with rainfall reaching over 2000 mm annually in the southwestern highlands compared to as low as 300 mm in the lowlands. The regions also experience very different seasonal regimes: while the June–September wet season (also known as the Kiremt season, with rainfall reaching as high as 350 mm/month) is common throughout most of the country, farmers and pastoralists in the North and the Centre rely yearly on an additional short wet season from February–May known as the Belg season. The South is exposed to rains between February–May and October–December (the Bega season), while rains are very scarce in the far eastern parts of the country [41].

Analyses of historic climate data (1981–2014) revealed the occurrence of more frequent droughts, increases in mean temperatures, more erratic rainfall, and more frequent heavy rains [42, 43]. These changes have had an impact on farmer livelihoods as well as on national economic performance. For example, studies have shown a close relationship between annual rainfall variability and agricultural GDP as well as affecting overall GDP growth.[12] Droughts in particular have had great impact on farmers' livelihoods. In terms of impact on livelihoods, the 1984 and 2003 droughts affected 7.5 and 12.6 million people respectively [43]. Losses from the 2006 floods amounted to US$3 million, 800 human lives, and 20,000 homes [44]. More recently, the El Niño event in 2015/16 resulted in Ethiopia experiencing one of the worst drought in decades, with over 10.2 million people estimated to be in need of food aid [45]. These events led to crop damage, animal loss, loss of livelihoods, migration to urban areas and increases in malnutrition.

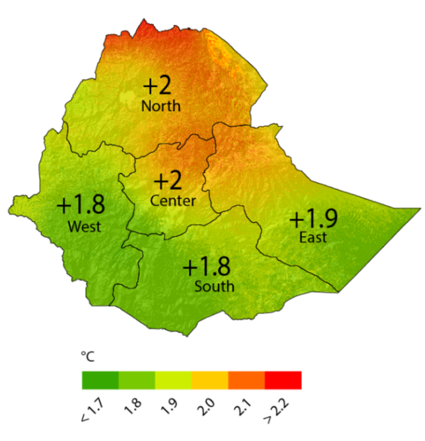
In terms of future trends, projections using any of the four main GHG emissions scenarios used by the IPCC indicate a continued increase in mean temperature throughout the entire country, with the greatest increases expected to be experienced in the northern parts of the country. Higher variability of rainfall is also expected, with rains becoming more unpredictable, more unreliable, and more intense [46]. Future climate projections indicate increases in annual rainfall for Ethiopia as a whole, with these increases being greatest in the southern and southeastern parts of the country and least in the central and northern parts of the country. These increases are largely a result of increasing rainfall during the short rainfall season (October–December) in southern Ethiopia; however, changes in precipitation were found to be variable, with some scenarios and time lines indicating decreases in rainfall. Intra- and inter-seasonal rainfall variability are also expected to increase.

The possible impacts of these changes on agricultural production in the country include, among others, the following:

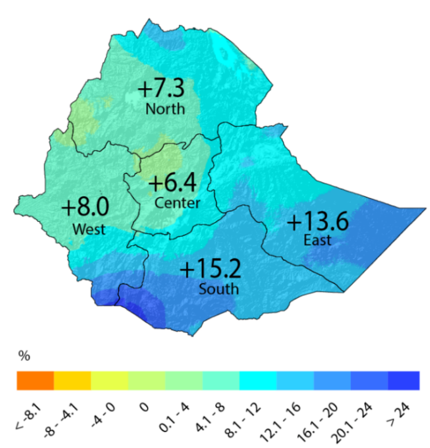
- Changes in water availability for crop and livestock production.
- Increased competition and conflicts over pasture and water for livestock.
- Geographical shifts and reductions in areas suitable for production of teff, maize, barley and sorghum [47].
- Shifts from livestock rearing to crop cultivation, from nomadic to sedentary livestock keeping, and/or from pastoralist to agropastoralist [48].

Projected changes in temperature and precipitation in Ethiopia by 2050 [49, 50, 51]

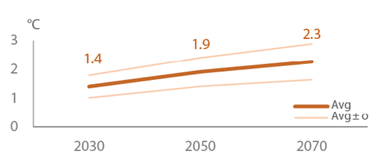
Changes in annual mean temperature (°C)



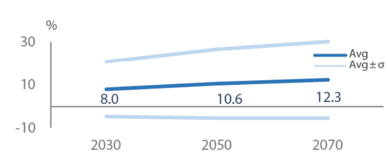
Changes in total precipitation (%)



Average temperature (°C)

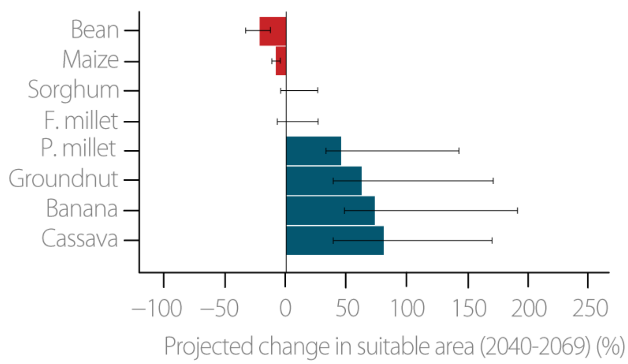


Average precipitation (%)



12 http://go.nature.com/2Bdh6FU

Projected change in suitable area in Ethiopia (2040-2069)



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 climate smart if they maintain or achieve increases in productivity as well as at least one of the other objectives of climate-smart agriculture (adaptation and mitigation). Hundreds of technologies and practices around the world fall under the heading of CSA [2].

Although traditional agricultural techniques such as repeated tillage, usage of ox-drawn wooden ploughs, low yielding crop varieties and traditional animal breeds are still common, Ethiopian farmers have begun to adopt new, improved technologies in both crop and livestock production systems. For crop production, there are efforts to promote organic fertilizer use and precise fertilizer application as opposed to the use of blanket fertilizer recommendations, while use of improved (drought- and heat-tolerant) cereal varieties (teff, maize, sorghum, wheat and barley) and crop rotations are increasingly being practiced. For pulses (faba beans and chickpea), the use of improved varieties, application of biofertilizers and development of cropping calendars informed by meteorological data are among the CSA practices being implemented. For coffee production, irrigation, mulching and agroforestry (tree shade) comprise key climate-smart practices. For agroforestry in coffee production, some key considerations for success include choice of tree, planting density and canopy management.

For livestock, the use of improved breeds (hybrids or crossbreeds), changing to more resilient animal types (goats), fodder conservation and feed production are common practices. These livestock management practices are also being combined with broader sustainable land management practices such as improved rangeland management, controlled grazing, planting of fodder trees and area closures,[13] which are implemented for environmental, economic and social benefits. For example, area closures in Ethiopia have been found to improve soils and natural vegetation, regulate floods, improve soil fertility, provide alternate income in the form of beekeeping and provide a source of fodder (cut-and-carry system) for livestock. These benefits are in addition to the carbon sequestration benefits that accrue as the land fills with vegetation [52]. Improved animal veterinary services and the training of community animal health workers (paravets) are also being promoted as a means of supporting overall livestock health and resilience to climate hazards, as well as improved efficiency of production. Many of the crop- and livestock-based CSA practices also help build system's resistance to pests and diseases, such as in the case of drought-tolerant crop varieties and livestock breeds, and the use of rotations in crop production.

In the broader Ethiopian context, climate-smart practices and technologies are being implemented within the framework of integrated watershed management, which incorporate a broad range of practices in crop and livestock production including agroforestry, crop rotation and intercropping [11] as well as broader soil and water conservation measures such as soil/stone bunds, terracing, infiltration ditches, and tie-ridges among others. It is important to note that although soil conservation practices, such as reduced tillage and crop rotations, have long been practised by farmers in Ethiopia, the promotion of conservation agriculture as a package with associated benefits has experienced various challenges related to knowledge, technology and awareness that still need to be addressed [53].

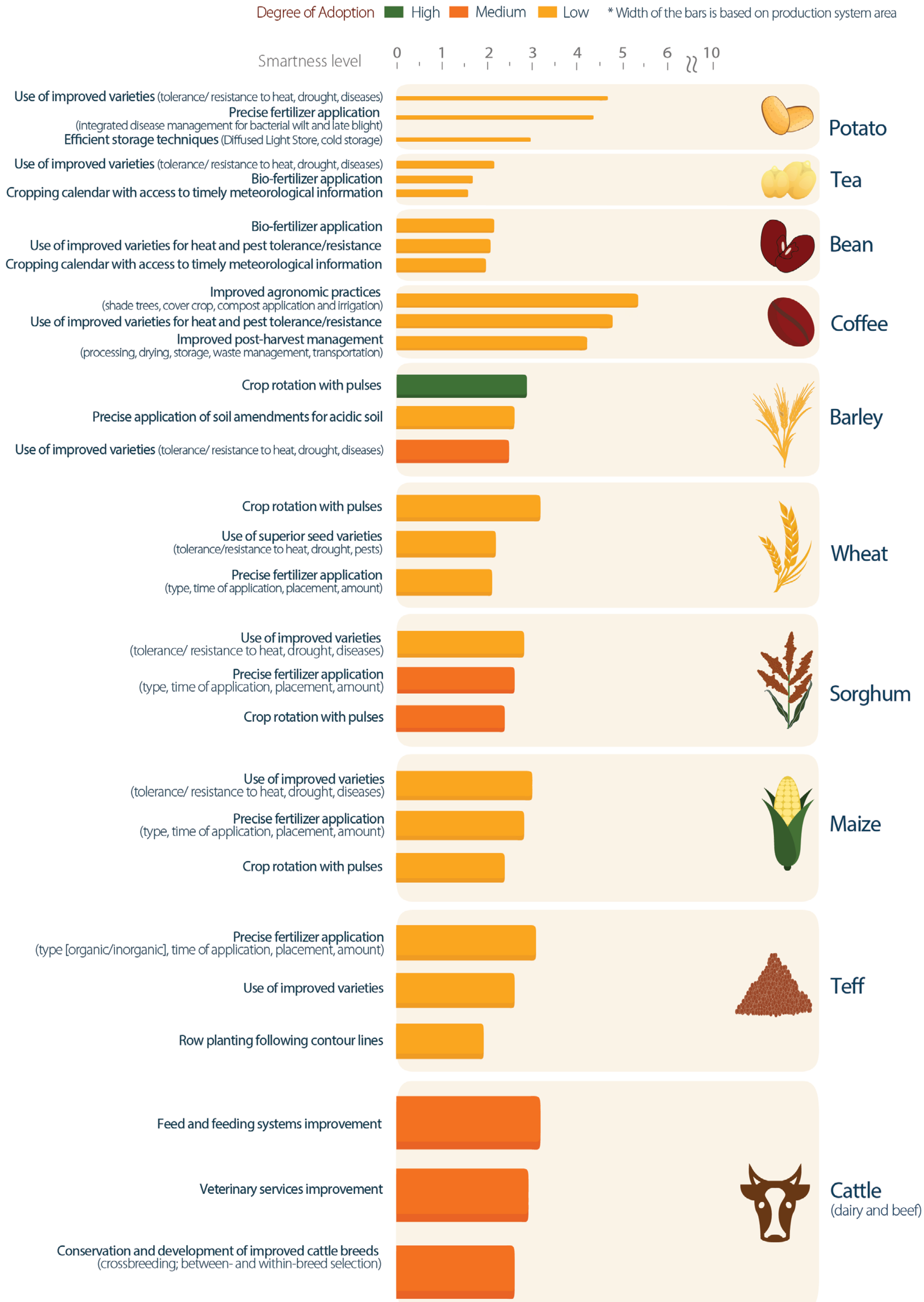
In terms of adoption, most of the CSA practices and technologies identified have low-to-medium on-farm adoption rates, despite their potential benefits to adaptation, productivity increase and mitigation efforts. Many of the key barriers to widespread adoption include limited or no access to productive inputs (improved seeds and fertilizer), lack of access to credit, lack of adequate machinery and technology (e.g. row planters), low access to formal markets to sell produce, and limited extension service quality and access particularly in relation to climate-smart agriculture. Low participation in extension services programmes has also been noted; driven by factors such as "suspicion of efficacy," insufficient arable land, and unavailability of programs that suit the farmers' needs [4] as well as limited technical capacity by the extension agents on issues such as climate change adaptation. Low access to and use of credit is mostly associated with inability to repay the loan and lack of return on investments, both of which can be addressed through conducting of cost–benefit analysis of different CSA practices combined with sensitization of farmers and microfinance providers on which practices to invest in, the likely returns and the required repayment periods.

Uncontrolled and free grazing, which limits implementation of some climate-smart practices (e.g. mulching), has been part of the tradition and routine of farmers for generations. Switching to new, improved feeding systems would require a change in perceptions and attitudes [54], and additional efforts of extension workers to share and demonstrate to farmers the benefits of practices such as cut and carry. Capacity building of extension agents in the on-field implementation of CSA technologies and practices, in close cooperation with research institutions, becomes of utmost importance for effective knowledge transfer to farmers.

The following graphics present a selection of CSA practices with high climate smartness scores according to expert evaluations. The average climate smartness score is calculated based on the individual scores of each practice on eight climate smartness dimensions that relate to the CSA pillars: yield (productivity); income, water, soil, risks/information (adaptation); energy, carbon and nutrients (mitigation). A practice can have a negative/ positive/ zero impact on a selected CSA indicator, with 10 (+/-) indicating a 100% change (positive/negative), and 0 indicating no change. Practices in the graphic have been selected for each production system key to food security, as identified in the study. A detailed explanation of the methodology and a more comprehensive list of CSA practices can be found in Annexes 3 and 4, respectively.

13 Sometimes also referred to as exclosures.

Selected CSA practices and technologies for production systems key for food security in Ethiopia



Case study of CSA in Ethiopia: the System of Teff Intensification (STI)

Teff (*Eragrostis tef*) is a staple cereal of Ethiopians' diet, mainly grown by women and used primarily for making the traditional fermented bread, *injera*. Planting involves the manual spread of very tiny seeds (approximately 2,500 per gram) on repeatedly ploughed soil. This practice is labor intensive with low productivity (an average of just 1.5 ton per hectare nationally).

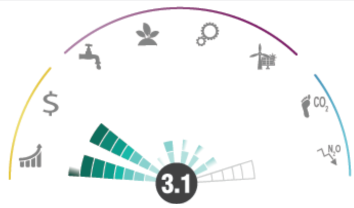
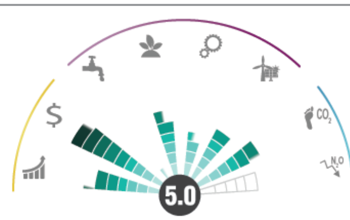
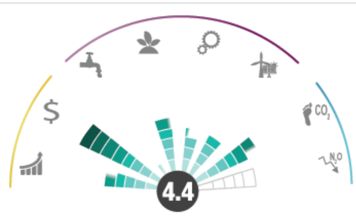
In order to increase yields, the System of Teff Intensification (STI), an adaptation of the System of Rice Intensification (SRI), was initiated in the 2008/09 season at the Debre Zeit Agricultural Research Center, Central Ethiopia, by the Sasakawa-Global 2000 program. In STI, young teff seedlings (20-days old) are transplanted at 20x20 cm spacing. Organic and inorganic nutrients are also applied to the soil, to help improve yields and address inherent soil nutrient deficiencies.

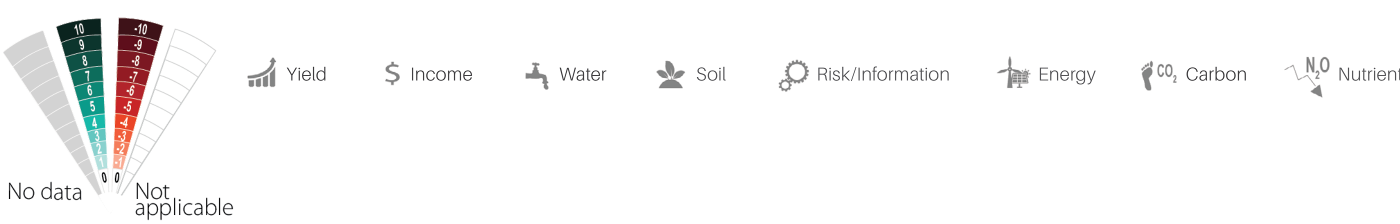
The Agricultural Transformation Agency (ATA), a federal government agency, conducted STI demonstration trials at two major centers for agricultural research in Ethiopia, Debre Zeit and Mekele, in collaboration with the local partner, the Institute for Sustainable Development (ISD), and with partial funding from Oxfam America. Positive results from the trials encouraged efforts to increase the number of demonstration plots in major teff-producing regions of Oromia, Amhara, Tigray and SNNPR (Southern Nations Nationalities and Peoples' Region) [55].

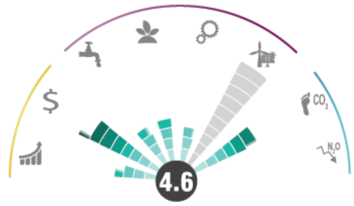
From applying STI methods, farmers obtained average yields of 2.7 t/ha in the 2011/12 season (higher than the 1.5 t/ha national average for broadcasted teff), while maximum yields amounted to approximately 5 t/ha. In the subsequent year (2012/13 season), a new, less intensified approach, for the STI was tested by roughly 160,000 farmers who replaced transplanting with direct seeding. This approach, which usually requires wider row spacing and the utilization of a mix of organic (compost) and inorganic (urea and diammonium phosphate [DAP]) fertilizers to increase soil organic matter, resulted in average yields of 2.1 t/ha [56]. While these yields are slightly lower than those for full STI implementation, direct-seeded STI requires less labor for sowing and weeding and improves the balance of moisture and air in the soil [57]. The choice of STI approach, however, depends on the farmer's capabilities. Following these trials, the Ethiopian Government scaled out the STI management area to over 1 million hectares in the 2013/14 season.

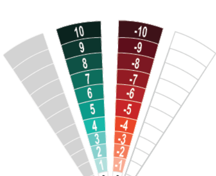
System of Teff Intensification (STI) in Ethiopia showing high tillering.
(Photo: Cornell University, SRI International Network and Resources Centre).

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

CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Teff (7.4% of total harvested area)				
Precise fertilizer application: type (organic/ inorganic), time of application, placement, amount	Highlands 30-60%	S		**Productivity** Maintains or increases yield. Reduces production costs. **Adaptation** Adequate, timing, amount, and placement of inorganic fertilizers can reduce negative effects of excessive fertilization. Reduces soil salinity and nutrient leaching. **Mitigation** Reduces emissions intensity. Precise fertilizer management can reduce nitrogen fertilizer-related nitrous oxide (N_2O) emissions.
	Midlands 30-60%	S		
Use of improved varieties	Midlands 30-60%	S		**Productivity** Increases in yield and quality at harvest. **Adaptation** Reduces yield loss due to pests and diseases in periods of adverse climatic conditions. **Mitigation** Benefits from reduced use of chemical inputs and energy consumed for pesticide application.
	Lowlands 30-60%	S		
Potato (0.2% of total harvested area)				
Use of improved varieties (tolerance/ resistance to heat, drought, diseases)	Highlands <30%	S		**Productivity** Increases in yield and income (reduced cost for fungicide application). **Adaptation** Improves food security bridges during shortage months and/or when other crops are not mature. **Mitigation** Reduces emissions intensity per unit of product.
	Midlands <30%	S		

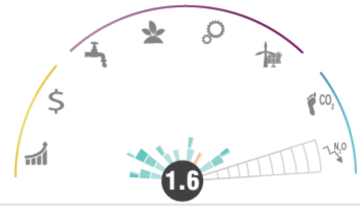
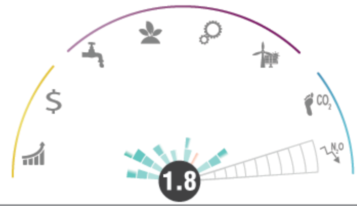
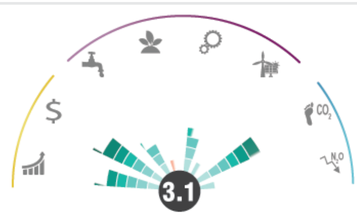


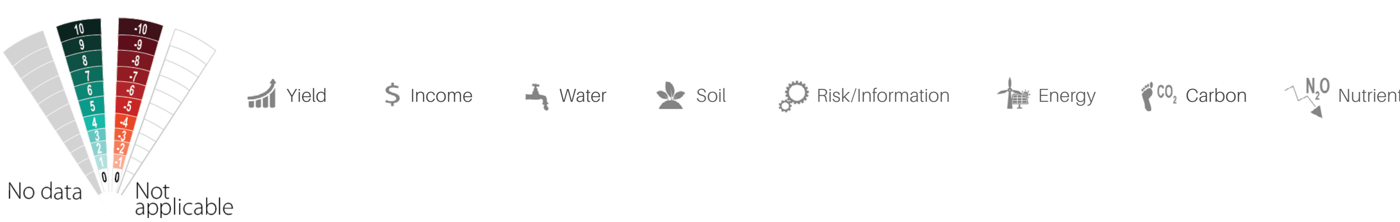
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Potato (0.2% of total harvested area)				
Precise fertilizer application: type, time of application, placement, and amount; Integrated disease management for bacterial wilt and late blight	Highlands <30%	M		**Productivity** Maintains or increases yield. Reduces production costs. **Adaptation** Reduces the use of inputs. Reduces soil salinity and nutrient leaching. **Mitigation** Reduces nitrogen emissions through efficient use of fertilizers. Reduces CO_2 emissions associated with fertilizer transport.
	Midlands <30%	M		
Sorghum (5% of total harvested area)				
Use of improved varieties (tolerance/ resistance to heat, drought, diseases)	Highlands <30%	S		**Productivity** Increases in yield and income. **Adaptation** Increased responsiveness to unpredictable weather patterns. **Mitigation** Reduces emissions intensity per unit of product.
	Midlands <30%	S		
Precise fertilizer application: type, time of application, placement, amount	Highlands <30%	M		**Productivity** Increased crop productivity and farmer's income. **Adaptation** Increases responsiveness to extreme weather events. Reduces environmental impact when inorganic fertilizers are used (leaching). Efficient use of scarce financial resources. **Mitigation** Contributes to reduced emissions per unit of product.
	Midlands <30%	M		

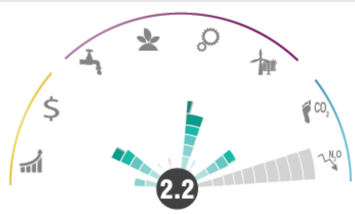


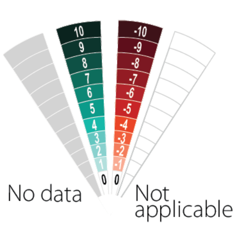
No data
Not applicable

Yield · Income · Water · Soil · Risk/Information · Energy · CO_2 Carbon · N_2O Nutrient

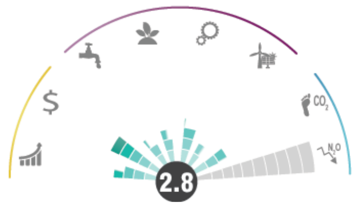
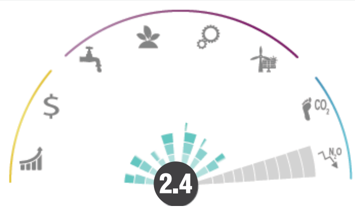
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Chickpea (0.6% of total harvested area)				
Bio-fertilizer application	Highlands <30%	M		**Productivity** Contributes to an economically and ecologically sustainable fertilization option. **Adaptation** Increases supply or availability of nitrogen or other primary nutrients. Reduces pollution in aquifers and soils due to over-fertilization. **Mitigation** Reduces energy consumption and emissions intensity per unit of product.
	Midlands <30%	M		
Cropping calendar with access to timely meteorological information	Highlands <30%	M		**Productivity** Increases land and crop productivity per unit of product. **Adaptation** Increases resilience to extreme natural events such as drought or floods, reducing crop failure. Reduces soil erosion. **Mitigation** Some impact on fertilizers, water and other inputs saving by enabling timely fertilizer application and other agronomic practices.
	Midlands <30%	M		
Cattle (Dairy and Beef) (20% of total harvested area)				
Feed and feeding systems improvement	Highlands <30%	M		**Productivity** Increases milk and meat yield and income. **Adaptation** Improves efficiency in natural pastures management. Increases availability of pastures/forages during extreme weather conditions. **Mitigation** Increases in productivity reduce GHG emissions per unit of product. Reduces methane (NH_4) emissions related to enteric fermentation.
	Midlands <30%	M		

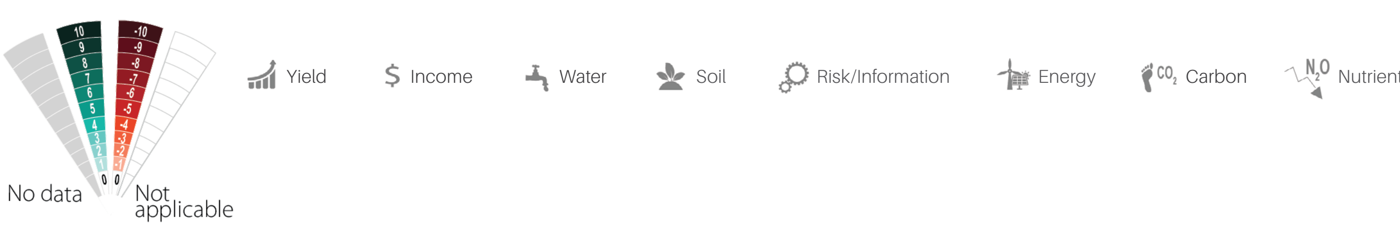


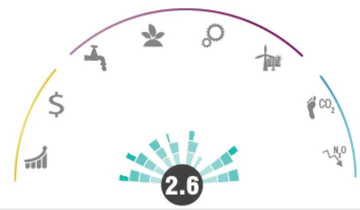
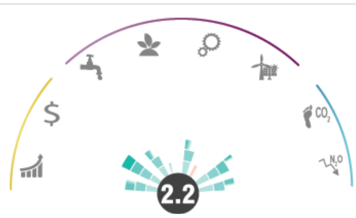
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Cattle (**Dairy and Beef**) (20% of total harvested area)				
Veterinary services improvement	Highlands 30-60%	M		**Productivity** Increases in productivity and income through increased product (milk and meat) quality. **Adaptation** Contributes to the development of optimal nutritional alternatives for animals. Potential reductions in post-harvest loss. **Mitigation** Increases production efficiency reducing GHG emissions per unit of product.
	Lowlands 30-60%	M		
Wheat (4.4% of total harvested area)				
Use of superior seed varieties (tolerance/ resistance to heat, drought, pests)	Highlands 30-60%	S		**Productivity** Increases in yield and income. **Adaptation** Increased responsiveness to unpredictable weather patterns. Local varieties can present greater resistance to diseases and heat stress. **Mitigation** Reduces emissions intensity per unit of product.
	Midlands 30-60%	S		
Crop rotation with pulses	Highlands <30%	S		**Productivity** Reduces financial vulnerability by diversifying production. Medium- to long-term soil fertility increases can lead to higher yields. **Adaptation** Improves soil quality (biological, physical and chemical characteristics). Increases efficiency in water and soil use. **Mitigation** Nitrogen fixation through leguminous plants reduces nitrogen fertilizer requirements. Increases soil organic matter, and soil carbon stock.
	Midlands <30%	S		

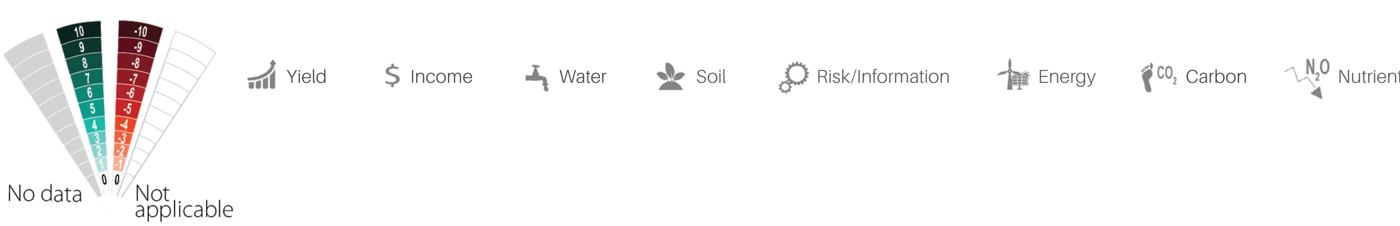


Yield · Income · Water · Soil · Risk/Information · Energy · CO_2 Carbon · N_2O Nutrient

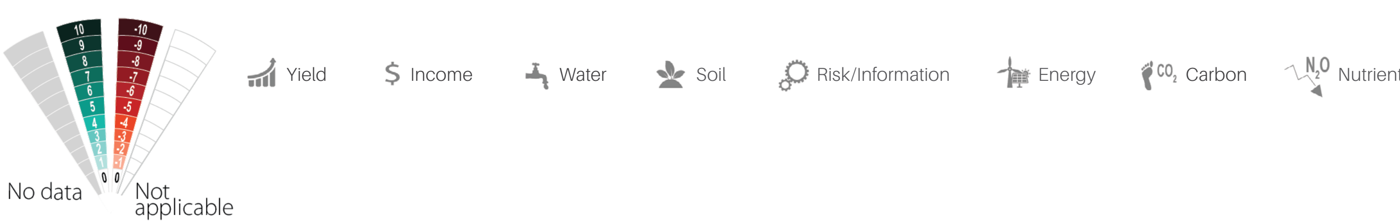
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Barley (2.9% of total harvested area)				
Crop rotation with pulses	Highlands >60%	S		**Productivity** Reduces financial vulnerability by diversifying production. Medium- to long-term soil fertility increases can lead to higher yields. **Adaptation** Conserves soil nutrients and moisture. Improves soil fertility and reduces pest and disease risks. **Mitigation** Nitrogen fixation through leguminous plants reduces nitrogen fertilizer requirements. Increases soil organic matter, and soil carbon stock.
	Midlands >60%	S		
Precise application of soil amendments for acidic soil	Highlands <30%	S		**Productivity** Greater yield stability and income under adverse soil conditions. **Adaptation** In conditions of drought or excessive rains, favors crop adaptation to soil pH. Reduces crop failure risk. **Mitigation** Increases in productivity reduce GHG emissions per unit of product.
	Midlands <30%	S		
Maize (5.5% of total harvested area)				
Use of improved varieties (tolerance/ resistance to heat, drought, diseases)	Highlands 30-60%	S		**Productivity** Increases in yield stability despite climate variability and biotic stress. Greater income. **Adaptation** Increases in crop resistance to pests and diseases. Reduction in water consumption. Greater product quality. **Mitigation** Improves emissions intensity levels due to productivity increases.
	Midlands 30-60%	S		



CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Maize (5.5% of total harvested area)				
Precise fertilizer application: type, time of application, placement, amount	Highlands 30-60%	S		**Productivity** Maintains or increases yield. Reduces production costs. **Adaptation** Reduce the use of inputs. Reduces soil salinity and nutrient leaching. Benefits in soil quality when integrating organic fertilizers. **Mitigation** Reduces nitrogen emissions through efficient use of fertilizers. Reduces CO_2 emissions associated with fertilizer transport.
	Midlands 30-60%	S		
Beans (faba beans) (0.8% of total harvested area)				
Use of improved varieties for heat and pest tolerance/ resistance	Highlands <30%	S		**Productivity** Increases in yield and income. Minimizes yield loss. **Adaptation** Increases food availability and nutritional security. Minimizes damage risk due to pests and diseases. **Mitigation** Reduces GHG emissions per unit of product.
	Midlands <30%	S		
Bio-fertilizer application	Highlands <30%	S		**Productivity** Contributes to an economically and ecologically sustainable fertilization option. **Adaptation** Increases supply or availability of nitrogen or other primary nutrients. Reduces pollution in aquifers and soils due to over-fertilization. **Mitigation** Reduces energy consumption and emissions intensity per unit of product.
	Midlands <30%	S		



CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA pillars
Coffee (1.4% of total harvested area)				
Use of improved varieties for heat and pest tolerance/ resistance	Highlands <30%	L		**Productivity** Increases in yields and reduces investment in pesticides and water use. **Adaptation** Maintains local coffee germplasm as well as quality. Diminishes yield loss due to reduced risk of pest and disease incidence. **Mitigation** Reduces GHG emissions per unit of product.
	Midlands <30%	L		
Improved agronomic practices (shade trees, cover crop, compost application and irrigation)	Highlands <30%	L		**Productivity** Crop diversification can improve yields, product quality and income. **Adaptation** Crop diversification can improve yields. Potential benefits for food and nutrition security and income diversification (trees for timber and fruits). Maintains or improves soil fertility status. **Mitigation** Increases carbon capture and storage both above- and below-ground. Benefits by reducing chemical inputs.
	Midlands <30%	L		



Enabling institutions and policies for CSA

There are five tiers of government in Ethiopia, each with different roles and duties with regards to policy making and implementation: the federal government, the regions, zone administrations, woreda, and kebele. The federal government is responsible for the formulation and implementation of national policies, strategies and plans and also allocates the budget to the regions, depending on population size and capacity to contribute to national budget through revenues. The Regional Councils are entitled to legislate and execute laws, but also to exercise judicial power. The regions design socio-economic development plans that meet national-level targets and are also able to generate their own revenue, although dependency on federal budget is still high [58]. This illustrates a complex context not only for legislation and policy development, but also for budget allocation and management.

As weather variability and changes in climate have continued to affect Ethiopia's agriculture sector, people's livelihoods and the economy as a whole, the CSA approach has gained a lot of momentum in the institutional and policy sphere over the years, in an effort to reduce climate impacts and to help build a more resilient, food-secure and economically competitive agriculture sector.

Most institutions surveyed facilitate information sharing and extension, and, to a slightly lesser extent, promote technology development and innovation. Allocation of funds towards mitigation is minimal across all institutions surveyed.

Climate change action was previously under the mandate of the Environmental Protection Authority (EPA), established after the Climate Change Conference in Copenhagen in 2009. Following the restructuring of governmental institutions, the Ministry of Environment, Forest and Climate Change (MEFCC) became the lead entity for the country's climate framework, which is now also in charge of the country's legislation and coordination of activities related to environmental degradation and forests. MEFCC is the overall coordinator of national climate-change-related activities in the country including being the focal point for the UNFCCC and Global Environment Fund (GEF) as well as National Designated Authority (NDA) for the Green Climate Fund (GCF) and Designated National Authority (DNA) for the Adaptation Fund.

The Ministry of Agriculture and Natural Resources (MoANR) is a key institution promoting CSA practices in the country, mainly through various projects and programmes implemented by its different units including: the Climate Resilient Green Economy (CRGE) Coordination Unit, the Sustainable Land Management Programme (SLMP)[14] Coordination Unit, the Soil Information and Fertility Directorate, Agricultural Growth Programme (AGP) Coordination Unit, and the National Agricultural Research System, among others [11]. CSA initiatives promoted by MoANR link to improved productivity and climate resilience of the agricultural sector, targeting primarily practices such as soil and water conservation, conservation agriculture, agroforestry systems, fodder production (cut and carry) and improved varieties. Apart from the above-mentioned SLMP, the Ministry also implements the Managing Environmental Resources to Enable Transitions (MERET) to More Sustainable Livelihoods Coordination Unit, which is a World Food Programme (WFP)-supported project initiated in the 1980s, and includes activities such as water harvesting, reforestation, seedling production, soil fertility management and construction of farmland terraces [11].

The Agricultural Transformation Agency (ATA) is an institution mandated to improve the livelihoods of smallholder farmers. ATA undertakes four major programmes that target: (i) agricultural production and productivity of smallholder farmers; (ii) processing and value addition in agribusinesses for improved market access; (iii) sustainable and inclusive growth for improved farmers' resilience; (iv) and capacity building of agricultural institutions for project implementation and impact maximization. ATA has a broad portfolio of CSA-related work, including the training of extension actors on CSA practices, such as conservation agriculture, enhancing agricultural decision making through enhanced access to climate information and weather station installations, supporting improved access to agrometeorological information.[15]

In terms of research, the Ethiopian Institute of Agricultural Research (EIAR) and its regional research institutes, federal and regional research centers, as well as universities constitute the National Agricultural Research System (NARS) in Ethiopia, whose principal aim is to generate and promote the adoption of information, knowledge, improved practices and technologies that increase agricultural productivity. The NARS collaborates with extension workers, civil society organizations, NGOs, seed enterprises, international research centers, and the private sector. EIAR's work related to climate-smart agriculture includes climate modelling; conducting of on-farm trials of new varieties; and the testing of agrometeorological tools such as Agro-weather Decision Support System (DSS)[16] to improve farmers' access to weather information and hence support adaptation efforts. Numerous international research institutes are also involved in CSA-related research in the country. CGIAR Centers such as CIAT, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Maize and Wheat Improvement Center (CIMMYT), International Center for Agricultural Research in the Dry Areas (ICARDA), World Agroforestry Centre (ICRAF), International Livestock Research Institute (ILRI), and International Water Management Institute (IWMI), are working on topics such as biogas from dairy waste management, soil and water conservation, agroforestry and conservation agriculture. For example, CIMMYT is implementing the project on Sustainable Intensification of Maize–Legume Cropping Systems for Food Security in Eastern and Southern Africa (SIMLESA), which is conducting research on and promoting maize–legume intercropping. The Farm Mechanization and Conservation Agriculture for Sustainable Intensification (FACASI) programme focuses on identifying appropriate small-scale machinery (e.g. 2-wheel tractors) to improve planting, harvesting, milling and transport among smallholder farmers. Both projects are funded by the Australian Centre for International Agricultural Research (ACIAR) along with other partners. The Water and Land Resource Centre (WLRC), associated with the Addis Ababa University,

14 The SLMP was launched in 2008 to address the challenges to agricultural production in the major agricultural potential regions of the Ethiopian highlands through watershed rehabilitation and productive agricultural use of rehabilitated land. The Ministry has chosen CSA as a guiding paradigm to implement the second SLMP phase [59]. The intention is to integrate climate-resilient production methods into the rehabilitated landscapes. On-farm soil conservation and re-vegetation measures as well as changes in livestock management are an integral part of CSA, as they increase farmers' capacities to adapt to climate impacts.

15 www.ata.gov.et/highlighted-deliverables/agro-meteorology/

16 http://bit.ly/2koPOFm

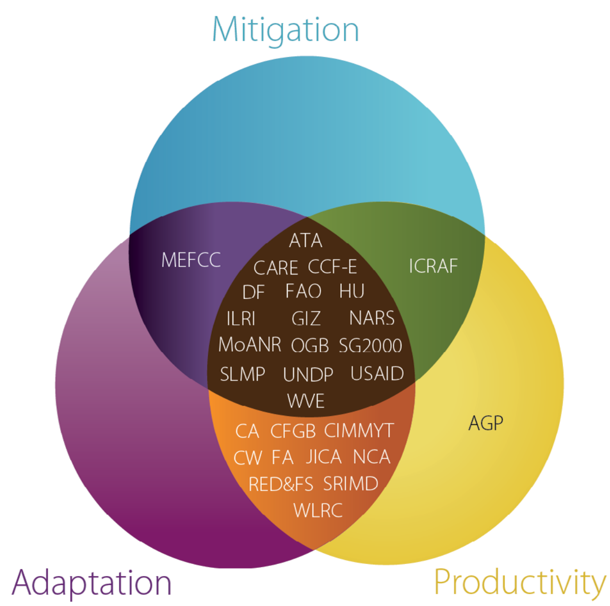
engages in research activities related to watershed and integrated landscape management, including implementation of sustainable land management (SLM) practices to increase productivity, rehabilitation of degraded lands, and management of the natural resources base. The Ethiopian Environment and Forest Research Institute (EEFRI), established in 2015, is also conducting research related to agroforestry, forest product utilization and climate change, among others. Haramaya University (HU) is also set to become a key CSA institution as the host for the soon to be established African Center of Excellence in Climate-Smart Agriculture and Biodiversity Conservation, which will aim to produce research and technically skilled personnel on CSA for the Eastern and Southern Africa regions; with master's programs being established in Climate-Smart Agriculture as well as Biodiversity and Ecosystem Management [53].

The work of national and local NGOs on CSA relates mainly to building smallholders' climate resilience and food security in the face of climate-related hazards, particularly droughts. Ethiopia was also one of the three initial pilot countries for the African Union-NEPAD iNGO CSA Alliance, which comprises Oxfam, Concern Worldwide Ethiopia, World Vision, Catholic Relief Services (CRS) and CARE International and whose aim is to support the adoption of climate-smart practices by 6 million farming households in sub-Saharan Africa by 2021. Separately, these NGOs are conducting various activities related to climate-smart agriculture. World Vision Ethiopia (WVE), for example, has been implementing the Humbo Assisted Natural Regeneration Project since 2006. This is a community-managed afforestation and reforestation initiative covering 2,728 hectares and funded by the World Bank's BioCarbon Fund under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change (UNFCCC) [11]. CARE International also leads a consortium of partners (SNV, Farm Africa and Mercy Corps, among others) implementing the Climate-Smart Initiative, which aims to better integrate CSA into the Productive Safety Net Programme (PSNP) and the Household Asset Building Programme (HABP). Aspects of the initiative include supporting development of climate information hubs; supporting access to biogas technologies and efficient stoves; water harvesting and efficient irrigation for vegetable production; livelihood diversification through promotion of chickpea, lentil and faba bean production as well as support for dairy production. As a whole, rather than simply providing food or cash incentives, farmers are given training on climate change and provided with a means to invest in their own resilience. Organisations such as Food for the Hungry (FH), Terepeza Development Association (TDA), and Sasakawa Global (SG2000) have been specifically promoting conservation agriculture and green manuring within their projects [11].

For international organisations, the Food and Agriculture Organization of the United Nations (FAO) has a long history of support for conservation agriculture and other climate-smart practices in Ethiopia, through the organization of demonstration plots and introduction of equipment (including jab planters and oxen-drawn seed and fertilizer planters), as well as training of extension agents for the development of conservation agriculture farmer field schools [11]. Additionally, FAO, with funding from the Common Market for Eastern and Southern Africa (COMESA) and the Norwegian Agency for Development Cooperation (NORAD), has been supporting conservation agriculture awareness raising and coordination through the Natural Resources Management Directorate of the Ministry of Agriculture and Natural Resources (MoANR). Through the Growth and Transformation Plan (GTP), the United Nations Development Programme (UNDP) has been providing institutional capacity building support to MoANR and ATA, for on-field interventions targeting economic growth and poverty reduction, climate change and environment vulnerability. The German Development Cooperation Agency (GIZ) has been supporting the Government of Ethiopia's CSA efforts, particularly through involvement in the multi-stakeholder process to develop a CSA field manual for the Sustainable Land Management Programme (SLMP-II). The manual includes the identification of "baskets of options" that can be taken as climate-smart packages to farmers, under the premise that an integrated approach to CSA provides greater benefits against the three CSA pillars than a single-practice approach.

The following graphic highlights key institutions whose main activities relate to one, two or three CSA pillars (adaptation, productivity and mitigation). More information on the methodology and results from interviews, surveys and expert consultations is available in Annex 5.

Institutions for CSA in Ethiopia



AGP Agricultural Growth Programme Coordination Unit **ATA** Agricultural Transformation Agency **CA** Christian Aid **CARE** CARE Ethiopia **CCF-E** Climate Change Forum Ethiopia **CFGB** Canadian Foodgrains Bank **CIMMYT** International Maize and Wheat Improvement Center **CW** Concern Worldwide **DF** Development Fund of Norway **FA** Farm Africa **FAO** Food and Agriculture Organization of the United Nations **GIZ** German Development Cooperation Agency **HU** Haramaya University **ICRAF** World Agroforestry Centre **ILRI** International Livestock Research Institute **JICA** Japan International Cooperation Agency **MEFCC** Ministry of Environment, Forest and Climate Change **MoANR** Ministry of Agriculture and Natural Resources **NARS** National Agricultural Research System - Ministry of Agriculture and Natural Resourses **NCA** Norwegian Church Aid **OGB** Oxfam **RED&FS** Rural Economic Development and Food Security Sector Working Group **SG2000** Sasakawa Global **SLMP** Sustainable Land Management Programme Coordination Unit **SRIMD** Soil Resources Information And Mapping Directorate - Ministry of Agriculture and Natural Resourses **UNDP** United Nations Development Programme **USAID** United States Agency for International Development **WLRC** Water and Land Resource Centre **WVE** World Vision Ethiopia

Ethiopia ratified the UNFCCC in 1994 and the Kyoto Protocol in 2005. The Government presented two National Communications to the UNFCCC, in 2001 and 2016. Furthermore, as part of its commitments as a member of the Comprehensive Africa Agriculture Development Programme (CAADP), it developed the CAADP Compact in 2009. This endorsed the three main objectives set by African Heads of States and Governments through CAADP, namely agricultural growth, food security and improved livelihoods, outlining the necessary instruments for using these as guiding pillars for future Government programmes and activities. The operationalization of the CAADP Compact is outlined in the Agricultural Sector Policy and Investment Framework (PIF, 2010-2020), which prioritizes research and development of crop varieties and systems adapted to new (dry) climate conditions, water harvesting techniques, agroforestry, and improved information systems (weather forecasts). In 2016, FAO supported the screening of the PIF for climate-smart agriculture, a process meant to identify and enhance climate-smart components within the investment plan, coinciding with its mid-term review. This screening along with other findings of the PIF mid-term evaluation could be important in directing national-level funding for CSA in the country.

The Government submitted the Nationally Appropriate Mitigation Actions (NAMA) to the UNFCCC Secretariat in 2010, where key mitigation strategies for the agriculture sector included investments in compost production and application and agroforestry systems. Ethiopia also submitted its Intended Nationally Determined Contribution (INDC) to the UNFCCC in June 2015, pledging a 64% reduction in emissions by 2030 compared to the business-as-usual scenario. The INDC is based on Ethiopia's Climate-Resilient Green Economy (CRGE) Strategy established in 2011, which represents the first attempt to integrate climate change and green growth efforts across all sectors of the economy. The CRGE's overall goal is to enhance the population's adaptive capacity and climate resilience, while achieving middle-income status by 2025. The strategy is based on four pillars, two of which relate to CSA, namely: 1) Agriculture: improving crop and livestock production practices for greater food security and better income for farmers, while reducing emissions; and 2) Forests: protecting and re-establishing forests for their economic and ecological values, including carbon stocks [11]. One of the strategies highlighted in the CRGE is the use of energy-saving stoves as a means of reducing deforestation. In agriculture, CSA-related strategies include soil fertility management, conservation agriculture, residue management, efficient irrigation and watershed management for crops, as well as controlled grazing and improved feed production for livestock. In total, 41 options are identified to facilitate the attainment of the CRGE objectives in the agriculture and forestry sectors.

The Agriculture Sector Programme of Adaptation to Climate Change (ASPACC) was also formulated in 2011 with the main objectives of contributing to the country's commitments to the UNFCCC, through integration of climate change into sectoral policies and development efforts. The development of a climate change adaptation plan to minimize agriculture sector vulnerability was another key objective set by the ASPACC [15].

The Ethiopian Programme of Adaptation to Climate Change (EPACC) from 2011, built on the National Adaptation Program of Action (NAPA),[17] aims to mainstream climate adaptation into national-level decision-making processes, with a particular focus on poverty elimination, climate resilience, and sustainable development. Sectoral and regional programmes for putting EPACC into action have already been developed.

The Growth and Transformation Plan (GTP), now in its second phase (GTP II, 2016–2020), focuses on the gradual shift from traditional to high-value crops and livestock production in the highlands and agricultural out-scaling in the lowland areas (by converting rangelands into irrigation schemes), in order to accelerate growth in production. A concerted effort was also placed on mainstreaming climate change adaptation and mitigation issues across all GTP II pillars.

The country's vulnerability to climate change is also acknowledged in the Environmental Policy of Ethiopia (EPE), issued in 1997. The EPE serves as the overarching environmental policy framework in the country, with a particular focus on forestry and sustainable natural resource management.

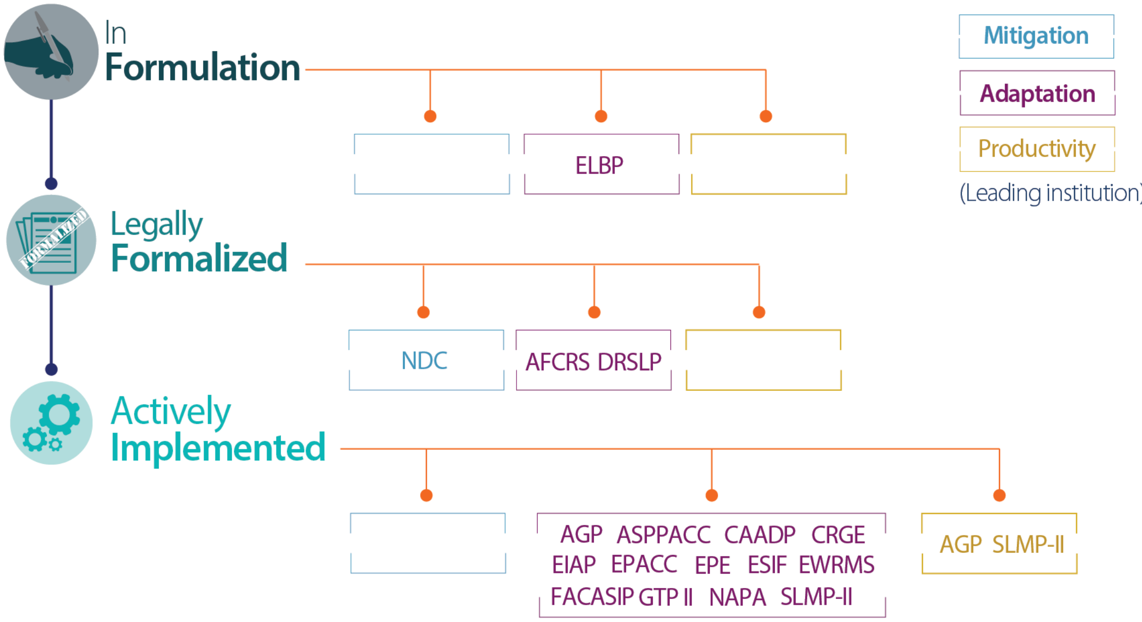
Overall, the country has a clear institutional and policy framework to support the mainstreaming of climate change action in agricultural sector development. The Government, in collaboration with its development partners, has shown progress in bringing CSA on the policy arena and closer within farmers' reach, through investments in research, capacity building of extension workers and field demonstrations. As such efforts continue to grow in number and scope, coordination of interventions and alignment with existing policies will be key for effective resource spending and value addition.

Moreover, while efforts to increase productivity and adaptive capacity are essential to the sector's sustainable growth, exploring opportunities that current and potential policy innovations can bring for mitigation would increase the likelihood of achieving the triple win: productivity, resilience, and low-emissions development in agriculture.

The graphic on page 21 shows a selection of policies, strategies and programs that relate to agriculture and climate change topics and are considered key enablers of CSA in the country. The policy cycle classification aims to show gaps and opportunities in policy-making, referring to the three main stages: policy formulation (referring to a policy that is in an initial formulation stage/consultation process), policy formalization (to indicate the presence of mechanisms for the policy to process at national level) and policy in active implementation (to indicate visible progress/outcomes toward achieving larger policy goals, through concrete strategies and action plans). For more information on the methodology and results from interviews, surveys and expert consultations, see Annex 6.

17 The 2007 NAPA is considered to be the first attempt for inter-sectoral coordination on climate adaptation work [11]. Key priority actions and projects included in the NAPA included, among others: promotion of a drought/crop insurance program; strengthening of drought and flood early warning systems; development of small scale irrigation and water harvesting schemes; improvement of rangeland resource management practices; community-based sustainable use of wetlands; capacity building; and improved food security through large-scale water development projects [60].

Policies for CSA in Ethiopia



AFCRS Agriculture and Forestry Climate Resilient Strategy (2015) (MoANR) **AGP** Agricultural Growth Programme (2011) (MoLF) **ASPPACC** Agriculture Sector Programme of Plan on Adaptation to Climate Change (2011) (MoANR) **CAADP** Comprehensive Africa Agriculture Development Programme (2009) (MoANR) **CRGE** Climate-Resilient Green Economy Strategy (2011) (MoANR) **DRSLP** Drought Resilience and Sustainable Livelihoods Program (2013) (MoLF) **EIAP** Environmental Impact Assessment Proclamation (2002) (MoEF) **ELBP** Ethiopian Livestock Breeding Policy (2015) (MoLF) **EPACC** Ethiopian Programme of Adaptation to Climate Change (2011) (MoANR) **EPE** Environmental Policy of Ethiopia (1997) (MoANR) **ESIF** Ethiopian Strategic Investment Framework for Sustainable Land Management (2011) (MoANR) **EWRMS** Ethiopian Water Resources Management Strategy (1999) (MoANR) **FACASIP** Farm Mechanization and Conservation Agriculture for Sustainable Intensification Programme (2013) (EIAR) **GTP II** Growth and Transformation Plan II (2015) (MoANR) **NAPA** National Adaptation Program of Action (2007) (MoEF) **NDC** Nationally Determined Contribution (2015) (MEFCC) **SLMP-II** Sustainable Land Management Programme II (2013) (MoANR)

Financing CSA

In Ethiopia, future expenditures on drought-related interventions to ensure food security of the population have been projected to range from US$7.3 million to as high as US$1.2 billion annually, depending on the climate scenario (wet/dry).[18] On the other hand, very wet climate change shocks could bring about a drop in GDP by 8%, while the very dry climate scenario may decrease GDP by 10% by 2050.[19] These would include costs for infrastructure repair and maintenance (especially in the case of floods and heavy rains), and investments in hydropower generation, among others. Adapting the agricultural sector to climate change through investments in research and development and farm management practices, coupled with irrigation and drainage infrastructure could reduce the impacts of climate hazards, however, estimates have placed the costs of adaptation investments between US$68 and US$71 million annually between 2010 and 2050 [45].

At present, annual investments in the agriculture sector in the country amount to US$1 billion. Over a third (approximately 40%) is public funding, through MoANR. However, to implement the 41 forestry- and agriculture-related options outlined in the CRGE, additional funding of US$400–600 million is estimated to be required [40]. The CRGE Facility was set up through a collaboration between the Ministry of Finance and Economic Development (MoFED) and MEFCC to enable the implementation of the priority actions identified by the CRGE strategy, through a coordinated administration of funds allocated from domestic (public and private) and international resources [61].

Ethiopia currently spends approximately US$440 million annually on climate change action (primarily on adaptation actions), which represents almost 11% of total government expenditure and almost 6% of the yearly financing required to implement the CRGE Strategy.[20] Most funding (approximately 80%) channeled through the national budget comes from domestic contributions, and not international public resources, as one would expect.[21] International public climate funds mainly come from the UK, Japan, EU, Ireland, and Norway and target areas such as food security (37% of total

18 The figures are based on projections for a wet scenario in 2040 and a dry scenario in 2030 respectively.

19 Compared to a scenario with no climate change.

international public funds), education (13%) and agriculture (11%), among others [62].

In 2011/12, three-quarters of the climate change expenditure was at the MoANR (for irrigation and land management projects) and the Ministry of Water, Irrigation and Electricity (MoWIE). The amount of international direct support to climate change projects and programmes has yet to be estimated. It has also been observed that spending is often vaguely reported, not offering much detail on the activities targeted by the funding.

Ethiopia has been accessing climate funds from various international sources, including the Scaling-Up Renewable Energy Program for Low Income Countries (SREP) of the Climate Investment Funds (CIF), the Global Environment Facility (GEF), the Clean Development Mechanism (CDM), among the most important ones. For agriculture- and food security-related projects, funds are sourced from partners such as the Canadian International Development Agency (CIDA), the International Fund for Agricultural Development (IFAD), the World Bank, and the Government of Norway, among others. NORAD and the Norwegian Development Fund (DF), for example, have been supporting national CSA coordination and various studies through partners such as FAO. Some of the key initiatives include training of extension service workers in crop and livestock production, farmers and pastoralists on good agricultural practices, livestock management, non-cereal (vegetable and fruit) production, and women in nutritious feeding practices, among others.

Banks and microfinance institutes also play an important role in financing CSA investments of smallholder farmers and value chain entrepreneurs. The Oromia Cooperative Bank of Ethiopia (OCBE), for example, established by the Oromia Regional Government, supports local agri-businesses that need to finance activities related to agricultural production, in a context where commercial banks largely finance export-related infrastructure. However, access to credit in rural areas is generally low. Bank coverage in these areas is poor – roughly 1% of the rural population has a bank account. Moreover, land cannot be used as collateral for credit, which further alienates smallholders from opportunities to finance their farm investments [63].

To encourage increased adoption of vital agricultural inputs (particularly fertilizer and improved seed), the MoANR and ATA have developed an Input Voucher System (IVS), as part of an overall Rural Financial Services (RFS) strategy. According to this new strategy, distribution of inputs is primarily financed by the regional governments and distributed through multipurpose cooperatives by cash or partial credit.

In March 2017, the Adaptation Fund Board approved the first ever regional Adaptation Fund project titled "Agricultural Climate Resilience Enhancement Initiative (ACREI)," for which Ethiopia is one of the target countries along with Uganda and Kenya, and which focuses on enhancing access to climate information and scaling up of CSA practices through farmer field schools and community adaptation initiatives. The project will be implemented by the World Meteorological Organization (WMO), FAO, the Intergovernmental Authority on Development (IGAD) and government departments and institutions in the three target countries.

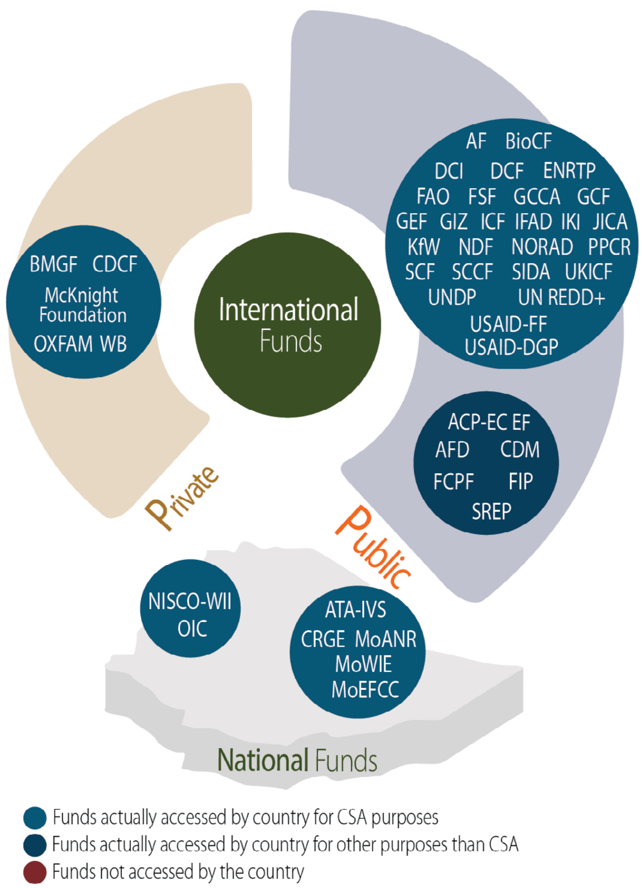
In addition, agricultural insurance, particularly weather-index based crop and livestock insurance, is limited. Some innovative financial instruments, such as the Nyala weather index-based insurance system; Oromia Insurance Company's livestock insurance schemes; Horn of Africa Risk Transfer for Adaptation (HARITA) insurance for work scheme, and other input and technology financing programmes have been developed in Ethiopia. However, most are small scale and have been restricted to pilot programmes rather than being rolled out at scale. Greater effort could be placed on expanding insurance services to smallholder crop and livestock farmers, with an opportunity to both build the resilience of farmers and also encourage private sector involvement in CSA.

Despite various funds being accessed by the country for CSA-related activities, additional financing is required to help Ethiopia prepare for and adapt to the effects of climate change. Although large international climate financing instruments such as the Green Climate Fund (GCF) exist, access is contingent upon countries developing high-quality proposals and having adequate mechanisms for monitoring and implementation. An example of the need for high-quality proposals is the Green Climate Fund (GCF) Board's lack of agreement to fund Ethiopia's US$100 million project on "*Responding to the increasing risk of drought: building gender responsive resilience of the most vulnerable communities"* that aimed to build resilience of drought-affected communities in the country. The project has since been approved, however this highlights the need for development of improved proposals that better integrate CSA-related activities. Other funds from bilateral and multilateral partners, while crucially important, are at the moment not adequate to address the scale of the climate change challenge in Ethiopia. Ensuring sustainable financing from public and private sources will be necessary for the scaling up of CSA efforts. Additionally, increased transparency in how funds are allocated and spent would foster more cooperation between actors and would increase the likelihood that commitments would be turned into results. The methodology and a more detailed list of funds can be found in Annex 7.

20 The total cost of the CRGE Strategy is estimated at US$150 billion up to 2030, equaling approximately US$7.5 billion annually [41].

21 For 2010–2013, financing for adaptation activities constituted 51% of total international public finding, while mitigation and mitigation + adaptation activities were financed by 19% and 31% of these sources, respectively [58].

Financing opportunities for CSA in Ethiopia



ACP-EC EF African, Caribbean and Pacific - European Commission Energy Facility **AFD** French Development Agency **AF** Adaptation Fund **BioCF** BioCarbon Fund **BMGF** Bill & Melinda Gates Foundation **ATA-IVS** Agricultural Transformation Agency- Input Voucher System **CDCF** Community Development Carbon Fund **CDM** Clean Development Mechanism **CRGE** Climate Resilient Green Economy Facility **DCF** Danish Carbon Fund **DCI** Development Cooperation Instrument **ENRTP** Environment and Sustainable Management of Natural Resources Thematic Programme **FAO** Food and Agriculture Organization of the United Nations **FCPF** Forest Carbon Partnership Facility **FIP** Forest Investment Program **FSF** Japan's Fast-Start Finance **GCCA** Global Climate Change Alliance **GCF** Green Climate Fund **GEF** Global Environment Facility **GIZ** German Development Cooperation Agency **ICF** Italian Carbon Fund **IFAD** International Fund for Agricultural Development **IKI** International Climate Initiative **JICA** Japan International Cooperation Agency **KfW** German Development Bank International Climate Initiative **MoANR** Ministry of Agriculture and Natural Resources **MoEFCC** Ministry of Environment, Forest and Climate Change **MoWIE** Ministry of Water, Irrigation and Electricity **NDF** Nordic Development Fund **NISCO_WII** Nyala Insurance Company-Weather Index Insurance **NORAD** Norwegian Agency for Development Cooperation **OIC** Oromia Insurance Company **PPCR** Pilot Program for Climate Resilience **SCCF** Special Climate Change Fund **SCF** Spanish Carbon Fund **SIDA** Swedish International Development Cooperation Agency **SREP** Scaling up Renewable Energy Program **UKICF** United Kingdom International Climate Fund **UNDP** United Nations Development Programme **UN REDD** United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation **USAID-DGP** United States Agency for International Development – Development Grants Program **USAID-FF** United States Agency for International Development – Feed the Future **WB** The World Bank Group

Ethiopia's agricultural sector is a key economic driver and a source of livelihoods for over 80% of the country's population, yet its GDP share has been challenged by other sectors (such as manufacturing), while the effects of weather variability and climate hazards on agriculture have been shown to not only have an impact on food security and agricultural GDP but also on national GDP and overall economic growth. The sector and those who rely on it for a living are, therefore, highly vulnerable to weather variability and climate change and hence the need to continue investing in resilience building of the sector, while pushing for sustainable growth within the context of Ethiopia's economic development targets as elaborated in the Climate-Resilient Green Economy Strategy.

Agriculture has been a key forerunner in the effort to mainstream climate change into planning, receiving most of the climate financing available through national and international public funds. While this has been particularly beneficial for projects and programmes targeting productivity increase and food security, coordination with other sectors (health, environment) has not been fully operationalized, leaving important integration potential untapped.

A number of CSA-related practices have either been practiced, are currently being practiced or are being promoted by various organisations (private and public) or through various policies and programmes. Improving the knowledge on the costs and benefits of different CSA-related practices at local level could be an important way of encouraging adoption of locally appropriate practices that are aligned to both national and local priorities.

A commonly agreed upon principle in Ethiopia is that higher economic and environmental returns from CSA practices and technologies are most likely obtained if several measures are implemented jointly, through an integrated (farm- or landscape-level) approach to climate-smart agriculture rather than a single-practice-based approach. A better understanding of how and under which conditions various CSA practices can be associated on farms, watersheds and landscapes would help maximize benefits for farmers and incentivize farmers as well as public and private sector actors to invest in these efforts.

Lastly, while various CSA-related programmes are being undertaken and various institutions are involved in CSA-related activities, there is still need for improved coordination of all actors, particularly in linking government initiatives with civil society initiatives. The conservation agriculture task force supported in recent years could be expanded and given a more prominent role and permanent seat as a climate-smart agriculture coordination unit within the Ministry of Agriculture and Natural Resources. In addition, moral, financial and technical support to the activities of the Ethiopia Climate-Smart Agriculture Alliance could help reach farmers and locations not currently targeted under other CSA-related programmes and projects in the country.

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: Food and Agriculture Organization of the United Nations (FAO). Rome. Available at: http://bit.ly/2iJluEQ

[3] World Bank. 2016. World Development Indicators: Ethiopia. World Bank, Washington D.C.

[4] Central Statistics Agency (CSA). 2016. Agricultural Sample Surveys 2015/2016 (2008 E.C.), Volumes I-IV. Federal Democratic Republic of Ethiopia; Ethiopia Central Statistics Agency (CSA), Addis Ababa.

[5] Yirgu L; Nicol A; Srinivasan S. 2013. Warming to Change? Climate Policy and Agricultural Development in Ethiopia. Future Agricultures Working Paper 071.

[6] FAO. 2015. FAOSTAT Database. Rome: Food and Agriculture Organization of the United Nations (FAO).

[7] Central Statistical Agency (CSA) and ICF. 2016. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiopia, and Rockville, Maryland, USA.

[8] UNDP. 2015. Human Development Report. United Nations Development Programme (UNDP). Available at: http://bit.ly/1nwKJGt

[9] Ethiopian Panel on Climate Change (EPCC). 2015. First Assessment Report, Working Group II Agriculture and Food Security. Ethiopian Academy of Sciences. Addis Ababa.

[10] MoFED. 2014. Development and Poverty in Ethiopia – 1995/96-2010/11. Ministry of Finance and Economic Development. Addis Ababa, Ethiopia. Available at: http://bit.ly/2i81VSw

[11] FAO. 2016. Ethiopia Climate-Smart Agriculture Scoping Study. Rome: Food and Agriculture Organization of the United Nations (FAO). Rome. Available at: www.fao.org/3/a-i5518e.pdf

[12] Molla T; Sisheber B. 2017. Estimating soil erosion risk and evaluating erosion control measures, *Solid Earth* 8, pp. 13–25.

[13] FAO. 2010b. Global Forest Resource Assessment, Rome: Food and Agriculture Organization of the United Nations (FAO).

[14] Gelaw AM; Singh BR; Lal R. 2014. Soil organic carbon and total nitrogen stocks under different land uses in a semi-arid watershed in Tigray, Northern Ethiopia. Agric. Ecosyst. Environ. 188:256-263.

[15] Federal Democratic Republic of Ethiopia (FDRE). 2011. Climate-Resilient Green Economy Strategy. Environmental Protection Authority (EPA), Addis Ababa, Ethiopia.

[16] IFPRI. 2012. Crop Production in Ethiopia: Regional Patterns and Trends Summary of ESSP II Working Paper 16, "Crop Production in Ethiopia: Regional Patterns and Trends." Research Note 11. IFPRI, Washington D.C.

[17] Chamberlin J; Schmidt E. 2011. Ethiopian Agriculture - A Dynamic Geographic Perspective. Development Strategy and Governance Division, International Food Policy Research Institute Ethiopia Strategy Support Program II, Ethiopia.

[18] Kassie M; Shifereaw B; Asfaw S; Abate T; Muricho G; Ferede S; Eshete M; Assefa K. 2009. Current Situation and Future Outlooks of the Chickpea Sub-sector in Ethiopia. ICRISAT and EIAR Joint Report.

[19] Central Statistics Agency (CSA) and the World Bank (WB). 2013. Ethiopia Rural Socioeconomic Survey. Survey Report. Ethiopia Central Statistics Agency (CSA) and the World Bank (WB).

[20] Central Statistics Agency (CSA). 2013. Report on livestock and livestock characteristics. Agricultural sample survey 2012/2013, Volume II, Statistical Bulletin 570. Ethiopia Central Statistics Agency. The Federal Democratic Republic of Ethiopia; Ethiopia Central Statistics Agency (CSA), Addis Ababa.

[21] Negra C. 2014. Integrated National Policy Approaches to Climate-Smart Agriculture. Insights from Brazil, Ethiopia, and New Zealand. CCAFS Report No. 11. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

[22] Alemayehu M. 2006. Range Management for East Africa: Concepts and Practices, Sponsored by RPSUD and Printed by A.A.U. Printed Press. Addis Ababa, Ethiopia.

[23] Central Statistics Agency (CSA). 2015. Area and production of major crops. Agricultural sample survey 2014/2015, Volume 1, Statistical Bulletin 568.

[24] Aragie EA. 2013. Climate Change, Growth, and Poverty in Ethiopia, CCAPS Working Paper No. 3. The Robert S. Strauss Center for International Security and Law.

[25] Hill R; Porter C. 2016. Vulnerability to Drought and Food Price Shocks: Evidence from Ethiopia. Policy Research Working Paper; No. 7920. World Bank, Washington, DC.

[26] USDA. 2014. USDA GAIN: Ethiopia Grain and Feed Annual 2014. United States Department for Agriculture (USDA).

[27] Tura H. 2016. Ethiopia's Persistent Food Insecurity: What went wrong? *All Africa*. March 2, 2016. Available at: http://allafrica.com/stories/201603021761.html

[28] Hassen IW; Dereje M; Minten B; Hirvonen K. 2016. Diet transformation in Africa: The case of Ethiopia. Ethiopia Strategy Support Programme. Working Paper 87. International Food Policy Research Institute (IFPRI).

[29] GOE. 2015. Government of Ethiopia Humanitarian Support Requirements for the year 2016. Ethiopia Humanitarian Country Team, Addis Ababa. Available at: http://bit.ly/2C41sd7

[30] Comprehensive Africa Agriculture Development Programme (CAADP). 2013. Food and Nutrition Country Paper – Ethiopia - draft. Central Africa Regional CAADP Nutrition Program Development Workshop, Addis Ababa.

[31] FAO. 2015b. Regional overview of food insecurity: African food security prospects brighter than ever. Accra: Food and Agriculture Organization of the United Nations (FAO).

[32] EIU. 2015. Food Security Index. The Economist Intelligence Unit (EIU). Available at: http://bit.ly/1U3NT2C

[33] WFP. 2016. Food Aid Information System. World Food Programme (WFP). Available at: http://bit.ly/1nwKY4r

[34] UNAIDS. 2015. The Joint United Nations Programme on HIV and AIDS. Available at: http://aidsinfo.unaids.org/

[35] Worku I; Dereje M; Minten B; Hirvonen K. 2016. Diet transformation in Africa: The case of Ethiopia. Ethiopian Development Research Institute (EDRI). International Food Policy Research Institute (IFPRI). Working Paper 87.

[36] WRI. 2016. Climate Data Explorer. World Resources Institute (WRI). Available at: http://cait.wri.org/

[37] Federal Democratic Republic of Ethiopia (FDRE). 2015. Intended Nationally Determined Contribution (INDC). Available at: http://bit.ly/1GsfaUZ

[38] Workneh N. 2006. Land Tenure and Technological Improvement in Smallholder Agriculture in Ethiopia. In: Desalegn R, Taye A. (eds.). Land and the Challenge of Sustainable Development in Ethiopia: Conference Proceedings, p. 147–166. FSS (Forum for Social Studies), Addis Ababa.

[39] Gebreselassie S. 2006. Land, Land Policy and Smallholder Agriculture in Ethiopia: Options and Scenarios. Future Agricultures Discussion Paper 008.

[40] Kasso M; Bekele A. 2016. Post-harvest loss and quality deterioration of horticultural crops in Dire Dawa Region, Ethiopia. Journal of the Saudi Society of Agricultural Sciences. In Press. DOI: 10.1016/j.jssas.2016.01.005

[41] DSU. 2016. Climate Change Profile: Ethiopia. The Dutch Sustainability Unit (DSU) of the Netherlands Commission for Environmental Assessment.

[42] USAID. 2015. Climate variability and change in Ethiopia. Summary report. United States Agency for International Development (USAID).

[43] Murphy C. 2014. Observed and projected climate change in the Philippines, Honduras, Kenya, Malawi and Ethiopia. Department of Geography, Maynooth University and Mavuto Tembo, Mzuzu Unviersity, Malawi. Available at: http://bit.ly/2id29YL

[44] Trócaire. 2014. Feeling the Heat. How climate change is driving extreme weather in the developing world? Ethiopia. The Overseas Development Agency of the Catholic Church in Ireland (Trócaire). Climate Change Report.

[45] WFP. 2016. Drought in Ethiopia: 10 Million People in Need. http://bit.ly/2zJkC6u

[46] Robinson S; Strzepek K; Cervigini R. 2013. The cost of adapting to climate change in Ethiopia: Sector-wise and macro-economic estimates. Ethiopia Strategy Support Program II, Working Paper 53.

[47] Evangelista P; Young N; Burnett J. 2013. How will climate change spatially affect agriculture production in Ethiopia? Case studies of important cereal crops. *Climate Change*, 119:855–873.

[48] Nassef M; Belayhun M. 2012. Water Development in Ethiopia's Pastoral Areas: A synthesis of existing knowledge and experience. Addis Ababa: Save the Children USA.

[49] 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. 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. 1029–1036. DOI: 10.1017/CBO9781107415324.024

[50] Ramírez 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.

[51] Ramírez-Villegas J; Thornton PK. 2015. Climate change impacts on African crop production. Working Paper No. 119. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark. Available at: http://hdl.handle.net/10568/66560

[52] Joosten K; Grey S. 2017. Integrating climate change adaptation and mitigation into the watershed management approach in Eastern Africa. Discussion paper and good practices. Addis Ababa, Food and Agriculture Organization of the United Nations (FAO).

[53] AKLDP. 2017. Conservation Agriculture Experience Sharing and Networking Workshop report. Agricultural Knowledge, Learning, Documentation and Policy (AKLDP) project, AgriProFocus and the Canadian Foodgrains Bank (CFGB). Addis Ababa, Ethiopia.

[54] Medhin G; Giorgis W; Endale G; Kiflu B; Kassa B. 2001. Country Profile on Potato Production and Utilization: Ethiopia. Ethiopian Agricultural Research Organization (EARO), Holetta Agricultural Research Centre, National Potato Research Program.

[55] Berhe T; Gebretsadik Z; Edwards S; Areya H. 2013. Boosting teff productivity using improved agronomic practices and appropriate fertilizer. In: Assefa H; Chanyalew S; Tadele Z. (eds). Achievements and prospects of tef improvement. Ethiopian Institute of Agricultural Research and University of Bern, Institute of Plant Sciences. pp. 133–140.

[56] Agricultural Transformation Agency (ATA). 2013. Results of 2012 New Tef Technology Demonstration Trials. A collaboration project among Agricultural Transformation Agency, Ethiopian Institute of Agricultural Research, and the Ministry of Agriculture. Addis Ababa, Ethiopia.

[57] Abraham B; Araya H; Berhe T; Edwards S; Gujja B; Khadka RB; Koma YS; Sen D; Sharif A; Styger E; Uphoff N; Verma A. 2014. The system of crop intensification: reports from the field on improving agricultural production, food security, and resilience to climate change for multiple crops. Agriculture & Food Security, 3:4. DOI: 10.1186/2048-7010-3-4

[58] Overseas Development Institute (ODI). 2016. Public spending on climate change in Africa Experiences from Ethiopia, Ghana, Tanzania and Uganda. ODI, London.

[59] MoANR. 2015. Climate Smart Agriculture (CSA) Field Manual: Zero Draft. CSA Working Group. Federal Ministry of Agriculture and Natural Resource Management, October 2015, Addis Ababa, Ethiopia

[60] UNFCCC. 2014. National Adaptation Programmes on Action. United Nations Framework Convention on Climate Change. Available at: http://bit.ly/1SCCzH9

[61] Climate and Development Knowledge Network (CDKN). 2014. Climate finance and Intended Nationally Determined Contributions as part of Ethiopia's green growth strategy. CDKN News, July 2014. Available at: http://bit.ly/2jlJhRP

[62] Eshetu Z; Simane B; Tebeje G; Negatu W; Amsalu A; Berhanu A; Bird N; Welham B; Canales Trujillo N. 2014. Climate finance in Ethiopia. Overseas Development Institute (ODI), UK.

[63] Agriculture Finance Support Facility (AgriFin). 2012. Enabling Environment: Access to Financial Services in Ethiopia. AgriFin, September 2012. Available at: http://bit.ly/2no6OMR

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Annex 1: Ethiopia's agro-ecological zones
Annex 2: Selection of agriculture production systems key for food security in Ethiopia (methodology and results)
Annex 3: Methodology for assessing climate smartness of ongoing practices
Annex 4: Long list of CSA practices adopted in Ethiopia
Annex 5: Institutions for CSA in Ethiopia (methodology and results)
Annex 6: Policies for CSA in Ethiopia (methodology and results)
Annex 7: Assessing CSA finances

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