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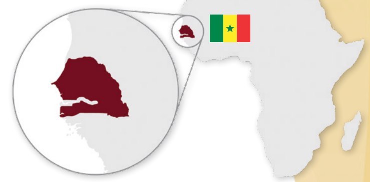
The U.S. Government's Global Hunger & Food Security Initiative



Climate-Smart Agriculture in Senegal

Climate-smart agriculture (CSA) considerations

- **P A M** Senegal's economic growth strategy identifies agriculture as the key driver for poverty reduction and enhancement of food security in the country. Development plans for the agriculture sector need to account for the implications on greenhouse gas (GHG) emissions, particularly for the expansion of rice cultivation and livestock production.
- **M** Livestock represents a major source of GHG emissions, and there exist opportunities for enhancing pasture management and integrating vegetation to reduce emissions and improve land management practices.
- **I A** The use of climate information has become integral to farmers' decision-making and farming practices.
- **$** Access to finance is limited for smallholder farmers and represents a significant barrier to adopting CSA practices.
- **A $** Climate index insurance is increasingly being adopted by smallholders in the millet, rainfed rice, maize and groundnut sectors, thanks to a 50% subsidy by the government and innovative payment schemes of integrating the cost of the premiums in the credit lent out to farmers for the purchase of inputs.
- **I $** Mobilizing private sector involvement in smallholder value chains opens the opportunity to generate sources of revenue and contribute to scaling out CSA in the country.
- **$** International funds have been accessed for climate change adaptation and food security, which can be linked to support the adoption of CSA practices.

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 GHGs, and require planning to address tradeoffs 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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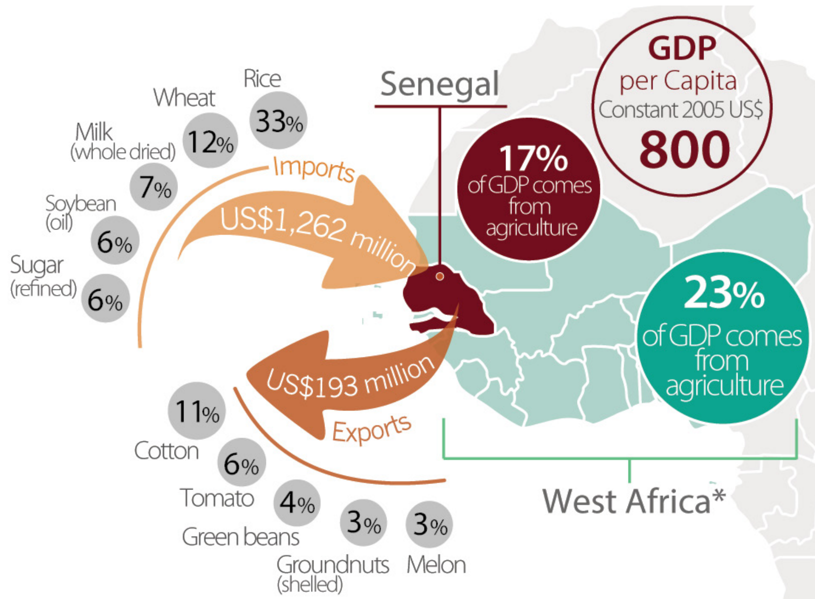
National context

Economic relevance of agriculture

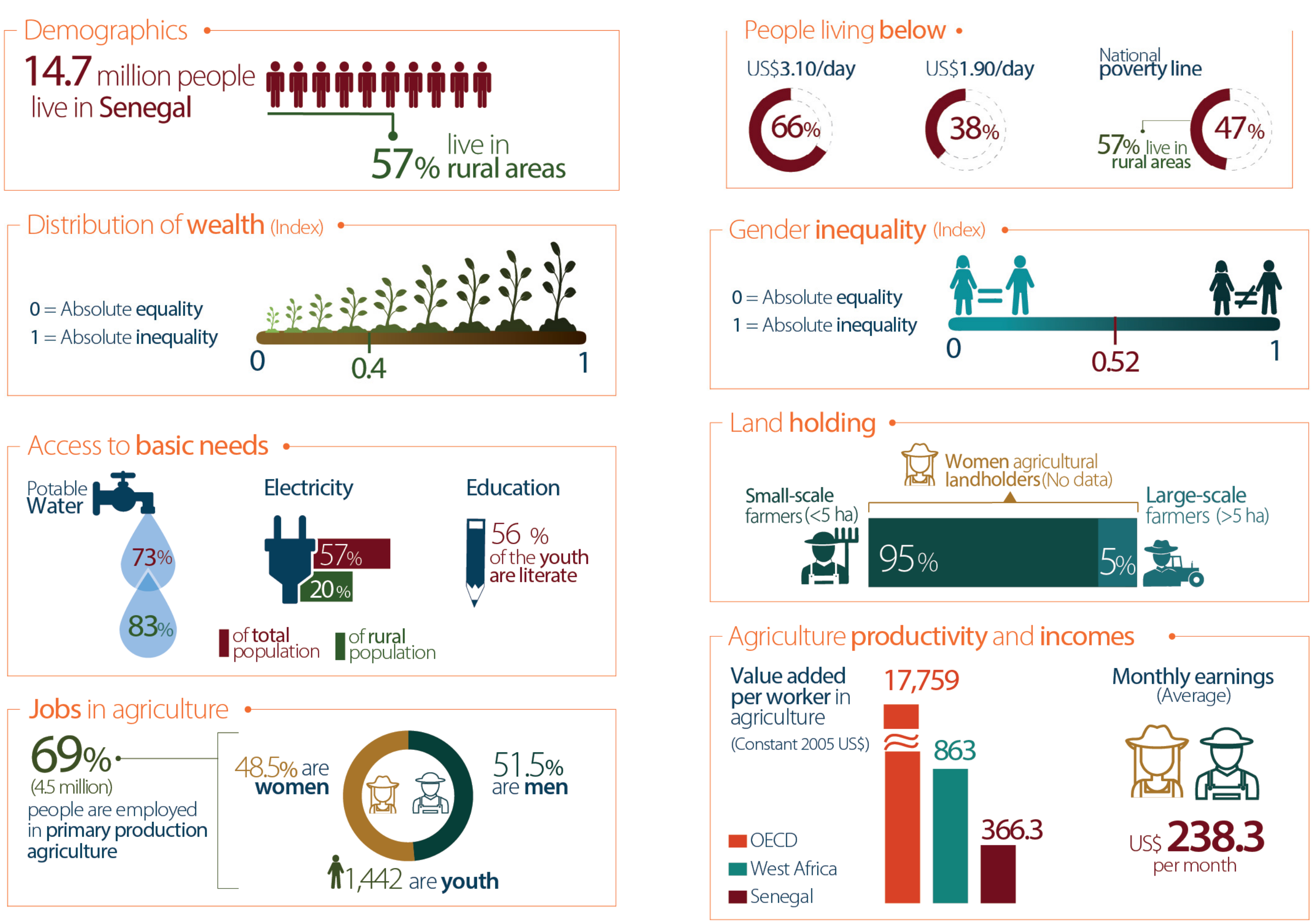
The agriculture and livestock sector is Senegal's main economic activity, representing approximately 17% of the gross domestic product (GDP) [3] and employing 70% of the population [4]. Yet, a combination of poor soil and weather conditions, a lack of infrastructure and access to quality seeds and fertilizer have left the sector underdeveloped and unable to meet the food requirements of the growing population. This has resulted in a heavy reliance on food imports, especially rice, which is the population's main staple crop with imports accounting for 65% of the national consumption [5]. The agriculture sector has the potential to grow and feed the population.

Economic relevance of agriculture in Senegal [3, 4]



*West Africa: Benin, Burkina Faso, Cape Verde, Ivory Coast, Ghana, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, São Tomé and Príncipe, Senegal, Sierre Leon, Togo, Liberia, Gambia

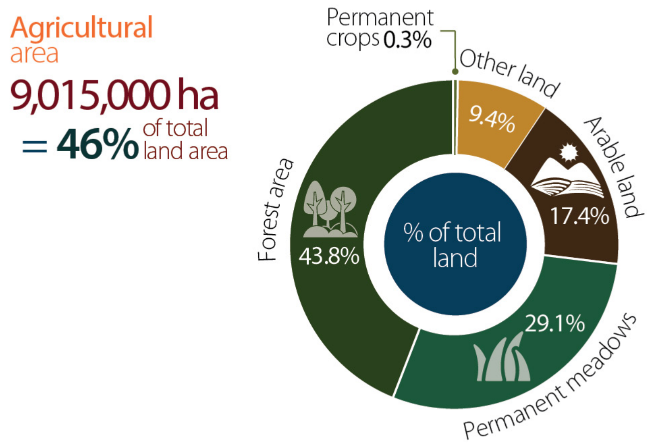
People, agriculture and livelihoods in Senegal [3, 4, 6, 7, 8, 9]



Land use

Agricultural land in Senegal constitutes approximately 46% of the country's total land area [4]. During the last four decades, the area of land under production has remained relatively stable at approximately 2.5 million hectares or 13% of the country's surface area cultivated annually (of the 3.8 million hectares classified as arable) [10]. A growing population and land intensification have caused overexploitation of natural resources and land degradation, impairing both agriculture productivity and ecosystem services [11]. The country's forests are declining at a rate of approximately 45,000 ha per year [12].[1]

Land use in Senegal [4]



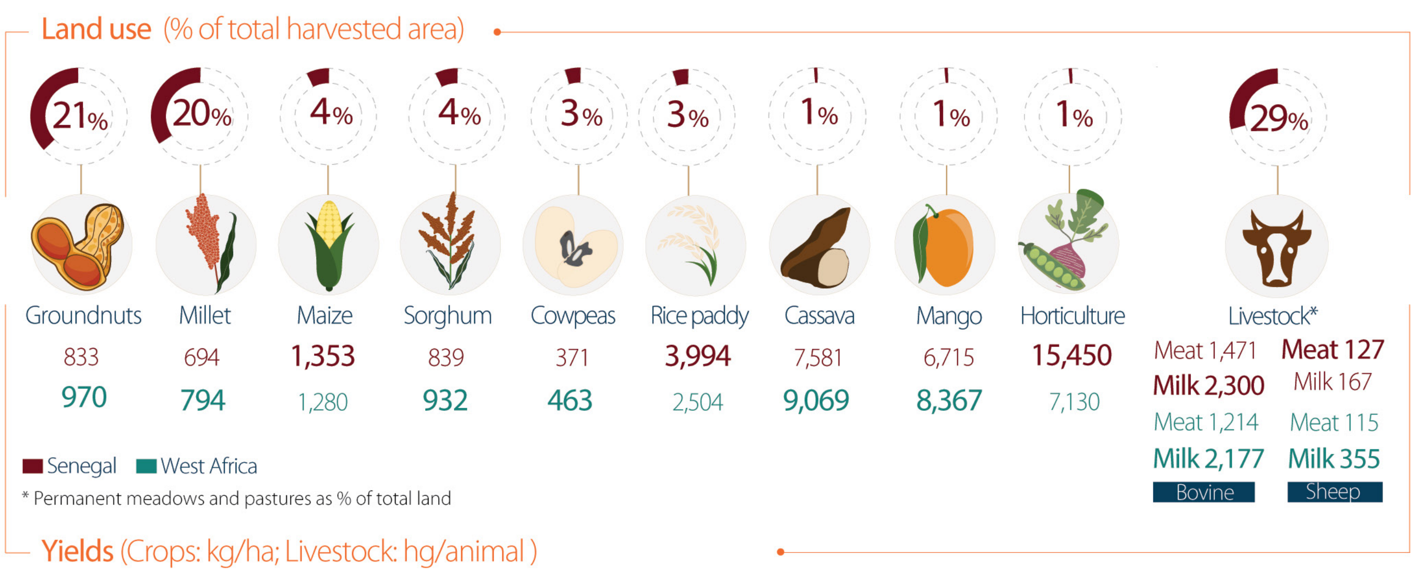
Agricultural production systems

The country is divided into six agro-ecological zones (AEZs) (Annex 1) based on biophysical and socio-economic characteristics. Although most crops are grown across the country, some are more dominant than others in the zones of the River Valley (irrigated rice, vegetable growing); Niayes (80% of the horticulture produced in the country); the Groundnut Basin (groundnuts, millet); Silvo-Pastoral zone (livestock); Eastern Senegal and Upper Casamance (rainfed rice) and Lower Casamance (rainfed rice).

The following infographic shows a selection of agriculture production systems key for Senegal'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.

Rainfall is the key factor that determines agriculture production as less than 5% of land cultivated is under irrigation. The agriculture economy is characterized by the dominance of smallholder farmers cultivating millet, sorghum, maize and rice for subsistence purposes. The country's main cash crops include groundnut and cotton.

Production systems key for food security in Senegal [4]



1 Deforestation is often associated with insecurity of land tenure in Senegal. Following independence, Senegal pursued a decentralization model of governance granting powers to local authorities to allocate users' rights to land through the Rural Community Law 1972. Under the law, landholders must demonstrate the economic productivity of the land. As a result, landholders are encouraged to clear forests to establish crops or livestock in order to secure their land rights.

The groundnut–millet rotation has traditionally been the dominant practice with more area devoted to groundnuts. However, in recent years, as groundnut yields have begun to decrease due to poor soil conditions and climatic factors, millet has increased in area.

As a risk management strategy, farmers in the Groundnut Basin are adopting alternative crops, such as cowpea and cassava, as these are more tolerant of poor soil conditions and drought [13]. In the Southern part of the zone, farmers are also diversifying their production to include watermelon and sesame. Rice production has increased steadily since the 1990s as the area under cultivation has expanded significantly due to investments in irrigation infrastructure in the River Valley, which produces 70% of the domestic rice production [14, 5].

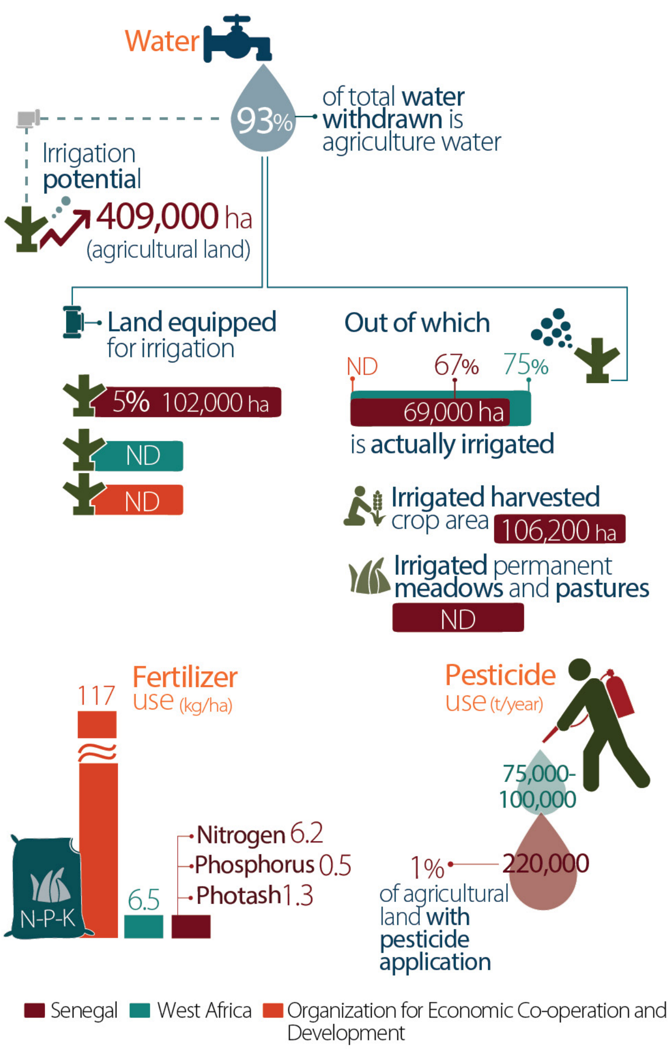
Although *maraîchage* (vegetable gardening) represents a small percentage of the overall agriculture production, its importance to food security and as a livelihood activity for women cannot be overlooked. It is the most promising agribusiness subsector due to its competitive advantage in land availability, climate and water conditions, low labor costs and proximity and capacity to supply European markets. Post-harvest losses and limited capacity to transform products for added value are key challenges limiting the development of the industry [17].

Livestock production also plays an important role in the country, contributing 4.2% of the sector's GDP, which has grown by 38% since 1997. It is practiced extensively in the northern River Valley and silvopastoral zones [13].

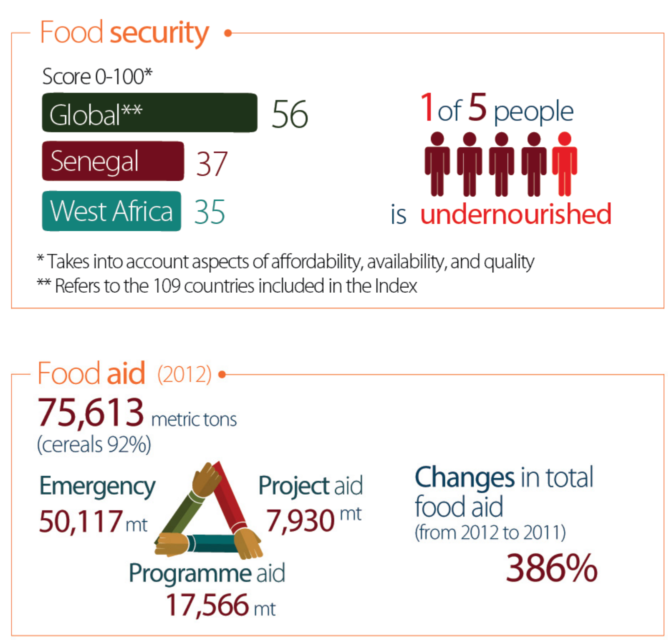
Food security and nutrition

Senegal is one of the least developed countries in the world, with 47% of the population living under the national poverty line and a score of 154 out of 186 on the Human Development Index. Food insecurity inflicts 16% of the population (2% are considered severe and 14% moderate), which is distributed unequally across the country. For instance, 15% of rural households suffer from food insecurity compared to 8% of urban households. At the departmental level, the data show that some areas are in a critical situation with over 50% of their households suffering from food insecurity, including: Goudomp (62%), Matam (58%), Vélingara, Bounkiling (57%), Sédhiou (55%), Oussouye (52%) and Médina Yoro Foulah (51%). The households most susceptible to food insecurity are those dependent on aid or begging, subsistence farmers and livestock herders [18]. The factors contributing to food insecurity in the country include climatic factors affecting agriculture production (rainfall variability, drought, floods), limited market access and price volatility.

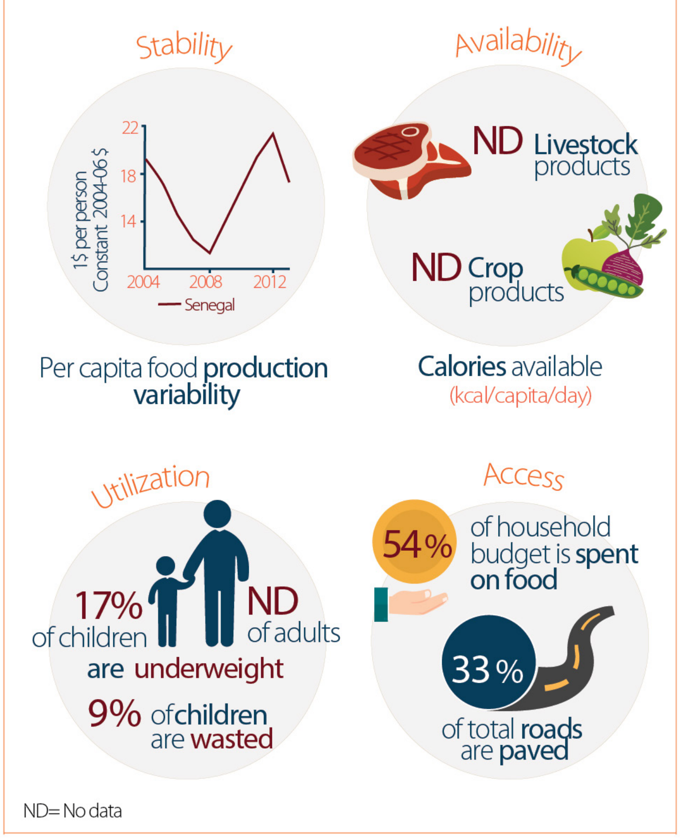
Agriculture input use in Senegal [3, 4, 15, 16]



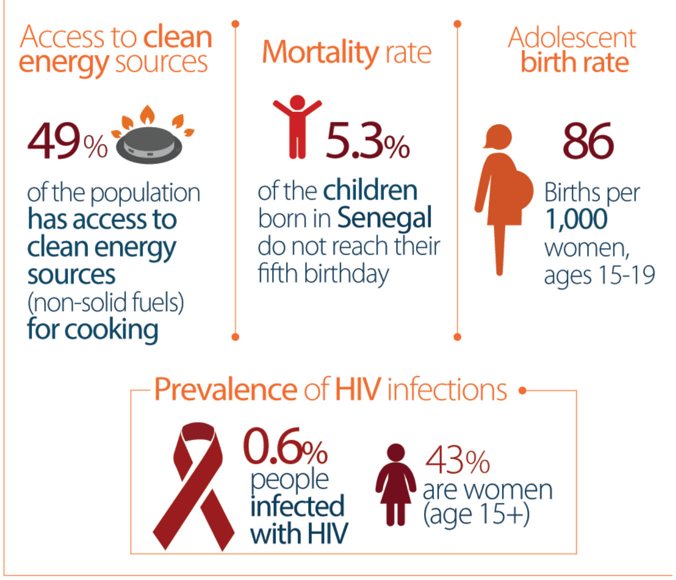
Food security, nutrition, and health in Senegal [3, 4, 19, 20, 21]



Food security indicators (selection)



Health



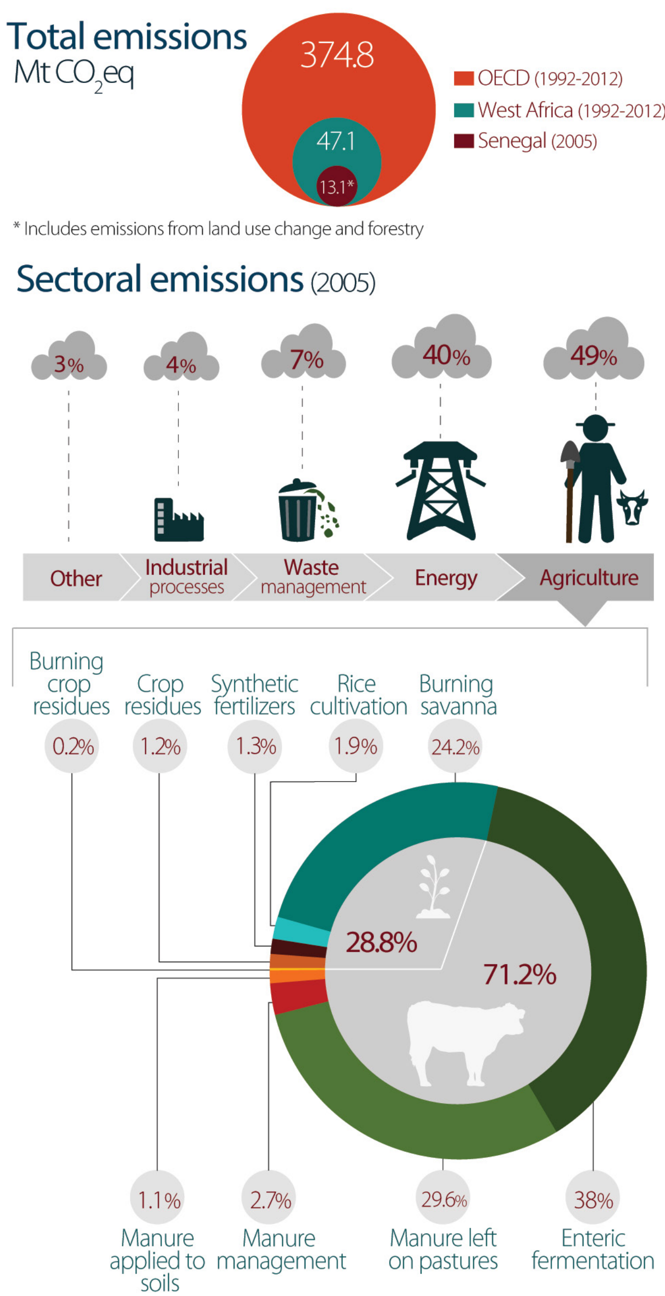
Agricultural greenhouse gas emissions

The agricultural sector contributes approximately 49% of the country's total GHG emissions.[2] According to national data used to prepare the Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), most emissions are associated to enteric fermentation and manure management, agricultural soils, and to lesser extents to rice cultivation and burning of crop residues [22].

As Senegal proceeds with plans to develop the agriculture sector, it is important to take into account the implications for GHG emissions, particularly for the expansion of rice cultivation and livestock production.

In the country's Intended Nationally Determined Contributions (CPDN, its French acronym) submitted to the UNFCCC, the government identified the following activities

Greenhouse gas emissions in Senegal [4, 22, 24]



2 However, the reported level of emissions varies across sources. WRI-CAIT data shows higher levels of total emissions for Senegal (30.94 Mt CO_2 eq) and lower agricultural emissions, as percentage of total emissions (33%), compared to values in the National Communication (13.1 Mt CO_2eq and 49%, respectively).

that can reduce GHG emissions from the agriculture sector [23]: implementation of the System of Rice Intensification (SRI); sustainable land management; use of good farm management practices; assisted natural regeneration (RNA, its French acronym); application of organic manure; agroforestry; silvopastoral systems; and installation of biodigesters.

Challenges for the agricultural sector

Despite efforts to increase agriculture productivity in recent years, the gap between national production and domestic needs has remained. The poor performance of the sector is attributed to several biophysical and socio-economic conditions:

- With the exception of the far South, Senegal is located in the drought-prone Sahel, a region characterized by irregular rainfall and poor soil conditions [12].
- The natural resources from which the sector relies on are showing signs of deterioration: land degradation affects 34% of the territory;[3] acidification affects 50% of the farmlands in the inner Casamance region, the River Valley, the Sine-Saloum and the Niayes areas; salinization affects 9% of degraded lands, mostly in the River Valley. Although some of the degradation may be attributed to natural processes, the majority is caused by human-induced land degradation and poor water management practices, excessive land clearing from peanut cash croppers and for charcoal production, overgrazing, inappropriate use of mineral and organic fertilizers and unplanned urbanization [25].
- The majority of producers are smallholder farmers who lack access to high-quality certified seeds, fertilizer, machinery, climate information, market access and financial services, all of which limit their ability to increase their yields and income. Access to and efficient use of fertilizers by smallholder farmers is essential to replenish soils and boost production.
- Although gender equality is guaranteed under the 2001 Constitution, in practice traditional social and religious norms tend to dictate women's use of and rights to land and resources, and they are susceptible to eviction if men claim the need for space, thus displacing women to areas of lower quality. Women's access to land is critical for diversifying food consumption in the household as they tend to plant vegetables and other non-staple crops [26].
- Consumers and producers in the country are exposed to high food prices and price volatility, increasing the households' food insecurity and vulnerability to climate change.[4]
- There is limited investment from the private sector in production and post-harvest activities, leading to a lack of rural infrastructure, including irrigation, storage/warehouses for post-harvest, transformation equipment and poor road conditions. It is estimated that 20–50% of vegetable and fruit production is lost due to insufficient infrastructure [15].
- Underdeveloped market systems both domestic and international. Constraints to market access include physical infrastructure as most markets are found along the main paved roads in the country, limiting access to farmers who live in the remote and more isolated areas. Smallholder farmers lack the capacity to process, store or distribute products; and processors in Dakar have limited information on the types of crops and quality of production.

Agriculture and climate change

Climate change is already an undeniable reality for Senegal. In a report published on the State of the Environment by the Ecological Monitoring Centre (CSE), the following trends are noted [10]:

- Mean annual temperature increased by 1.6 °C since 1950 with a stronger observed increase in the north of Senegal averaging 3 °C.
- A 30% reduction in rainfall between 1950 and 2000, with a strong variability from one year to another and from region to region. While precipitation trends have improved since 2000, it does not necessarily signal an end to the dry cycle.
- Higher frequency in flood events, particularly in the lower lying areas of Dakar and northwestern Senegal.
- Extreme droughts in 2002 and 2011 heightened food insecurity for over 200,000 and 800,000 people, respectively.
- Changes in the production of biomass, especially in the northern part of the country, reducing forage production for livestock activity.

Climate projections indicate [10]:

- Temperatures continue to increase by 1.1 to 1.8 °C by 2035, and up to 3 °C by the 2060s. Warming is faster in the interior of the country than compared to the coastal areas.

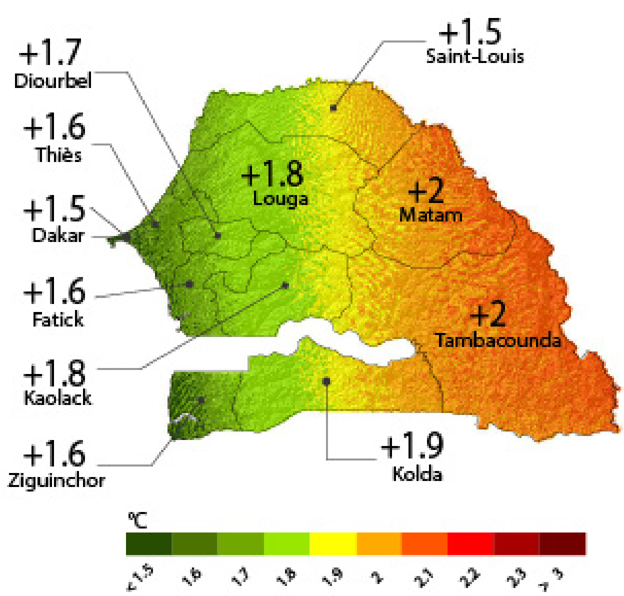
3 All production zones are affected by land degradation to some degree with the majority classified as "moderate." Areas classified as severely degraded include the sylvopastoral zone located in Louga, which is the traditional pastoral zone where most pastoralists permanently reside and the Central Groundnut Basin, where rainfed agriculture is dominantly practiced.

4 In 2013, the price for local cereals (millet and sorghum) was 10% higher than the average from the last 5 years and, in 2014, consumers paid approximately two times the world price for sugar and vegetable oil [27]. Fluctuations in the price of groundnuts – one of the most widely grown and exported crops – is susceptible to prices set by international markets and the harvest from that season. In 2013, the price for groundnuts rose by 47% from 2009 levels and dropped again by 27% between 2013 and 2014 [18].

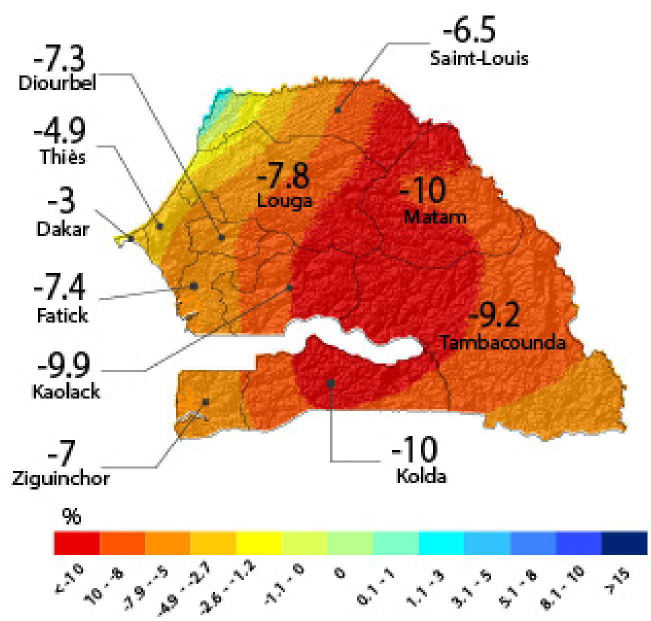
- While there is uncertainty in climate models for projections on precipitation, it is expected that similar trends will continue with higher rainfall events, but fewer rainfall events overall leading to dry spells. Some climate models show an increase in precipitation (50–100 mm) in the Casamance region and a severe decrease in eastern Senegal [28].
- Stronger demand of evapotranspiration from plants.
- Saltwater intrusion affecting irrigated rice production and vegetable growing in Niayes.
- Sea-level rise by 1 meter by 2100 destroying over 6,000 km^2 of land (approximately 8% of the territory), causing environmental degradation and soil erosion.
- Extreme events are expected, including prolonged droughts and more frequent flooding. The agriculture sector is sensitive to changes in temperature and

Projected changes in temperature and precipitation in Senegal by 2050 [31, 32, 33]

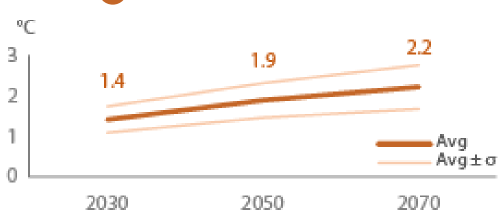
Changes in annual mean temperature (°C)



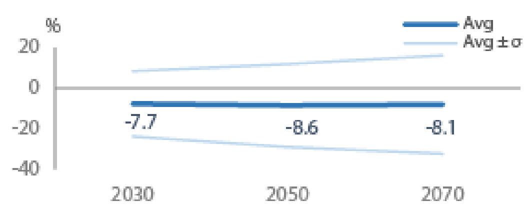
Changes in total precipitation (%)



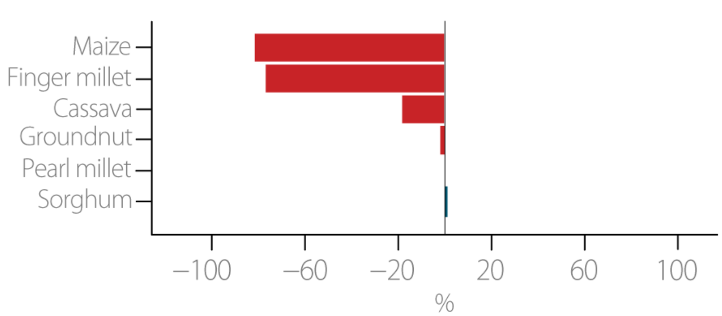
Average temperature (°C)



Average precipitation (%)



Projected change in suitable area in Senegal (2040–2069)



precipitation and is likely to have adverse impacts on crop yields and livestock. Crop models show that groundnut yields may decrease by 5–25%, and maize and rainfed rice yields may gain by 5–25% in areas where they are currently grown [28]. Crops such as cowpeas and cassava have a strong resistance to drought and high temperatures and can be cultivated on poor soils, which represent an adaptation opportunity for farmers located in the Groundnut Basin [29]. Millet and sorghum are also more resilient to and have a higher tolerance level of drought, and crop models also indicate an increase in production for these crops.

In the silvopastoral zone and northern River Valley, livestock producers are also at risk. Although livestock breeds in Senegal are well adapted to high temperatures, the impact of climate change on the production of biomass and water resources may affect the health of the animals and the traditional movement patterns of pastoralists and aggravate conflicts over limited resources [30]. Livestock-dependent households may be the most vulnerable to climate change as a reduction in precipitation may affect the quantity of pasture available, leading to competition over the limited resources. These farmers also tend to have fewer resources than "mixed"-system farmers [30].

CSA technologies and practices

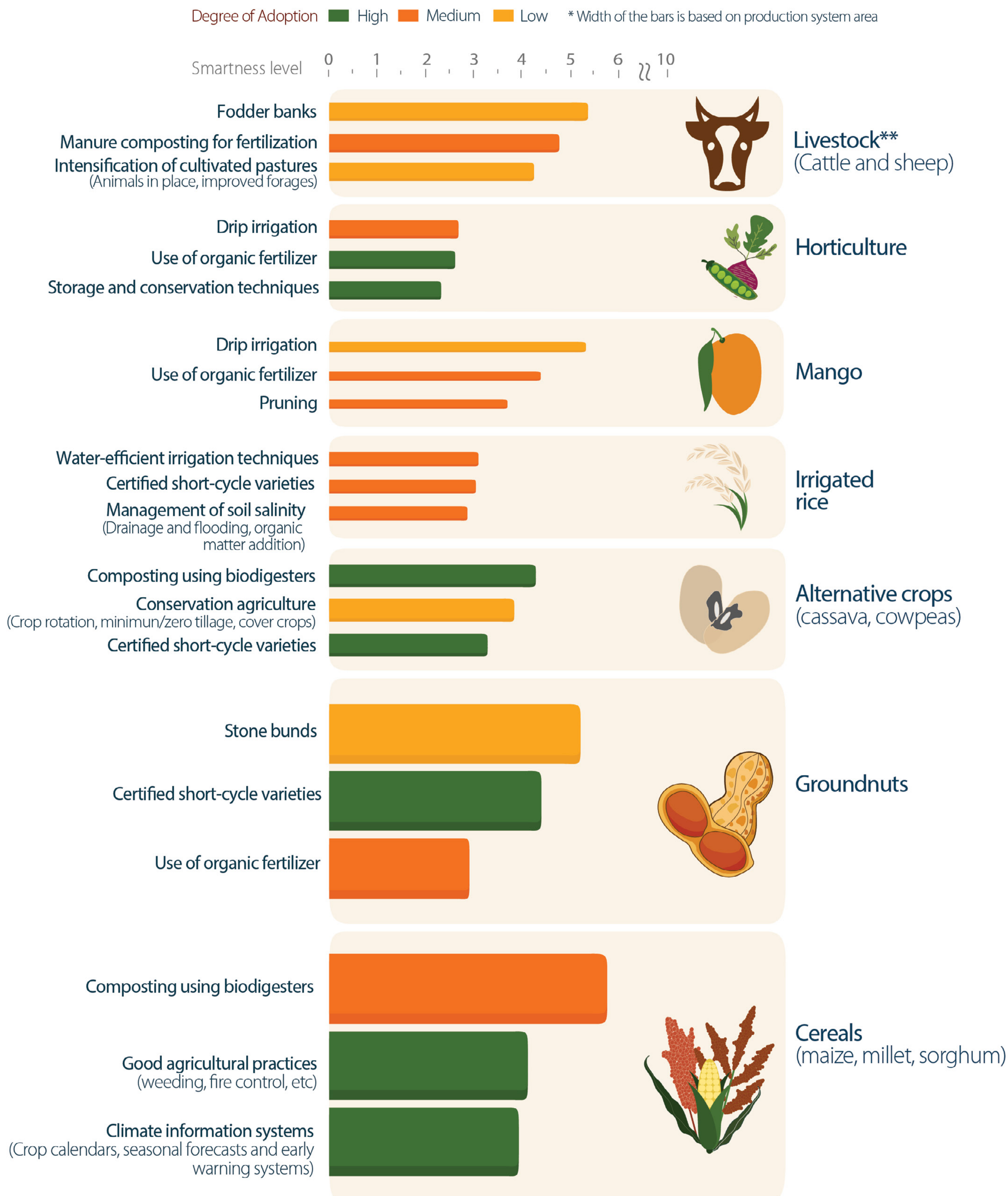
CSA technologies and practices present opportunities for addressing climate change challenges, as well as for economic growth and development of the agriculture sector. For this profile, practices are considered CSA if they enhance food security as well as at least one of the other objectives of CSA (adaptation and/or mitigation). Hundreds of technologies and approaches around the world fall under the heading of CSA.

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 practice's individual scores on eight climate smartness dimensions that relate to the CSA pillars: yield (productivity); income, water, soil, risks (adaptation); energy, carbon and nitrogen (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 graphics have been selected for each production system key for food security identified in the study. A detailed explanation of the methodology and a more comprehensive list of practices analyzed for Senegal can be found in Annexes 3 and 4, respectively.

In Senegal, examples of CSA practices exist, particularly among farmers who have been exposed to government, development and NGO programs. These include: use of high-quality certified seeds and short-cycle varieties, crop diversification, good agriculture practices (fire control, weeding), intercropping with cowpeas and groundnuts, agroforestry, assisted natural regeneration, use of stone bunds for water management, application of organic fertilizer, mulching and composting and use of Neem as a biological pesticide, particularly in the horticulture and arboriculture sectors. Livestock management practices include intensification and sedentarization of livestock and changing herd species for small ruminants. Pastoralism and especially nomadic transhumance is a common adaptation strategy practiced in the Sahel to cope with the climatic stresses and limited resources in the region [34]. Increasingly, farmers are organizing themselves into associations to pool resources and form savings groups. Farmers are also gaining access to and using climate information to make decisions (see Case Study).

The climate index insurance for groundnuts, maize, millet and rice has been developed to protect farmers from risks associated with drought or variable precipitation. The National Agricultural Insurance Company of Senegal (CNAAS, its French acronym) is in charge of underwriting crop and livestock insurance and is working with a number of partners to distribute insurance products to smallholder farmers. The government currently provides a 50% subsidy on agriculture insurance, making it more financially accessible to smallholder farmers.

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



** Unidentified production system area

Case study: Scaling out CSA in Senegal using climate information systems [35]

The use of climate information by farmers has become widespread across Senegal, with approximately 7.4 million rural people having access to such information. Thanks to a pilot project, which began in Kaffrine in 2011 under a collaboration between the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and national partners, such as the Senegalese National Meteorological Agency (ANACIM), farmers are now benefiting from climate information to support their day-to-day agriculture decisions. Using test plots, scientists worked with farmers to demonstrate the benefits of using climate information on yields. Farmers also received training on how to understand and use climate information, while being given the opportunity to voice the kind of information that they thought would be most relevant.

ANACIM, the main partner, produces four types of climate information: seasonal forecasts,[5] ten-day forecasts,[6] daily forecasts[7] and instant forecasts for extreme events.[8] Through key partnerships and multiple distribution channels, the use of climate information by rural farmers across Senegal has become a critical component in their agriculture inputs – just as seeds and fertilizer are. To disseminate the information, ANACIM partnered with the Union of Radio Associations and Community of Senegal (URACS), which transmits their forecasts through 82 community radio stations, in local languages. Broad cellular coverage in Senegal has allowed for the use of mobile technology to distribute climate information through SMS text messages. These messages are sent to farmers and extension agents who then relay the message to other farmers, thus creating a domino effect. The field agents are also critical to the system as not only do they relay the climate information, they are also well equipped to provide recommendations on planting methods such as seed selection. An important outcome of the participatory process during the pilot phase was the finding that women are more likely to receive climate information at gathering places or through personal contacts, highlighting the need of making sure that strategic women in the community receive the information so that they can pass it on to others.

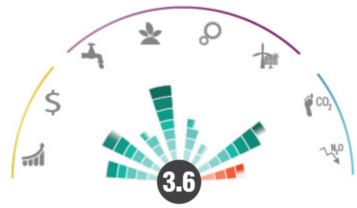
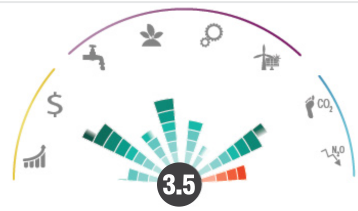
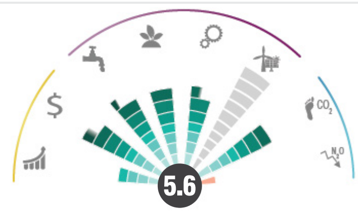
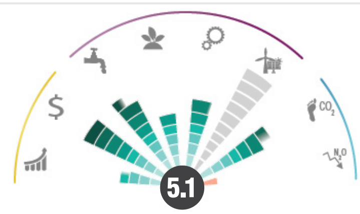
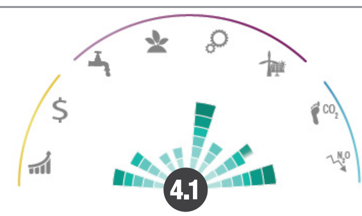
Producing the forecasts and getting the information into the hands of farmers was one challenge; however, ensuring that farmers actually use the information effectively was another. Through seminars, training and the integration of local knowledge, farmers are adapting their land management practices in consideration of the projected forecasts. For instance, in a season where rainfall is projected to be lower than average, farmers substituted maize for soya beans or sesame due to their lower water requirements. The onset date of the rainy season is also considered to be one of the most important pieces of climate information, which can help farmers avoid losing their seedlings due to early planting.

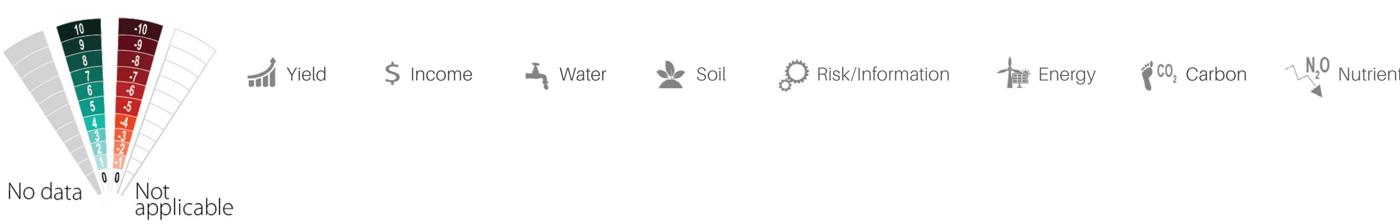
This example demonstrates the value in partnerships, various dissemination channels and local participatory knowledge for scaling out and adopting CSA practices.

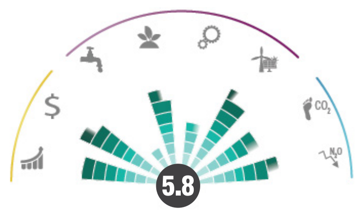
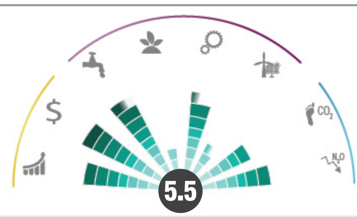
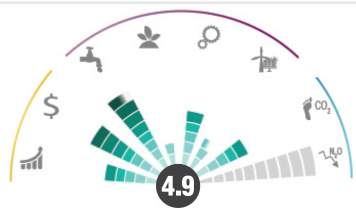
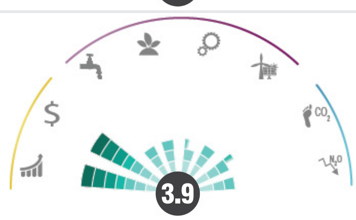
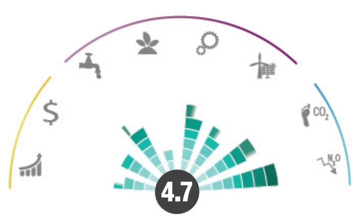
Photo: V. Meadu (CCAFS).

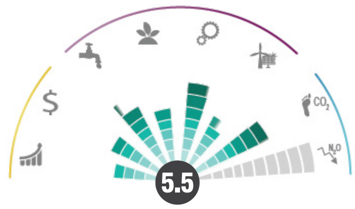
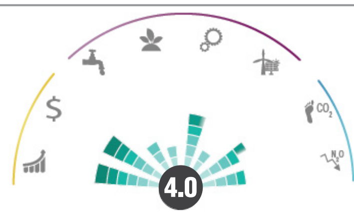
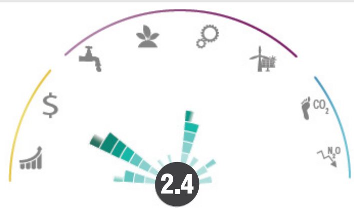
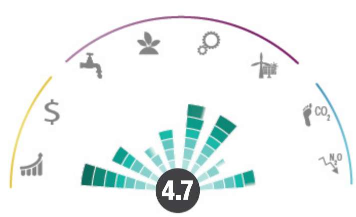
5 Developed in May in time for the planting season to determine what the expected trends in rainfall are likely to be.
6 Prepared during the rainy season to help identify upcoming dry spells and other anomalies.
7 Produced daily during the wet season and downscaled to the various regions.
8 Any indication of off-season showers, high winds or lighting is dispersed as soon as it is picked up through ANACIM's early warning system.

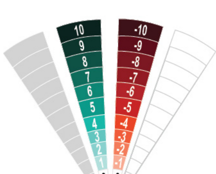
Table 1. Detailed smartness assessment for top ongoing CSA practices by production system as implemented in Senegal.

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
Irrigated Rice (2% of total harvested area)				
System of Rice Intensification	Silvo-pastoral zone 30-60%	S		**Productivity** Increases yield by mantaining optimun condition of plant development. **Adaptation** Promotes the efficient use of scarce water resources. **Mitigation** The practice may contribute to reductions in emissions when replacing mechanized by manual planting and when saving energy used in irrigation pumps. It may also contribute to reducing methane emissions.
	River Valley 30-60%	S		
Management of soil salinity (drainage and flooding, organic matter addition)	Silvo-pastoral zone >60%	S M L		**Productivity** Salinity reduction can lead to optimun conditions for plant development and production. **Adaptation** Management of soil salinity through drainage and flooding, ridges and furrows, addition of organic matter etc., increases nutrient availability and decreases crop exposure to climate risks. **Mitigation** Additions of organic matter can increase soil carbon stock.
	River Valley >60%	S M L		
Cereals (28% of total harvested area)				
Climate information systems (crop calendars, seasonal forecasts and early warning systems)	Silvo-pastoral zone >60%	S M L		**Productivity** Contributes to efficient use of agricultural inputs. Increases in product quality and/or quantity, and reduces crop losses through more informed decision making. **Adaptation** Improves farmers preparedness and responsiveness to unpredictable weather patterns and extreme weather events (risk management strategy). The practice also has an economic impact because it promotes the use of agricultural inputs more efficiently. **Mitigation** Planning appropriately for timely fertilization (the right time and amount applied) can reduce nitrogen emissions.
	Groundnut Basin 30-60%	S M L		



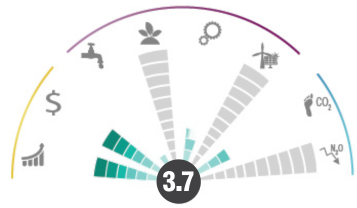
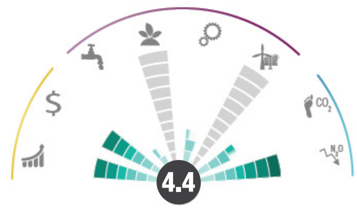
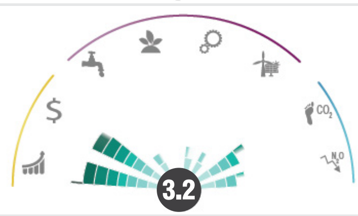
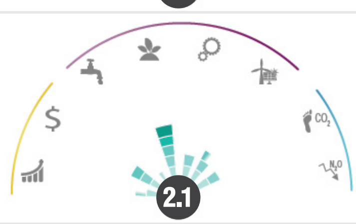
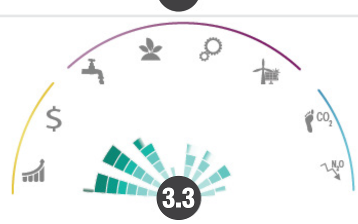
CSA practice	Region and adoption rate (%) <30 30-60 60>	Predominant farm scale S: small scale M: medium scale L: large scale	Climate smartness	Impact on CSA Pillars
Cereals (28% of total harvested area)				
Composting using biodigesters	Groundnut Basin 30-60%	S M L		**Productivity** Increases yields and production quality. **Adaptation** Contributes to soil restoration by improving its physical, chemical and biological characteristics. **Mitigation** Improved characteristics of the soil (structural, biological, etc.) leads to a better soil capacity to sequester carbon. Reduces methane emissions, since it is used for energy (butane gas).
Mango (1% of total harvested area)				
Drip irrigation (Micro-irrigation)	Groundnut Basin <30%	M L		**Productivity** Improves productivity and yields. **Adaptation** Increases resilience to drought, promoted by an efficient use of irrigation water. **Mitigation** Some impact on nitrogen emissions by efficient fertilizer aplication. A reduction in energy required for irrigation can reduce emissions intensity per unit of output).
	Niayes <30%	M L		
Pruning	Groundnut Basin 30-60%	M L		**Productivity** Increases productivity and reduces crop exposure to foliar diseases and the unnecessary overuse of fertilizers. **Adaptation** The increase in organic matter can facilitate soil restoration and water retention. **Mitigation** Helps increase soil organic matter, which may reduce emissions.
	Niayes 30-60%	S M		
Groundnuts (21% of total harvested area)				
Stone bunds	Sylvo-Pastoral zone <30%	S M		**Productivity** Medium- to long-term soil fertility increases can lead to higher yields. **Adaptation** Soil restoration and increased water infiltration can help restore degraded land. **Mitigation** Maintains or improves soil carbon stocks and soil organic matter content.

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
Groundnuts (21% of total harvested area)				
Stone bunds	Groundnut Basin <30%	S M		**Productivity** Medium- to long-term soil fertility increases can lead to higher yields. **Adaptation** Soil restoration and increased water infiltration can help restore degraded land. **Mitigation** Maintains or improves soil carbon stocks and soil organic matter content.
Certified short-cycle varieties	Sylvo-Pastoral zone 30-60%	S M L		**Productivity** High-quality seeds can improve yields by 30%. **Adaptation** Reduces soil erosion, increases water infiltration and organic matter accumulation, can help restore degraded land. **Mitigation** Improves biomass, which may promote carbon sequestration.
	Groundnut Basin >60%	M L		
Livestock (cattle and sheep) (NA)				
Fodder banks	Sylvo-Pastoral zone <30%	L		**Productivity** Increases productivity and income through increased product quality. **Adaptation** Improves quality and quantity of the feeds. Increases productivity per unit area. Promotes soil and water conservation. **Mitigation** Improved feed quality reduces methane emissions related to enteric fermentation. Nitrogen fixation through leguminous species reduces nitrogen fertilizer requirements.
Manure composting for fertilization	Sylvo-Pastoral zone 30-60%	S M		**Productivity** Increases productivity (on medium and long term) as a result of enhanced soil health and fertility. **Adaptation** Contributes to reductions in on-farm organic waste and odors. Facilitates the elimination of pathogens. Can provide alternative on-farm heating sources. **Mitigation** Contributes to reduced methane emissions upon aerobic composting.



No data Not applicable

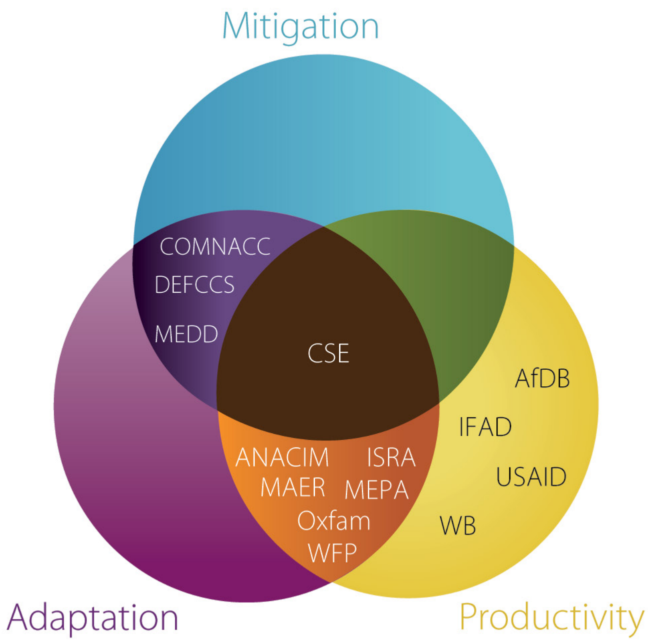
Yield Income Water Soil Risk/Information Energy CO_2 Carbon N_2O Nutrient

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
Alternative crops (cassava, cowpeas) (4% of total harvested area)				
Composting using biodigesters	Sylvo-Pastoral zone >60%	S M L		**Productivity** Increases production per unit area. **Adaptation** Contributes to soil restoration by improving its physical, chemical and biological characteristics. **Mitigation** Improved characteristics of the soil (structural, biological, etc.) leads to a better soil capacity to sequester carbon. Reduces methane emissions, since it is used for energy (butane gas).
	Groundnut Basin >60%	S M L		
Conservation agriculture (Crop rotation, minimun/zero tillage, cover crops)	Sylvo-Pastoral zone <30%	M L		**Productivity** Water conservation and use for organic fertilizer results in improved yields. **Adaptation** Helps preserve soil moisture and soil fertility to improve soil water retention and improves the accumulation of organic matter. **Mitigation** Maintains or improves soil carbon stocks and soil organic matter content.
Horticulture (NA)				
Use of organic fertilizer	River Valley >60%	S		**Productivity** Improves yields. **Adaptation** Improves soil fertility and plant growth. **Mitigation** Some impact on nitrogen emissions by reducing the application of chemical fertilizers. Composting techniques such as biodigester can offer alternative energy sources, reducing emissions. Improved soil conditions permits carbon sequestration.
	Niayes 30-60%	S M L		
Drip irrigation	River Valley 30-60%	S M L		**Productivity** Increases yields and revenues. **Adaptation** Increases resilience to drought, promoted by an efficient use of irrigation water. **Mitigation** Some impact on nitrogen emissions by reducing the application of chemical fertilizers. Composting techniques such as biodigester can offer alternative energy sources, reducing emissions. Improved soil conditions permits carbon sequestration.
	Niayes 30-60%	S M L		

Enabling institutions and policies for CSA

Senegal has several key institutions and policies aimed at supporting and increasing agriculture productivity and advancing CSA practices. 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 Senegal



AfDB African Development Bank **ANACIM** National Meteorological Agency **COMNACC** National Committee on Climate Change **CSE** Ecological Monitoring Centre **DEFCCS** Directorate of Water, Forests, Hunting and Soil Conservation – Ministry of Environment and Sustainable Development **IFAD** International Fund for Agricultural Development **ISRA** Senegalese Institute for Agricultural Research **MAER** Ministry of Agriculture and Rural Equipment **MEDD** Ministry of Environment and Sustainable Development **MEPA** Ministry of Livestock and Animal Production **USAID** United States Agency for International Development **WB** The World Bank **WFP** World Food Programme

The majority of institutions surveyed are, to some extent, working on CSA mainly through information distribution and action research with very few having financial incentives or budgets to implement practices. While these institutions work on activities related to CSA, this is often secondary to the primary objective of increasing agriculture productivity or food security in the country.

At the national level, MEDD plays a leading role in developing and promoting climate change policies. The key institutions for CSA development at the national scale are MAER and MEPA.

The country's leading agriculture research organizations facilitating the adoption of CSA practices include CSE and ISRA. CSE aims to strengthen participatory environmental and natural resource management for long-term economic development. In 2010, CSE was the first national institution to be accredited and to implement a project through the Adaptation Fund. ISRA conducts research on crop, livestock, forestry, fisheries and socioeconomic issues, including work with seed distributors to facilitate wider circulation of climate-resistant seeds to farmers.[9] ISRA also works closely with private sector companies in the groundnut and cotton industries.

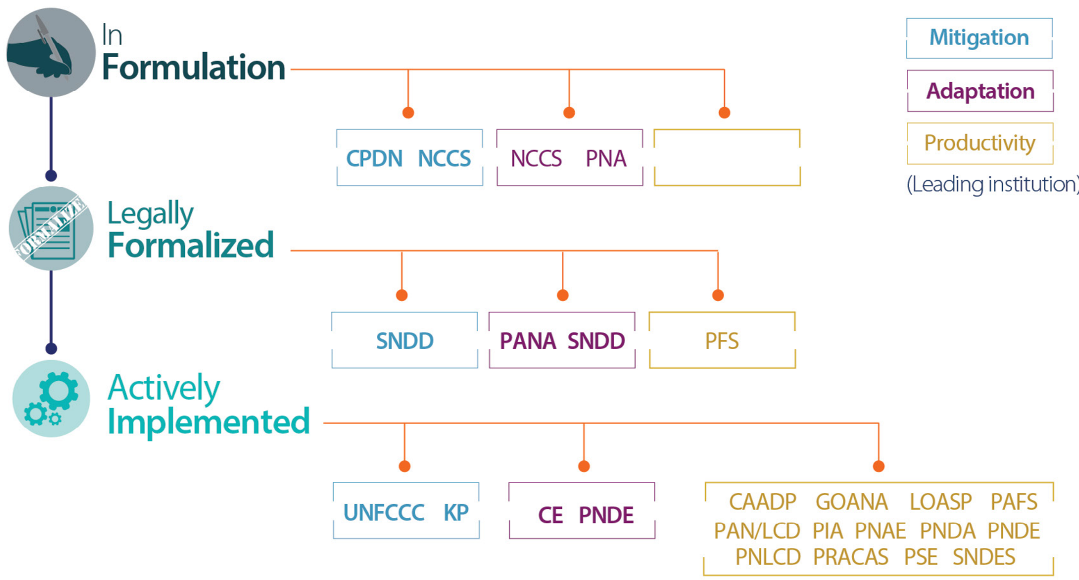
NGOs and development agencies have also been active in supporting the uptake of CSA practices. A wide range of projects across the country focus on enhancing the livelihoods of smallholder farmers and, because of the strong linkages between CSA and food security, many of these initiatives encompass climate risk management practices to some degree. For instance, the USAID Feed the Future Naatal Mbay project works with farmers across value chains (rice, millet and maize), facilitating their access to certified seeds, climate insurance, climate information, tools, training and markets, all of which strengthens the adaptive capacity of households.

An example of the government's commitment to foster a multisectoral approach and enable CSA action is the National Science-Policy Dialogue Platform for adaptation of agriculture and food security to climate change called the "CCASA/Senegal platform" supported by CCAFS. The platform is composed of a network of stakeholders, including scientists, policy and decision makers, farmers organizations, media and other key actors undertaking a regular exchange of information on climate-change-related issues for agriculture and food security. In view of its importance in building capacity among national actors for informed decision-making, the CCASA platform has been now formally institutionalized to represent MAER within COMNACC.

The next graphic (see page 16) 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/

9 ISRA's recent activities related to CSA include research and development of resistant seed varieties; crop modeling; post-harvest techniques; and, to a limited degree, agroforestry.

Policies for CSA in Senegal



CAADP Comprehensive Africa Agriculture Development Programme (2003) (MAER) **CE** Environment Code (Law 2001-01) (MEDD) **CPDN** Intended Nationally Determined Contributions (2015) (MEDD) **GOANA** Great Push Forward for Agriculture, Food, and Abundance (2008) (MAER) **KP** Kyoto Protocol (2002) (MEDD) **LOASP** Agro-Sylvo-Pastoral Orientation Law (2004) (MEPA) **NCCS** National Climate Change Strategy in Senegal (2014-2018) (MEDD) **PAFS** Forestry Action Plan of Senegal (1993) (DEFCCS) **PAN/LCD** National Action Programme Against Desertification (1998) (MEDD) **PANA** National Adaptation Programme of Action (2006) (MEDD) **PFS** National Forest Policy (2005-2025) (MEDD) **PIA** Senegal Agriculture Investment Plan (2011-2015) (MA) **PNA** National Adaptation Plan (MEDD) **PNAE** National Environmental Action Plan (1995) (MEDD) **PNCCS** National Policy for Climate Change in Senegal (MEDD) **PNDA** National Plan for Agricultural Development (2009-2015) (MAER) **PNDE** National Plan for Livestock Development (2012) (MEPA) **PNLCD** National Plan Against Desertification (1989) (MEDD) **PRACAS** Accelerated Program for Agriculture in Senegal (2014-2020) (MAER) **PSE** Senegal Emerging Plan (2013) (GS) **SNDD** National Strategy for Sustainable Development (2005) (MEDD) **SNDES** National Strategy for Economic and Social Development (2012-2017) (GS) **UNFCCC** United Nations Framework Convention on Climate Change (1994) (MEDD)

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.

Senegal has been formally engaged in the international climate change negotiations since ratifying the UNFCCC and the Kyoto Protocol in 1994 and 2002, respectively, and has presented three National Communications to the UNFCCC, in 1997, 2010 and 2016. COMNACC was established in 1994 to create a central platform for co-operation on climate change. COMNACC is responsible for coordinating, consulting, training and monitoring of international and national activities on climate change. In 2006, the country released its National Adaptation Plan of Action (PANA, its French acronym), which identified three priority areas for climate change adaptation: agriculture, water management and coastal preservation. Based on the PANA, the first national adaptation project "Adaptation to Coastal Erosion in Vulnerable Areas" was endorsed by the Adaptation Fund and is in the process of implementation through the CSE. In the framework of the twenty-first session of the Conference of the Parties (COP21), Senegal wrote its Third National Communication and its first CPDN. In the latter, the engagement of voluntary reduction of GHG is about 5% from 2020 to 2025 [23]. In addition, in the PIA, prepared as part of the country's participation in the CAADP, approximately 86% of the investments are consistent with the PANA priority areas, such as activities related to soil restoration, reforestation and community capacity training on natural resource management and integrated water management [36].

To cope with the challenges of economic development, poverty, food security and climate change, a number of political instruments have been put into place, namely:

- The **Agro-Sylvo-Pastoral Orientation Law** (LOASP, 2004): aims to increase production, quality and commercialization of agriculture and livestock products through modernization, valorization, access to credit and land privatization.
- The **National Strategy for Economic and Social Development** (SNDES, 2013–2017): seeks to accelerate economic growth through "growth, productivity and wealth creation" with agriculture identified as a top priority.
- The **Senegal Emerging Plan** (PSE, 2013): aims to boost the economy by 7% through the upcoming decade, and agriculture is identified as one of the key pillars to the country's economic development and poverty reduction.

- The **Accelerated Program for Agriculture in Senegal** (PRACAS, 2014–2020): is the mechanism for implementing the agriculture component of the PSE and has, as one of its objectives, to achieve self-sufficiency in rice by 2017.

Agriculture plays a central role in these documents and is identified as a critical component for achieving food security, poverty reduction and wealth creation for the country. However, their objectives are to increase productivity over a short to medium term with limited attention to the long-term development of the sector and implications for climate change.

A second limitation is that a large majority of policies identified have not effectively integrated climate mitigation or adaptation in a concrete way, lacking specific actions and dedicated resources to implement CSA practices. Although some of the activities outlined in these policies may be considered CSA practices, there needs to be a stronger emphasis on prioritizing climate change action to ensure that the growth in productivity does not come at the cost of strengthening climate resilience. For instance, promoting techniques for sustainable crop intensification through integrated soil fertility, pest and disease management, and agriculture diversification; and providing more financial resources to implement agroforestry and reforestation practices.

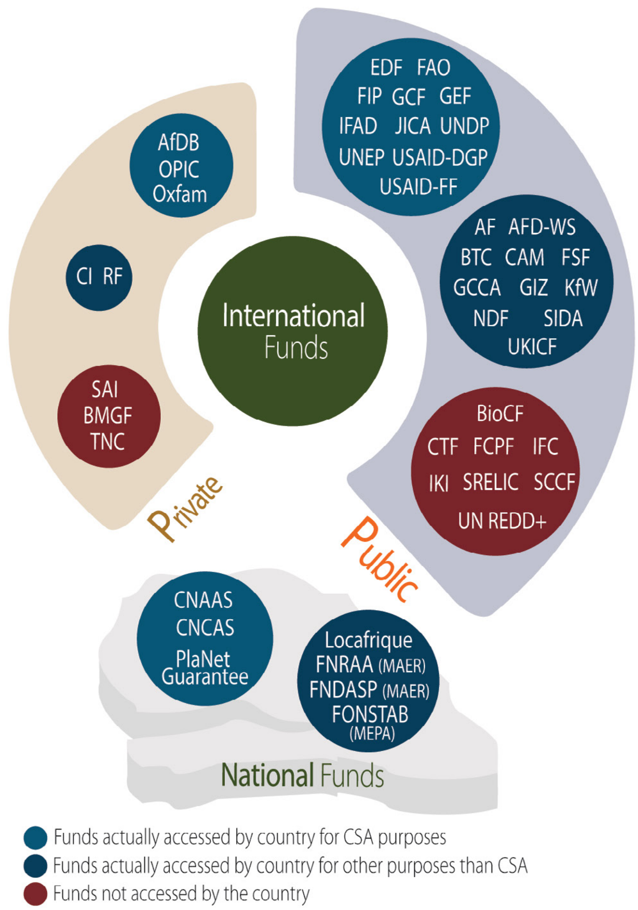
At the national scale, Senegal lacks a well-defined long-term strategy for climate change planning and needs to harmonize its current political instruments and foster a multi-sectoral approach to planning. The National Adaptation Plan is expected to be released in 2016, which is anticipated to help overcome these challenges and provide a greater long-term vision to agriculture sector planning.

Financing CSA

National opportunities for funding agriculture in Senegal include support from the government (MAER, MEPA), local private financial institutions such as CNCAS, National Bank for Economic Development (BNDE) and Locafrique, cooperatives, NGOs and, to some extent, the private sector. The graphic on the right highlights existing and potential financing opportunities for CSA in the country. The methodology and a more detailed list of funds can be found in Annex 7.

Between 2000 and 2006, the agriculture sector benefited from 4.6% of the country's national budget [36]. The main governmental funding mechanisms available include FNRAA and FNDASP, which are primarily accessed by the country's research institutions (i.e., ISRA). Through the FNRAA, a number of projects have been funded that have CSA characteristics including: the improvement of agriculture production through the application of bio-products and promotion of the use of vetiver – a perennial bunchgrass to combat erosion and improve soil fertility in the Niayes zone. The government executed a program for seed reconstitution

Financing opportunities for CSA in Senegal



AfDB African Development Bank **AFD** French Development Agency **AFD-WS** French Development Agency-Water and Sanitation **AF** Adaptation Fund **BioCF** Bio Carbon Fund of the World Bank **BMGF** Bill & Melinda Gates Foundation **BTC** Belgian Development Agency **CAM** Clean Development Mechanism **CI** Conservation International **CNAAS** The National Agricultural Insurance Company of Senegal **CNCAS** National Agricultural Credit Bank of Senegal **CTF** Clean Technology Fund **FAO** Food and Agriculture Organization of the United Nations **FCPF** Forest Carbon Partnership Facility **EDF** European Development Fund **FIP** Forest Investment Program **FN DASP** National Fund for Agro-Silvo-Pastoral Development **FNRAA** National Fund for Agricultural and Agri-Food Research **FONSTAB** Support Fund for Animal Sheds **FSF** Japan's Fast-Start Finance **GCCA** Global Climate Change Alliance **GCF** Green Climate Fund **GEF** Global Environment Facility **GIZ** German Development Cooperation Agency **IFAD** International Fund for Agricultural Development **IFC** International Finance Corporation **IKI** International Climate Initiative **JICA** Japan International Cooperation Agency **KfW** German Development Bank International Climate Initiative **MAER** Ministry of Agriculture and Rural Equipment **MEPA** Ministry of Livestock and Animal Production **NDF** Nordic Development Fund **OPIC** Overseas Private Investment Corporation **RF** The Rockefeller Foundation **SAI** Sustainable Agriculture Initiative **SCCF** Special Climate Change Fund **SIDA** Swedish International Development Cooperation Agency **SRELIC** Scaling Up Renewable Energy in Low-Income Countries **TNC** The Nature Conservancy **UKICF** United Kingdom International Climate Fund **UNDP** United Nations Development Programme **UNEP** United Nations Environmental 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 from 2013 to 2015, and ISRA was responsible for producing first-level seeds of groundnut, cowpea and cereals to meet the national needs.[10] Through MEPA, support comes from FONSTAB, which is a mechanism to implement the LOASP and linked to the FNDASP. It promotes the commercialization of the livestock sector through investments in machinery, processing, packaging and marketing.

CNCAS is the main credit provider to smallholder farmers across the country accounting for 50–60% of microfinance products [15]. They support individual farmers and farmers associations in obtaining credit to finance agricultural inputs and post-harvest activities. The credit union works through certified seed distributors to ensure that farmers taking out credit obtain high-quality seeds (to reduce risk of lending). The organization is also working to strengthen the value chain, particularly in rice cultivation and harvesting by promoting the establishment of warehouses for farmers to stockpile their rice to protect its quality until the sale. Very few other financial institutions provide farmers with loans for planting activities and tend to focus more towards developing the agribusiness sector, which includes mainly post-harvest activities.

International technical and financial support for climate initiatives comes from several sources. Senegal was one of the first countries in 2010 to access the UNFCCC Adaptation Fund to finance a project on coastal protection by the name of "Adaptation to Coastal Erosion in Vulnerable Areas," which was developed based on the PANA. They will also be one of the first countries to receive funding through the Green Climate Fund for a project to restore salinized lands and to increase the climate resilience of the coastal region's population.

With support from the World Bank and the Global Environmental Facility (GEF), the Government of Senegal created the Project for Inclusive Development and Sustainable Agribusiness in Senegal (PDIDAS), which provides smallholder farmers with access to funds to make investments necessary to improve agriculture productivity. Some of the eligible investments include training, inputs (seeds, fertilizer), agroforestry, transformation and commercialization of products.

While there are many bilateral and multilateral institutions supporting the implementation of projects related to agriculture development and food security, there are a limited number that are explicitly addressing climate change adaptation. Nonetheless, these resources have been used to make progress in strengthening farmers' access to high-quality inputs, financial mechanisms and training and investments in reinforcing the various components of the value chain for key crops in the country.

Potential finance

Smallholder farmers lack access to financial services, thus limiting their ability to adopt CSA practices. Extending financial services to producers to facilitate their access to high-quality inputs and to incentivize them to incorporate sustainable land-use practices is one approach to upscale investments in these practices. Financial services that support farmers throughout the full production cycle – from obtaining inputs to storage – can improve farmers' livelihoods and incomes. Working with farmers to organize and establish farmers' cooperatives or farmers' groups can also strengthen their negotiating and selling power to increase market access and generate higher revenues.

There is a significant opportunity to mobilize private sector investment in CSA, particularly by working through local agricultural enterprises, such as farmers' cooperatives and processors. These agribusinesses act as an extension service to smallholder farmers and have the ability to provide them with information and training to influence land management practices and increase yields. By ensuring that these enterprises have the appropriate climate information and knowledge on effective climate-smart practices, they can promote a rapid uptake of CSA practices among smallholder farmers. Leveraging existing smallholder value chains and commercializing others such as *bissap* (hibiscus), boaba, cashew apples and moringa have the opportunity to generate sources of revenue and contribute to scaling out CSA in the country. A key challenge is the lack of adequate quality control of harvests, storage facilities, knowledge on preservation and transformation techniques and access to capital and equipment. Engaging with financial providers to support services to small- and medium-size enterprises, notably in the agribusiness sector, may facilitate growth in the industry. For instance, the USAID Economic Growth Project introduced post-harvest quality control methods to rice farmers in the River Valley, which has increased the demand and price for domestic rice.

As a financing mechanism, REDD+[11] presents an opportunity for creating financial flows to mitigate GHG emissions through forest carbon activities. Senegal has the potential to reduce deforestation and contribute to saving approximately 7 million tons of CO_2 eq per year, while afforestation/reforestation activities could reduce 69 million tons of CO_2 eq each year. However, in order for the country to prepare and become "ready for REDD+," land tenure and rights to resources and carbon must be better defined [37].

Outlook

Senegal is making progress in developing a political landscape that is conducive to strengthening CSA initiatives in the country through the preparation of the PANA and Nationally Appropriate Mitigation Actions (NAMAs). The

10 In 2014, 80 tons of G3 (3rd level of seed) were produced by ISRA, while the national need was 60 tons; and the need for cereal first-level seeds was met for at least 2 years.

11 REDD+: UN Programme for Reducing Emissions from Deforestation and Forest Degradation, including conservation and sustainable management of forests and enhancement of forest carbon stocks.

successful examples of CSA practices across the country prove that when smallholder farmers have access to financial and technical resources and information (climate and market), they are inclined to adopt such practices.

Remaining challenges to CSA adoption on a wider scale include:

- Aligning climate policy documents with the country's economic and agricultural development policies to ensure that growth in the agriculture sector is achieved in a way that is climate smart.
- Engaging multiple sectors in decision making to facilitate identification, assessment and prioritization of the most appropriate CSA initiatives to scale out, particularly with financial institutions and private sector to generate financial flows for CSA practices.
- Controlling land and soil degradation, increasing water management and irrigation infrastructure, controlling the use of fertilizers and pesticides, as well as promoting an enabling environment for post-harvest activities and market access by smallholder farmers. These should be part of a wider strategy to economically reinvigorate the sector so that it can make a greater contribution to the country's food security and climate resilience.

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

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

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