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Transforming agriculture in Africa's Small Island Developing States

Lessons learnt and options for climate-smart agriculture investments in Cabo Verde, Guinea-Bissau and Seychelles

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Contents

The catch is brought in at Bubaque, part of the Bijagos archipelago of 88 islands and islets, for transportation to Bissau, the capital of Guinea-Bissau.

Key messages

- According to UNFCCC, sea surface **temperatures** have been increasing by 0.1 ºC per decade in the oceans where most SIDS are located. In the Atlantic and Indian oceans, which house the African SIDS, including Cabo Verde, Guinea-Bissau and Seychelles annual mean temperature increases of 2.0 ± 0.4 ºC have been projected by 2050.
- Although there are variations between models, projected changes in annual mean **precipitation** are -5.2 ± 11.9 percent and 3.1 ± 4.5 percent in the Atlantic and Indian oceans respectively by 2050. This high variability and the dependency on rainfall increases the vulnerability of the SIDS to prolonged droughts or floods in the rainy season.
- Since **agricultural production** in the SIDS is mostly rainfed, projected changes in temperature and rainfall are expected to affect water resources and lower crop yields if appropriate climate-smart practices and technologies are not adopted.
- Long-term data (1900–2018) on the **occurrence of natural hazards** in Cabo Verde, Guinea-Bissau and Seychelles indicate that they are most vulnerable to epidemics, drought, storms and floods in order of decreasing occurrence. Thus, the entry point for climate-smart agriculture interventions may prioritize those vulnerabilities to increase resilience in agriculture.
- **Promising climate-smart agriculture interventions** to address climate vulnerabilities in the three SIDS include: (a) developing a climate-smart food and nutrition system for households and communities; (b) integrating renewable energy interventions along the value chains, such as solar-powered irrigation systems; (c) cisterns for rainwater harvesting; and (d) climate information services for the benefit of farmers, pastoralists and fisherfolks.
- To achieve the desired sustainable, transformational results at scale, a **system-wide capacity development approach** across people, organizations, institutions, networks and policies is proposed that maximizes country-ownership, commitment and mutual accountability for results.

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Abbreviations and acronyms

AFOLU	Agriculture, Forestry and Other Land Use
CCAM	Climate Change Adaptation and Mitigation
CO_2	carbon dioxide
GDP	Gross domestic product
GGE	greenhouse gas emissions
IPCC	Intergovernmental Panel on Climate Change
$ktCO_2eq$	kilo tonnes of carbon dioxide equivalent
$MtCO_2eq$	Metric tonnes of carbon dioxide equivalent
NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
OECD	Organisation for Economic Co-operation and Development
SAMOA	Small Island Developing States Accelerated Modalities of Action
SDG	Sustainable Development Goal
SIDS	Small Island Developing States
SSA	sub-Saharan Africa
tCO_2eq	tonnes of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme

The Seychelles islands are vulnerable to flooding from high tides, a recurring natural hazard, the risk of which will increase with climate change.

1. Background

Fish for sale on a roadside in Seychelles, which imports much of its other foodstuffs, and grows other produce specifically for its tourism industry.

There are 58 Small Island Developing States (SIDs)[1] in the world. These boast of rich biodiversity landscapes, including a large variety of endemic species and indigenous knowledge that can make them the repository of our planetary ecosystem (UNEP, 2014). Nevertheless, the SIDS are identified as being one of the negatively impacted areas of climate change in the world, with huge implications for biodiversity loss and survival.

There is a general consensus that greenhouse gas (GGE) emissions from small islands are negligible in comparison to global emissions, but the effects of climate change are devastating as a consequence of the sea level rise associated with global warming (Nurse *et al.*, 2014). Long-term risks projected for small islands include increase in coastal flooding, freshwater stress and risks across marine ecosystems. Other threats to the SIDS include more frequent strong winds and cyclones,

[1] For more information see https://www.un.org/ohrlls/content/list-sids

sea water intrusion into aquifers, and freshwater scarcity (Kelman and West, 2009). The apparent inability of these countries to adequately and effectively adapt to these impacts is the result of a combination of factors, including their exposure, sensitivity and vulnerability to shocks, and the costly nature of adaptation measures (Robinson, 2019).

These factors exacerbate their already fragile natural environments, making it more difficult to produce sufficient food to meet their needs. Farming in SIDS is relatively small-scale, and there has been limited investment in agriculture and improved agricultural technology (FAO, 2016a). Thus, local agriculture production has not been competitive against imports and has difficulty competing in export markets. As a result, SIDS share unique vulnerabilities, notably food security and nutrition challenges. They are dependent upon a few productive export sectors and have a high marginal propensity to import (Teelucksingh *et al.*, 2013).

The largest food source in SIDS is food import as compared to national food production with food utilization characterized by nutritionally poor food choices (FAO, 2016a), resulting in the prevalence of non-communicable diseases. The SAMOA Pathway – the outcome of the Third International Conference on SIDS – highlights issues of food security and its linkages with climate change. Among the concrete actions to advance food security and nutrition are: (i) promoting further use of sustainable practices relating to agriculture; and (ii) increasing rural income and enhancing the resilience of agriculture and fisheries to the impacts of climate change, elements that are featured strongly in the principles of climate-smart agriculture. Climate-smart agriculture aims to sustainably increase productivity and income, adapt to the impacts of climate change and reduce GGE emissions where possible. This is in line with global targets (e.g. SDG 2) and Africa regional development targets (e.g. the Malabo Declaration) of achieving zero hunger, increased investment, increased resilience and higher agriculture productivity.

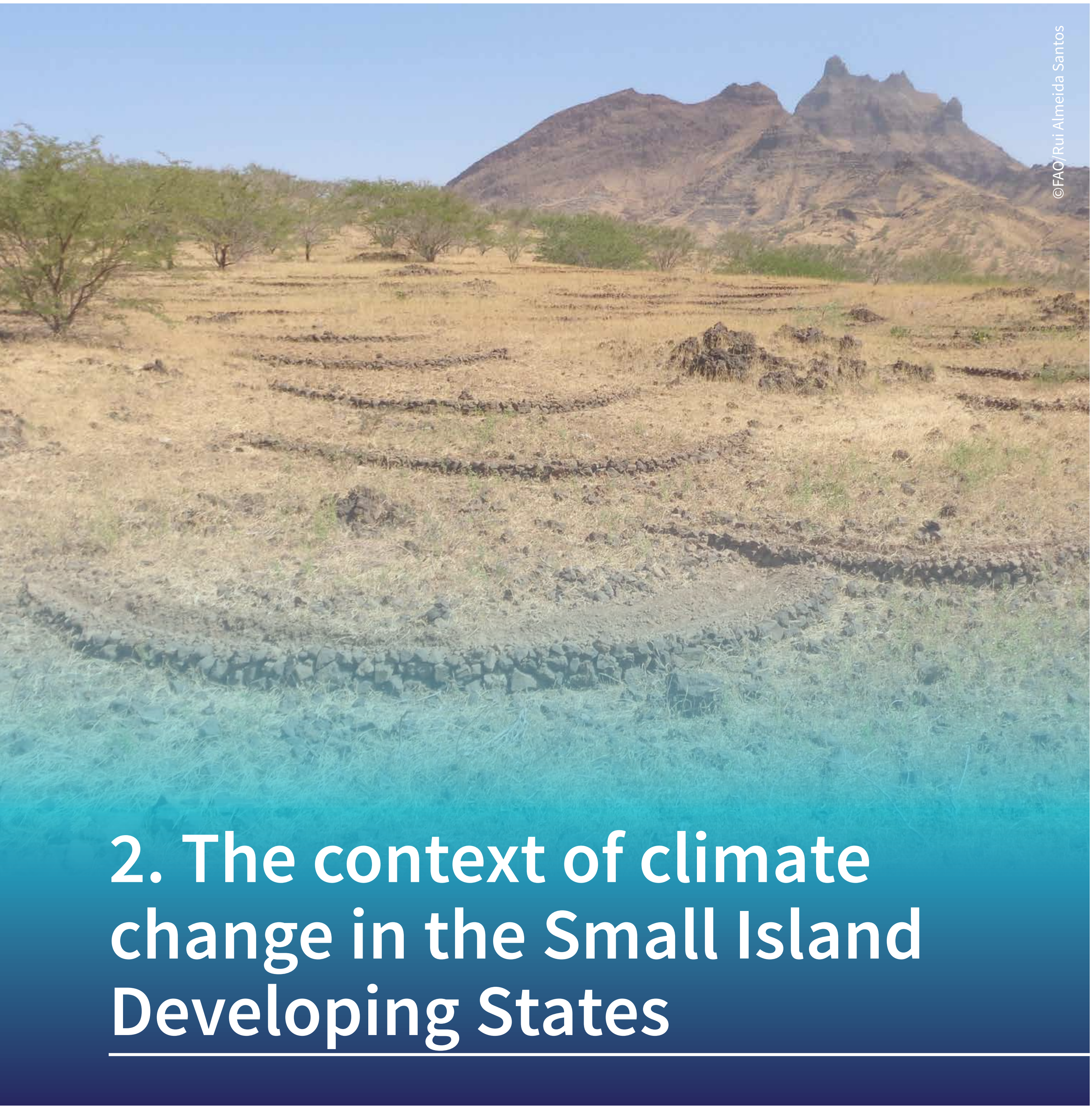
The SIDS in Africa are Cabo Verde, Comoros, Guinea-Bissau, Mauritius, Sao Tome and Principe and Seychelles; but this synthesis will focus on Cabo Verde, Guinea-Bissau and Seychelles, based on their country climate-smart agriculture profiles prepared by FAO, CCAFS and partners, thanks to the Africa Solidarity Trust Fund (ASTF). The present document will serve as a case study guiding countries at various development stages/income levels, with Guinea-Bissau being a least developing country, Cabo Verde a medium-income country, and Seychelles a high-income country. These islands are characterized by their small sizes (Cabo Verde ≈ 4 000 km^2, Guinea-Bissau ≈ 36 000 km^2 and Seychelles ≈ 450 km^2) and low indigenous population[2] (Cabo Verde: 543 767, Guinea-Bissau: 1 874 309 and Seychelles: 90 762) (World Bank, 2018) as well as geographical dispersiveness (Cabo Verde is an archipelago consisting of 10 islands in the Atlantic Ocean; Guinea-Bissau consists of a mainland bordered by Senegal and Guinea, with its Atlantic Ocean coast composed of an archipelago, the Bijagos, of more than 100 islands; and Seychelles is an archipelago of 115 islands in the Western Indian Ocean).

The agricultural sector in these countries is characterized by smallholder farming. For instance, 88.1 percent of farmers hold less than 2 ha in Guinea-Bissau and 90.9 percent hold less than 1 ha in Cabo Verde (FAO and ICRISAT, 2019a, 2019b). Data from FAO (2016a) indicate that among the three SIDS, only Seychelles has achieved undernourishment levels of less than 5 percent between 2014 and 2016. Guinea-Bissau has the highest undernourishment rate, of 20.7 percent, while Cabo Verde has 9.4 percent. Indeed, among the SIDS, Guinea-Bissau records the highest poverty level as the population below the poverty line reaches 69.3 percent, higher than other SIDS, with Cabo Verde and Seychelles reporting 26.6 percent and 13.6 percent respectively. All the above-mentioned factors are contributing constraints to these countries' access to food.

This report aims to share lessons learnt and identify needs and priorities for climate-smart agriculture interventions aimed to transform agriculture and promote better nutrition in Cabo Verde, Guinea-Bissau and Seychelles. The report provides technical guidance and information on ongoing and promising climate-smart agriculture practices and technologies and the context under which they are performing. The report further paves the ground for an evidence-based climate-smart agricultureinvestment through informed identification of opportunities at country and global levels. The report also compiles the information published in the individual climate-smart agriculture profiles (FAO and ICRISAT, 2019a, 2019b, 2019c) in addition to other literature and data published, focusing on common features of the three African SIDS as well as country specific issues.

The report includes an introductory chapter, and climate change and the importance of the AFOLU sectors in the second and third chapters, respectively. The fourth and fifth chapters discuss the challenges in agriculture and the needs and priorities for climate change adaptation and mitigation. The adoption of climate-smart agriculture for integrated climate action as well as barriers to adopting promising climate-smart agriculture technologies/practices are discussed in Chapter 6. Furthermore, the capacity development needs required to address barriers to adoption of climate-smart agriculture opportunities and drive sustainable and tranformational results at scale are discussed. Lastly, the forward-looking chapter discusses knowledge gaps, such as the insufficient capture of the fishery subsector in the country climate-smart agriculture profiles, given its contribution to food security and the countries' economy, and recommends priority areas to serve as entry points for climate-smart agriculture investments.

[2] Population values are mid-year estimates for 2018.



2. The context of climate change in the Small Island Developing States

Traditional half moons, known as caldeira, have been dug in Achada Leite on Santiago Island in Cabo Verde to increase the amount of rainwater which can be harvested.

2.1. GGE EMISSION AND SOURCES

2.1.1 GGE emission (tCO_2eq per capita)

Climate change affects all nations, regardless of their location or the size of their economy as a result of greenhouse gas emissions. From most recent production-based emissions data sources (Franzen and Mader, 2018; Our world in Data, 2021), the average per capita GGE emissions (in tCO_2eq) of the SIDS compared with the Organisation for Economic Co-operation and Development (OECD) and sub-Saharan Africa (SSA) during the recent five years (2012–2016) are presented in Figure 1 (CAIT Climate, 2020).

The GGE emissions per capita in OECD and SSA are equivalent to 11. 2 tCO_2eq and 1.8 tCO_2eq per person, respectively. In the SIDS, around 1.8 tCO_2eq is emitted per person at global level, while emissions are equivalent to 3.3 tCO_2eq and 4.4 tCO_2eq per capita for African SIDS and the three SIDS (Cabo Verde, Guinea-Bissau and Seychelles), respectively. It should however be noted that these GGE emissions do not include emissions embedded in importation nor exportation of goods.

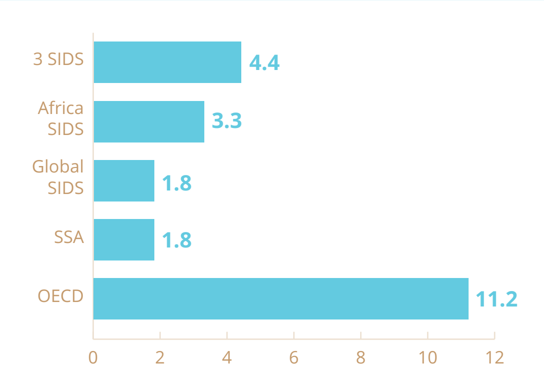
The analysis of the downscaled dataset in Figure 2 shows significant differences among the individual three SIDS countries as expected, due the differences in their sizes, economies and developmental levels.

The highest CO_2eq emissions per capita among the three SIDS is reported in Seychelles, followed by Guinea-Bissau and Cabo Verde. Seychelles with 13 tCO_2eq is the largest emitter per person and significantly exceeds the three SIDS average of 4.4 tCO_2eq. In terms of average value, it is important to note that in Guinea-Bissau and Cabo Verde, the per capita CO_2 emissions was below this threshold. For example, Guinea-Bissau was responsible for about 2 tCO_2eq per person between 2012 and 2016, while Cabo Verde was reporting the lowest, 1 tCO_2eq emissions per capita. Findings from this data analysis are consistent with previous study following SIDS statistics, in 2013. In general, high-income and upper-middle income SIDS (Seychelles) register high emission per capita. However, the low-income (Guinea-Bissau) and lower-middle-income (Cabo Verde) SIDS are responsible for the lowest CO_2 emissions per capita.

2.1.2 GGE emissions sources

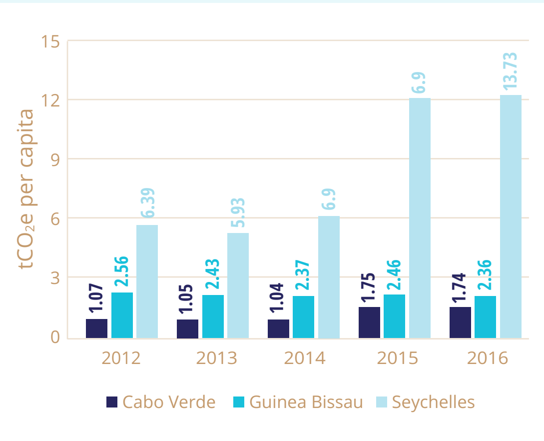
Breakdown of GGE emissions per sector is presented in Figure 3. The agricultural sector is the highest contributor to GGE emissions in Guinea-Bissau (44.7 percent), with land use, land use change and forestry (LULUCF) being a major CO_2 release factor in the atmosphere and thus a contributor of 36.9 percent to GGE emissions. As shown in Figure 3, most of the emissions in the African SIDS come primarily from the energy sector, and this is particularly valid for Cabo Verde and Seychelles.

It is interesting to note that in Cabo Verde, emissions from LULUCF was least (-0.2 MtCO_2eq) and offset approximately 28 percent of net GGE emissions of the country. This is mainly due to the successful large-scale reforestation programmes that have been implemented since the 1980s in Santiago and Santo Antao islands. A total of 243 km^2 of plantations were mapped all over Cabo Verde in 2013 (CILSS, 2016). This increase in forest cover is expected to grow through new reforestation initiative targeting about 10 percent CO_2 removal of the intended national reforestation targets. Data reported in FAO (2020) showed that the forestation rate was 300 ha/year during the last two decades 2000–2020, for a total of 46 000 ha of forest in 2020 (FAO, 2020). As a result,



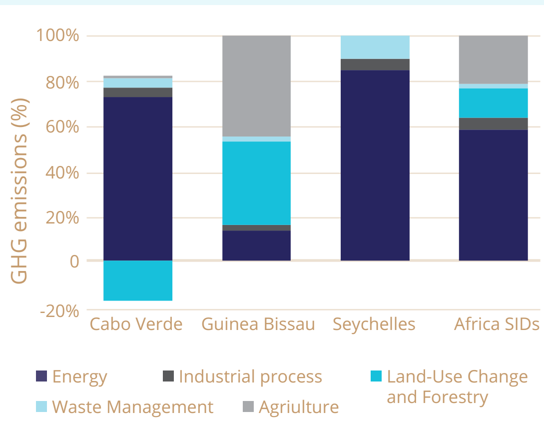
Source: CAIT Climate

Figure 1: GGE per capita, tCO_2eq per capita



Source: CAIT Climate

Figure 2: Greenhouse gas tCO_2eq per capita

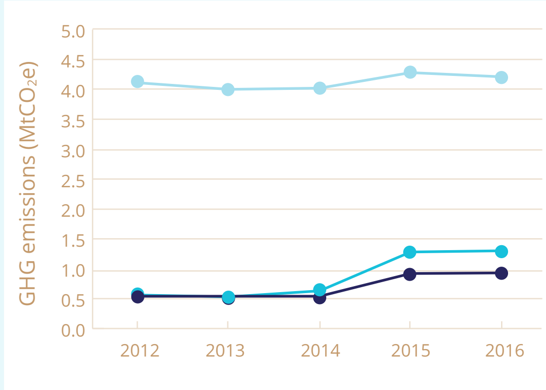


Source: CAIT Climate, average 2012–2016

Figure 3: Greenhouse gas emissions by sector

emissions and removals in this subsector consisted of variation of the carbon stock present in the forest areas (Republic of Cabo Verde, 2017).

The trends of GGE emissions economy-wide over the closest five years are presented in Figure 4. Preliminary estimates reveal that, after stable trends between 2012 and 2014 in Cabo Verde (0.5 $MtCO_2eq$) and Seychelles (0.6 $MtCO_2eq$), GGE emissions have grown markedly between 2014 to 2016 by 72 percent (0.9 $MtCO_2eq$) in Cabo Verde and 126 percent (1.3 $MtCO_2eq$) in Seychelles. Indeed, between 2014 and 2016, GGE emissions from energy has significantly increased from 0.5 $MtCO_2eq$ to 1.2 $MtCO_2eq$ in Seychelles (CAIT, 2020) while the sink capacity of forests was estimated at 0.8 $MtCO_2eq$ with an expected loss of 1 percent every five years (NDC, 2015). Emissions from the energy sector have more than doubled in Seychelles and approximatively doubled in Cabo Verde. Estimated GGE emissions in Guinea-Bissau reached the level of 4 $MtCO_2eq$ over 2012–2016. The projections reveal an exponential variation indicating that the level of total GGE emissions in Guinea-Bissau without mitigation measures will exacerbate by 2030 and reach a staggering 157.6 $MtCO_2eq$ by 2050 (Republic of Guinea-Bissau, 2018). Indeed, the agricultural sector is the mainstay of the Guinea-Bissau economy, a source of income for 85 percent of the population. As such, agriculture is most prevalent in Guinea-Bissau as opposed to other SIDS (Seychelles and Cabo Verde). The high GGE emissions in Guinea-Bissau may be due to the fact that most people in the country play a significant role in the agricultural sector. The agricultural sector, particularly the livestock sector, contributed the most to GGE emissions in Guinea-Bissau (CAIT climate, 2020).



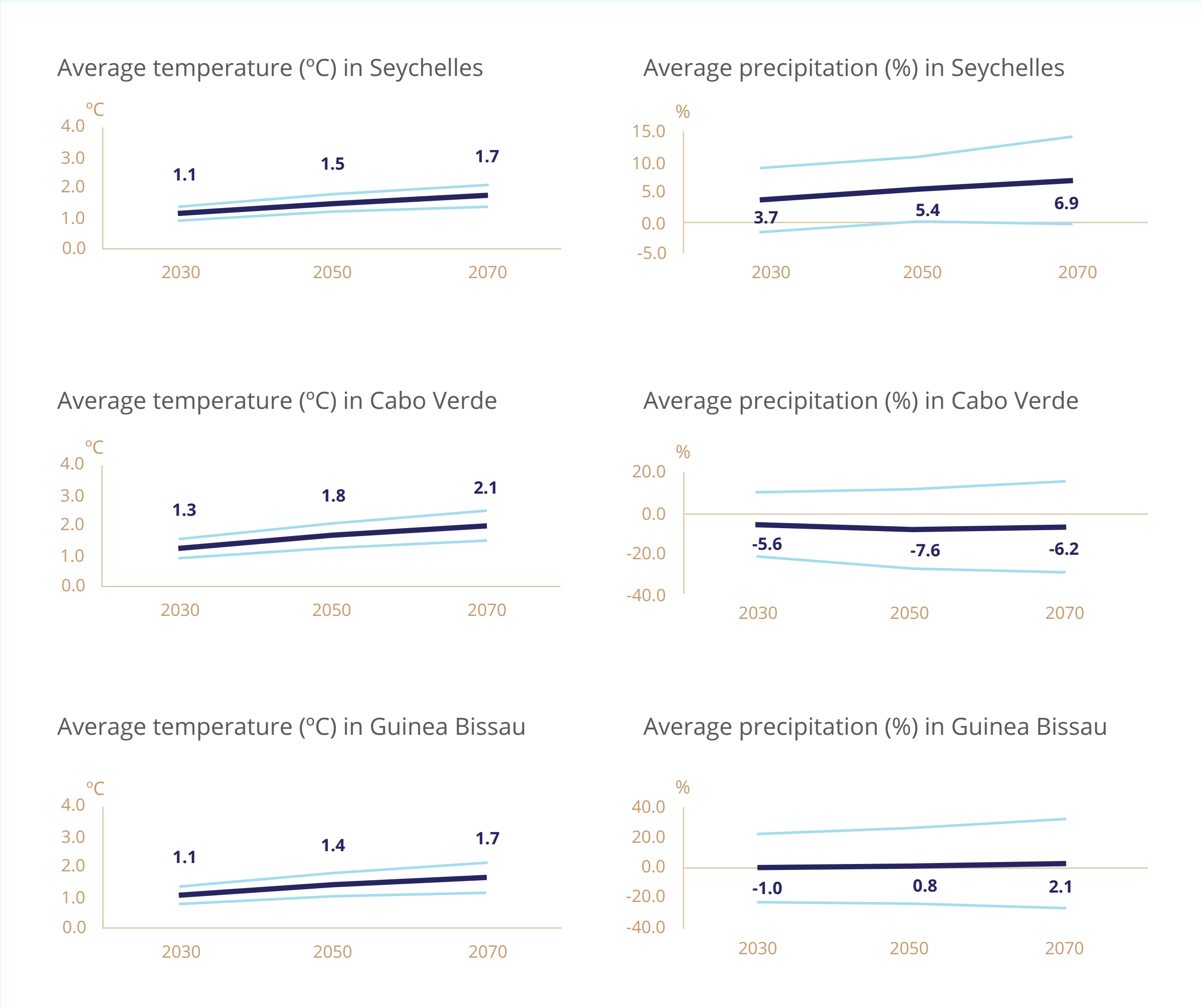
Source: CAIT Climate,2020

Figure 4: GGE emissions trends for Cabo Verde, Seychelles and Guinea Bissau

In Seychelles, the average annual per person fish consumption of 58.9 kg is one of the world's highest. Cabo Verde's average is 11.0 kg while Guinea-Bissau's is one of the world's lowest at 1.3kg.

2.2 PROJECTED CHANGES OF CLIMATE CHANGE FOR YEARS 2030, 2050 AND 2070

The climate scenarios report significant changes in the three SIDS countries (Figure 5). These scenarios systematically indicate increases in average daily temperature for each of the three SIDS while the rainfall remains much variable. In Seychelles and Guinea-Bissau, temperature could increase up to +1.5 °C and +1.4 °C (according to RCP 4.5 scenario), respectively, for the period 2030–2050, and could potentially reach +1.7 °C from 2050–2070 for both SIDS. The temperature trends reveal a great increase up to 1.8 °C in 2050 in Cabo Verde that may reach +2.1 °C in 2070. Rainfall shows decreasing trends in Cabo Verde by -7.6 percent in 2050 and -6.2 percent in 2070. Seychelles will experience an increase in rainfall of +5.4 percent in 2050 and +6.9 percent in 2070. An increase in rainfall is estimated for Guinea-Bissau with few trends of +0.8 percent in 2050 that may reach 2.1 percent in 2070.



Source: FAO and ICRISAT, 2019

Figure 5: Projected changes in temperature and precipitation for Seychelles, Cabo Verde and Guinea-Bissau

3. Importance of the agriculture, forestry and other land use sectors in the Small Island Developing States

A team from FAO Guinea-Bissau sets off to visit climate-smart agriculture programmes in the Bijagos archipelago, 48km from the mainland of Guinea-Bissau.

3.1 LAND USE

The percentages of lands classified as agricultural land are 20 percent, 58 percent and 3 percent for Cabo Verde, Guinea-Bissau and Seychelles, respectively (Figure 6), which reflects the level of agriculture contribution to the GDP of the countries as well as the number of people involved in primary agricultural production.

The constitution of the agricultural land by country is presented in Figure 6. Although the short-term prospects for forest production intensification in terms of wood production in natural forests is limited in most SIDS, the indirect economic and environmental benefits of the sector are considerable.

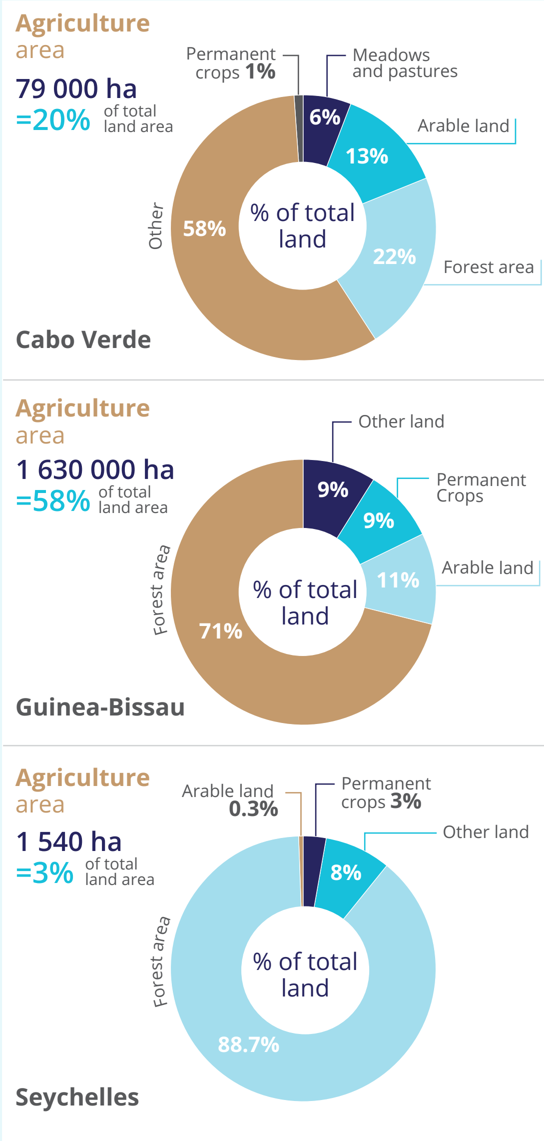
3.2 AGRICULTURE IN THE SIDS

Of the three SIDS, Guinea-Bissau is the country where agriculture contributes the highest to the GDP (49 percent) (Figure 7), with 8 percent for Cabo Verde and 2 percent for Seychelles. The percentage of people involved in primary agriculture production follows a similar trend, with 69 percent in Guinea-Bissau, 18 percent in Cabo Verde and 3.7 percent in Seychelles (Figure 8).

While the percentages of people involved in agriculture are indicated only in the proportion of women and men in this report as it is a regional synthesis, it is important to emphasise that for climate-smart agriculture investment projects development and implementation, additional data at national and subnational levels should include the proportion of rural households that are female headed and the migration of youth and how this impacts agriculture. Furthermore, an overview of how rural communities and households are organized (gender roles, responsibilities, rights and dynamics); which sectors have cooperatives, associations; and how women's self help groups play an important role in resilience should be included.

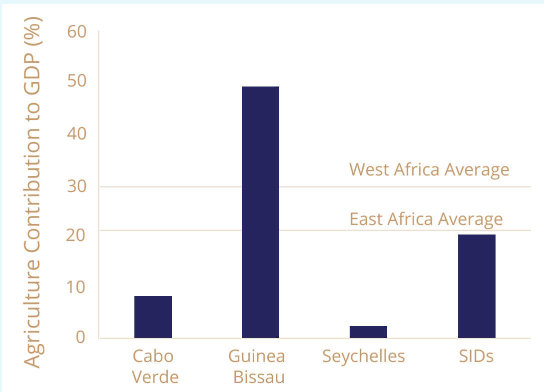
The agricultural sector is characterized by subsistence production (except cashew and groundnut in Guinea-Bissau) under rainfed and irrigation systems. Like in many developing countries, agriculture in the SIDS is mostly rainfed with the rate of irrigated lands being below the irrigation potential. With regards to fertilizer, all the countries have low usage rate, well below the OECD countries' average of 119 kg/ha, with Cabo Verde presenting a higher rate than African Union-endorsed average of 50 kg/ha as adopted in the Abuja Declaration on Fertilizers in 2006. Cabo Verde has the highest amount of usage of 55.6 kg/ha, followed by Seychelles with 48.9 kg/ha. The lowest usage is by Guinea-Bissau with 1.3 kg/ha (FAO, 2016b).

The major crops produced in the SIDS in general are maize, pulses, rice, cashew, vegetables and fruits. For country specifics, a list of the major produce is presented in Figure 9. While fish is very important for the diet and contributes immensely to the food security and economy of the countries, it is notably not captured in the climate-smart agriculture country profiles of Cabo Verde, Guinea-Bissau and Seychelles due to the specificity and the complexity of the fishery sector, a shortcoming discussed in Chapter 7. The major crops in Cabo Verde are maize, pulse, vegetables, coconut, sugar cane, roots and tubers, with cereals constituting a major part of the diet in addition to proteins. In Guinea-Bissau, the major crops are cashew nut, rice, groundnut, sorghum, plantain, roots and tubers, maize, millet and coconut, and palm oil. While groundnut and cashew are mostly for the export market, rice, which is the largest



Source: FAO and ICRISAT, 2019a, 2019b, 2019c

Figure 6: Land use for agriculture in the SIDS



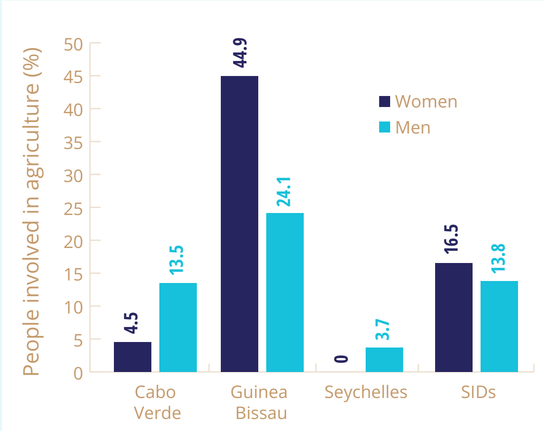
Source: FAO and ICRISAT, 2019

Figure 7: Agriculture contribution to GDP of SIDS compared to Western and Eastern Africa

cereal, constitutes the main staple food. In Seychelles, the major agriculture products include crops such as vegetables, fruits, roots and livestock.

The coastlines of all the three SIDS also offer important avenue for marine fisheries and play an important role in the provision of employment, foreign exchange and food to the population. According to FAO (2018e), the fisheries sector in Cabo Verde reported a total capture production of about 26 580 tonnes in 2018 of which tuna made up 76 percent, most of which is exported. Aquaculture is almost non-existent.

An estimated 6 700 tonnes of total catch was reported in 2016 by vessels flying the Guinea-Bissau flag, of which about 6 550 tonnes are from marine fisheries and 150 tonnes from inland fisheries. However, most of the catches in the exclusive economic zone (EEZ) were carried out by foreign industrial fishing vessels (FAO, 2018d). In Seychelles, although industrial fishery is a major pillar of the economy, artisanal fisheries remain of great importance for food security, employment and cultural identity. The total capture production between 2007 and 2014 was between 65 000 tonnes and 87 000 tonnes. This amount increased to 136 200 tonnes in 2017. Over 95 percent of the catches are usually tuna species caught by industrial Seychelles-flagged vessels, and mainly exported (FAO, 2019).



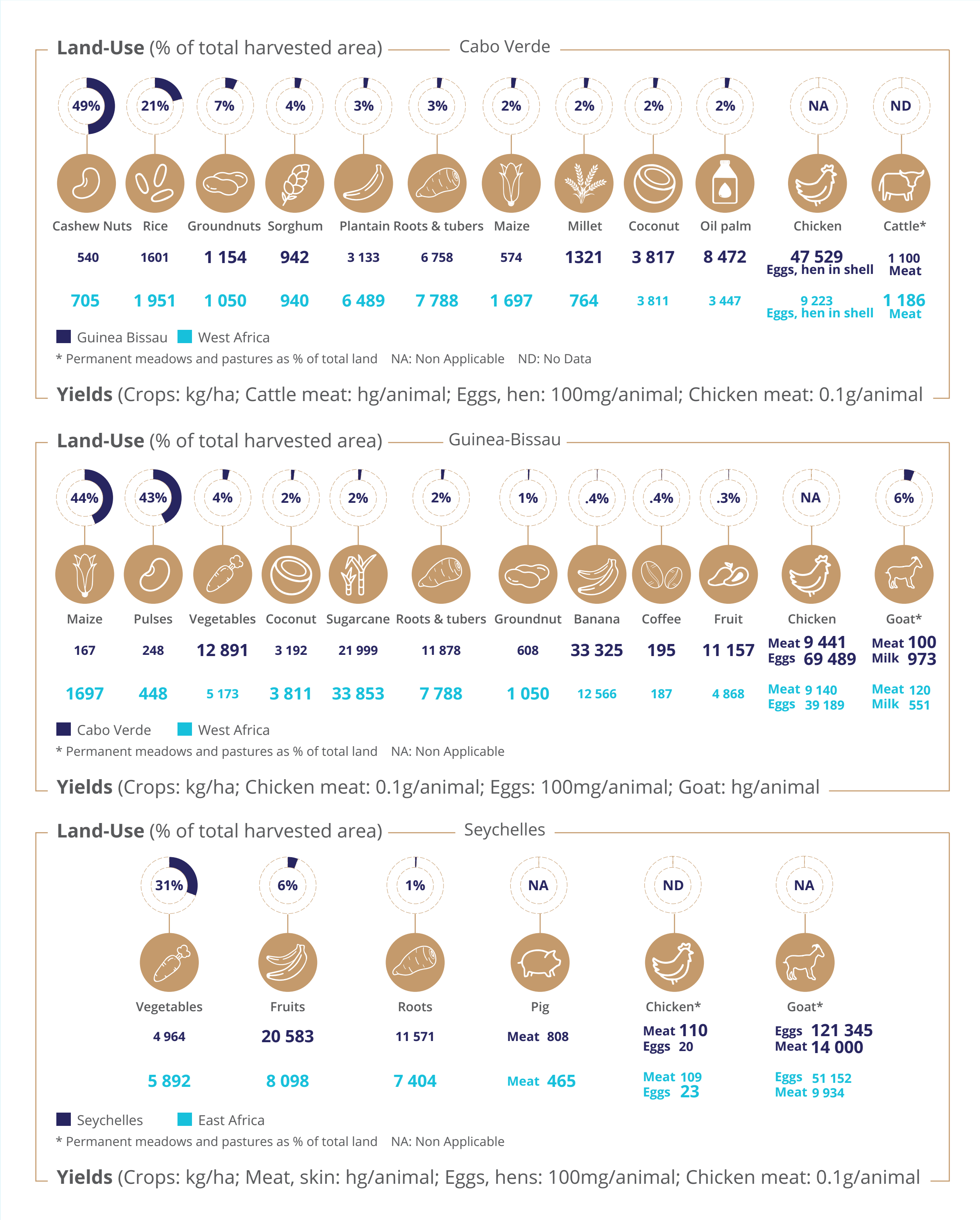
Source: FAO and ICRISAT, 2019

Figure 8: Percentage of population involved in agriculture (primary production)

Box 1: Per capita fish consumption

The per capita fish consumption of the countries are as follows: 11.0 kg in Cabo Verde accounting for about 12 percent of total animal proteins (FAO, 2018e). On the other hand, fish consumption per capita is low in Guinea-Bissau and estimated at 1.3 kg in 2016 (FAO, 2018c). With 58.9 kg, Seychelles is among the higher per capita fish-consuming countries in the world (FAO, 2019d).

Yellowfin tuna caught by small-scale artisanal fisherfolk are offered for sale in the harbour market of Victoria, the capital of Seychelles.



Source: FAO and ICRISAT, 2019a, 2019b, 2019c

Figure 9: Production systems key for food security in the SIDS

©FAO/Caritas Cabo Verde

4. Challenges to agriculture

Women learn how to integrate local ingredients, which have not traditionally been used, into nutritious meals, in Porto Novo, Santo Antão island, Cabo Verde.

In general, the major challenges to agriculture in the SIDS countries as identified in the countryclimate-smart agriculture profiles includes population growth and dynamics, rapid urbanization, limited marketing opportunities for islanders in their home countries, massive imports of food stuff (which does not encourage local production and processing), and climate change and variability.

Growth in population and changes in population dynamics: The populations of the SIDS are expected to continue growing, with those of Cabo Verde and Guinea-Bissau projected to more than double by

2050 (FAO and ICRISAT, 2019a, 2019b). An aspect of population dynamics which is not favoring agriculture is the "migration and brain drain". This is very visible in a country like Cabo Verde, although the positive aspect is remittances. Increase in food demand as a result of population growth has resulted in heavy reliance on food imports. In Seychelles, where the percentage of people involved in agriculture is the lowest amongst the SIDS under consideration, there is also the challenge that agriculture is driven by an ageing population and the youth trained in modern farming techniques prefer to work in different sectors after their training.

Rapid urbanization and land-use changes: As the trend is with most developing countries, the SIDS are also experiencing an increase in urban population. The competition for land use for infrastructure and tourism poses a challenge to agricultural production. It is important for key policy documents to focus on regulations in land tenure and planning of settlements. For instance, in Seychelles, a new government policy facilitates access to arable lands and investment capital at a reduced interest rate to encourage private initiatives and youth involvement in agricultural production, and processing has been instituted (Personal Communication with Seychelles Ministry of Agriculture and Fisheries).

Limited marketing opportunities: Marketing opportunities are a challenge for the SIDS. In Cabo Verde and Guinea-Bissau, for instance, smallholder farmers lack the knowledge and skills on aligning value chains to marketing and commercialization, which is key to achieving sustainable livelihoods.

Massive imports of food stuff: Food import is perhaps one of the key challenges of local agricultural production in most of the African SIDS. This is particularly severe in the three SIDS under consideration in this study. These islands are famous for their tourist attraction; and most of the hotels owners are usually oriented to outside sources for their supply of food stuff for their restaurants. Policies are being considered to ameliorate this development. In Seychelles, for example, hotels and other tourist establishments are required by law to patronize local food products for up to 20 percent of their food products demands. Furthermore, it is important to incorporate the "institutional political economy" at global, regional and national level (e.g. incentive/disincentive systems such as subsidies, trade policies, investments, etc.), which may hamper or promote the uptake of climate-smart agriculture practices at scale as part of the proposed systemic capacity enhancement process.

Climate change and variability: Currently, agricultural production in SIDS is under stress from sea-level rise, coastal erosion and shortage of freshwater, with projected climate change effects such as heat stress, changes in soil moisture and evapotranspiration, as well as changes in extreme weather events, eg. tropical cyclones, floods and droughts to exacerbate the situation (UNFCCC, 2005). In Cabo Verde, the arid nature exacerbated by severe drought in the last three years coupled with high rainfall-dependent agriculture makes it very vulnerable to climate change with negative impacts on food security. Similarly, changes in onset/end of rainy season, dry spells, as well as rising temperatures in Guinea-Bissau, threaten the per capital food availability. In Seychelles, changes in climate coupled with limited arable land, tropical storms and floods make agriculture very vulnerable.

In the fisheries subsector, climate change impacts such as sea-level rise, acidification and changes in currents affect both the quantity and distribution of the ocean's fish as well as the marine biodiversity. In addition, the increase in the frequency of extreme weather events threaten the fishery sector with lives and equipment at stake.

4.1 COUNTRY CLIMATE RISK/VULNERABILITY ASSESSMENT

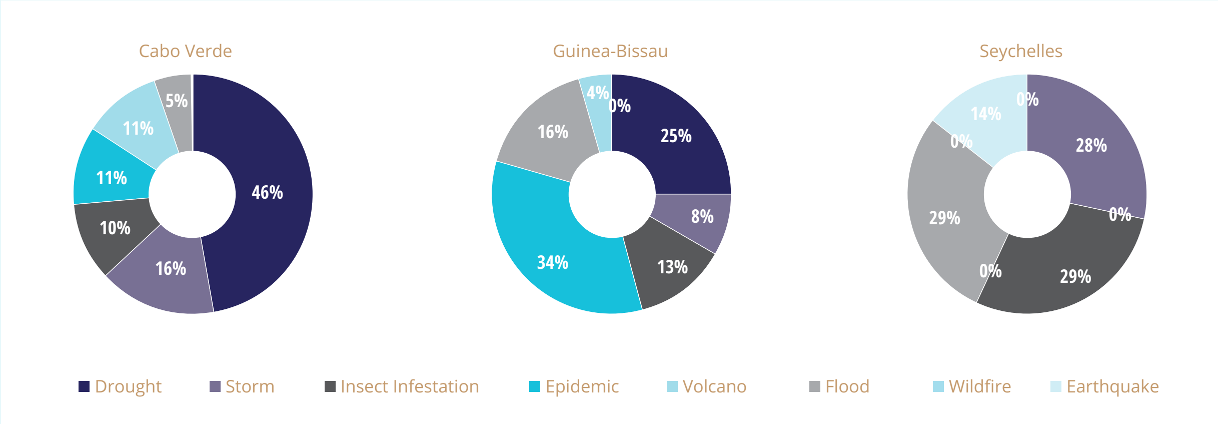
The analysis of the occurrence of natural hazards from the World Bank vulnerability assessments indicates that major climate change threats facing the African SIDS are similar in nature with crosscutting vulnerabilities being epidemic, storm and floods. Guinea-Bissau and Cabo Verde share common vulnerabilities of drought and insect infestation while the country-specific vulnerabilities are volcanic activity, wildfires and earthquakes for Cabo Verde, Guinea-Bissau and Seychelles, respectively. A summary of the common as well as country-specific vulnerabilities is presented in Figure 10.

A chart of the average annual natural hazard occurrence for the individual countries from 1900 to 2018 is presented in Figure 11. Collectively, drought and epidemic have the highest average occurrence in the three SIDS under consideration (24 percent) while storms and flood have the next highest level of occurrence with 17 and 16 percent, respectively. This indicates that in the case of limited resources, priorities may be given to programmes that address vulnerabilities with the highest annual occurrence.

Drought: In general, the SIDS rely on one or all of the three main natural sources of water: surface water (rivers, small lakes), rainwater and groundwater with some of them like Seychelles entirely dependent on surface water (UNFCCC, 2007). This makes them highly vulnerable to current and predicted changes in precipitation due to climate change resulting in both inter- and intravariability rainfall. According to the World Bank (2020), decreases in rainfall has been observed between 1901 and 2016, with a probable reduction

CLIMATE CHANGE VULNERABILITIES	COUNTRIES		
	Cabo Verde	Guinea-Bissau	Seychelles
Epidemic Flood Storm	★	★	★
Drought Insect infestation	★	★	
Volcanic activities	★		
Wild fires		★	
Earthquake			★

Figure 10: Common and country-specific vulnerabilities of three African SIDS



Data source: World Bank, 2020a, 2020b, 2020c

Figure 11: Average annual occurrence of natural hazards for 1900–2018 in Cabo Verde, Guinea-Bissau and Seychelles

in wet season rainfall in Cabo Verde. Similarly, mean annual precipitation indicates that precipitation has decreased over the period of 1961–1990 in Guinea-Bissau in addition to delays in the start of the rainy season, decrease in precipitation during the rainy season as well as an extended dry season. In Seychelles, rainfall variability over Mahe has been observed.

The observed variability in precipitation has negative consequencies on the availability of water resources. For instance, in semi-arid Cabo Verde with an average rainfall of 225 mm/year, approximately 20 percent is lost through surface runoff, 13 percent infiltrates recharging aquifers, and 67 percent evaporates (World Bank, 2020a), making it highly vulnerable to drought. In Guinea-Bissau, 100 000 and 32 000 people were affected by drought in the years 2002 and 2004, respectively (World Bank, 2020b). In Cabo Verde, the severe drought over the last three years (since 2017) has greatly challenged and continues to challenge agricultural production.

Epidemic: Most small island nations are in tropical areas with weather condusive to the transmission of diseases such as malaria, dengue, filariasis, and schistosomiasis (Nurse *et al.*, 2014), a situation further worsened by the impact of climate change such as increase in temperature, humidity and flooding. It should be emphasized that as caregivers, women are more burdened with these impacts as children under five are usually in their care, and pregnancy also increases their susceptibility to intradomiciliary transmission. According to IPCC (2014), pregnancy is a period of increased vulnerability to a wide range of environmental hazards, including extreme heat (Strand *et al.*, 2012) and infectious diseases such as malaria, foodborne infections, and influenza (Van Kerkhove *et al.*, 2011). Thus, differentiation of impacts on women and men is very important during project development in order to develop measures targeted at their specific needs.

Flood: Flooding is a recurring natural hazard in Guinea-Bissau. Cabo Verde and Seychelles experience flooding depending on the tides. The World Bank reports that in 2003, 2004 and 2005, flooding damaged bridges and makeshift housing in the eastern region of Guinea-Bissau, resulting in a loss of 63 hectares of food production, and displaced people from their communities whereas in Seychelles, very high tides combined, resulting in flooding up to 50 m inland in 2007. Apart from the direct damage to agriculture and infrastructure, flooding also has negative impacts on public health and tourism.

Storm: Due to their location in tropical and subtropical oceans, the climate of SIDS is influenced by ocean-atmosphere interactions that manifest themselves in extreme weather events such as hurricanes and cyclones, which are associated with storm surges (UNFCCC, 2007). This situation is further exacerbated by climate change, resulting in damaging consequences on agriculture, biodiversity, infrastructure and displacing people. In Seychelles, for instance, a storm in 2001 resulted in the loss of over 1 000 endemic palms (UNFCCC, 2007).

Insect infestation: Changes in climate such as increase in temperature is expected to affect the growth rate of insect population. This will result in yield decrease, pre- and post-harvest losses and ultimately decline in food security as well as increased vector-borne diseases.

5. Needs and priorities for improving climate change adaptation and mitigation in the Small Island Developing States

Salted fish for sale in the market in Bubaque, in the Bijagos archipelago of Guinea-Bissau, where most fish-salting is traditonally carried out by women.

In their nationally determined contributions (NDCs), the SIDS in general identify energy, transport and forestry for mitigation, whereas agriculture, water, environment and coastal zone protection are earmarked for adaptation. The two archipelagoes, Cabo Verde and Seychelles, rely heavily on fossil fuels for energy and thus, renewable energy features prominently in their mitigation measures.

The mitigation targets communicated by these countries in their year-pledges and nationally determined contributions aim at significantly reducing the levels of emissions by sectors (CAIT Climate, 2020). For example, Seychelles has an overriding aim of reducing its economy wide absolute GGE emissions by 122.5 ktCO_2eq (21.4 percent) in 2025 and estimated 188 ktCO_2eq in 2030 (29.0 percent) relative to 2030 businessas-usual scenario emissions. Energy, public electricity (generation and demand-side management) and solid waste are among key identified sectors to meet GGE target.

Cabo Verde has outlined its commitment to reduce the emissions in the energy sector. The mitigation contributions are expressed in the form of non-GGE target in the form of 15 percent renewable energy by 2030 and energy efficiency targets along with other nationally appropriate mitigation actions (NAMAs) for the sectors of energy, transport, waste, and AFOLU (Agriculture, Forestry and Other Land Use). In addition, afforestation measures of 10 000 ha unconditionally and up to 20 000 ha with support, with an estimation of planting area of 400 trees per hectare. If 20 000 ha are successfully planted, this will generate a long-term sequestration gain of 360 tCO_2eq per hectare sequestered after 30 years, corresponding to 7.2 $MtCO_2eq$.

The major actions for mitigating GGE emissions for Guinea-Bissau include reforestation and the establishment and implementation of policies and planned actions in forestry and energy sectors as well as the development of a legal framework for low carbon development (Republic of Guinea-Bissau, 2018).

In addition, some actions that are identified in the respective NDCs cut across the energy and agricultural sectors. In Cabo Verde for instance, the aim of increasing water supply for agricultural use would require the country to have energy infrastructure to pump and distribute water. In Seychelles, the potential to use waste to produce biogas has been identified as one of the actions. Using agricultural waste, especially livestock and other organic waste to produce biogas, can support this specific action.

In the agricultural sector, the key adaptation options identified at the country level as reported in their NDCs are presented in Table 1.

Table 1: Key adaptation options in agriculture in the NDCs of three African SIDS

Climate change adaptation options identified in NDCs	Countries		
	Cabo Verde	Guinea-Bissau	Seychelles
Adopt and integrate climate change into local development plans, forest management plans		●	
Develop new, more resistant crops		●	
Disseminate more efficient small-scale irrigation technology	●		
Diversify income-generating activities by promoting artisanal fishing activities (providing training, equipment, microcredit)	●		
Integrate early warning systems in agriculture			●
Promote blue economy	●		●
Protect coastal ecosystems		●	
Promote soil conservation schemes	●	●	
Research and innovate to strengthen climate resilience			●
Strengthen governance, strategy development and capacity-building	●		
Support agriculture, forestry and fisheries with new, innovative and climate-resilient technologies		●	●

5.1 NEEDS TO IMPROVE CLIMATE CHANGE ADAPTATION AND MITIGATION

The needs of the SIDS to improve CCAM are similar in the countries and include the need for capacity-building, research and technology transfer in addition to funding.

Systemic capacity development with awareness creation: Learning as well as organizational and institutional development in line with good practices (FAO 2017) on the causes and impacts, as well as adaptation and mitigation efforts are needed in the African SIDS. There is a need to invest in an inclusive capacity assessment based on a questionnaire or facilitated question guide at regional, national and subnational level to identify needs, potentials and a baseline to track progress. Based on the capacity assessment, a capacity-enhancement strategy should be defined that includes clearly defined results and rigorous track progress and results to optimize learning, capture lessons learned and channel experiences into strategic communication and resource mobilization efforts (both from external partners as well as realigning national investments).

As an important and interconnected step, there is an urgent need to sensitize people at community and institutional level (private sector and civil society) as well as in schools to ensure that climate change adaptation and mitigation are mainstreamed into all sectors, planning and development. In order to spread awareness, it is important to constantly share results, achievements and good practices with stakeholders through the most effective ways of communication, depending on the specific needs, level of vulnerability, and most of all the capacity to access information of every type of stakeholders. This could be enhanced by participatory management approaches such as Farmer Field Schools and Climate Field Schools, which support alternative and inclusive ways of education on sustainable agricultural practices, by involving farmers and other local stakeholders in the first line, and improving their understanding of how to properly apply climate information to cropping strategies.

There is also a need to address the gaps and barriers to climate change adaptation and mitigation identified by the countries and to assess whether climate and meteorological experts are effectively involved in the research and decision-making processes. For instance, in its NDC, Guinea-Bissau cites poor development of training and research on climate change, insufficient scientific training on vulnerability, adaptation and mitigation of climate affects, among others, as some of the barriers to adaptation and mitigation of climate effects. In Cabo Verde, increased research and farmers' capacity development for the sustainable provisions and use of improved seeds of key cultivars, such as maize, cowpea, tomatoes, are priority actions in the development of the agricultural sector. In Seychelles, efforts are oriented towards boosting agrotourism development through capacity assessment and training for farmers and agroprocessors, awareness-raising on the nutritional and health benefits of agroforestry and horticulture products; promotion of best practices of climate-smart agriculture; and identification of viable domestic-market opportunities for value-added food production. In addition, access to value-added niche markets through information on market opportunities, standards, environmentally sound practices and new uses of traditional products should be supported.

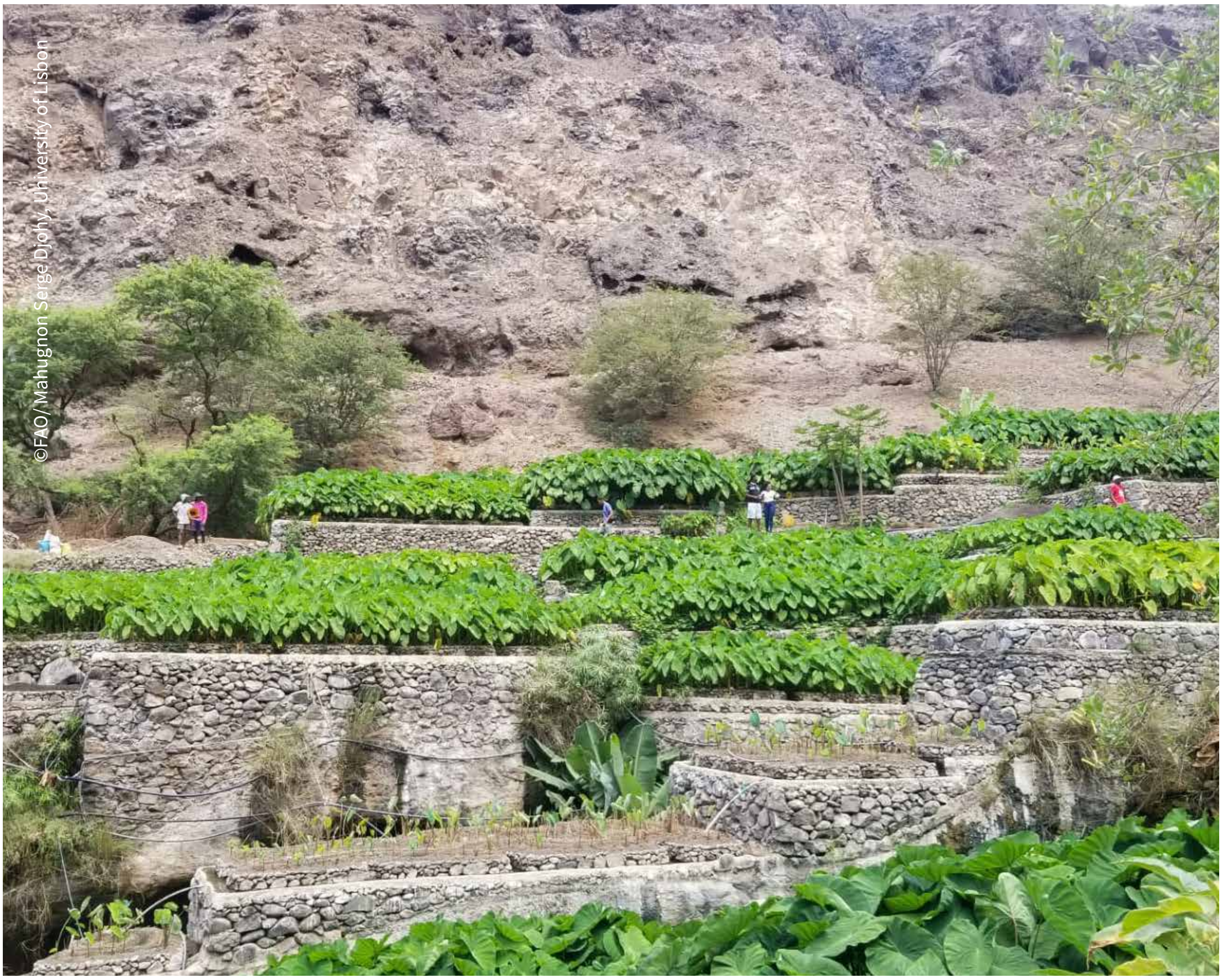
More so, strengthening key organizations, institutions and networks is important to go beyond awareness and training only. This may include enhancing sectoral and intersectoral coordination mechanisms, strengthening multistakeholder networks and aligning climate-smart agriculture relevant policies. These efforts should also be grounded in rigorous, multiscalar, participatory and holistic gender analyses that identify ways to redress context-specific constraints as an intrinsic part of designing adaptation measures.

Research and monitoring: Most of the African SIDS have limited capacity to conduct research and monitor climate change. There is therefore a need to build capacities to strengthen climate services and early warning systems of countries and develop strategic research partnerships within Africa and elsewhere, in order to be able to conduct research and secure scientific information to provide evidence-based solutions to observed and projected climate change challenges. It is imperative to reach out to women and make the research gender-sensitive and responsive.

To strengthen meteorological service and the ministries of agriculture's capabilities and capacities to monitor climate variables as well as deliver climate information services/products to the end users, the following services, products and tools are recommended:

- warning, nowcasting and very short-range forecasts (e.g. strong wind events, thunderstorms, flash floods, hail risk warnings);
- short-term advisory (1-2 days) (e.g. rainfall events);
- medium-term advisory (3-7 days) (e.g. dry spells, heat stress for animals and plants, flood risk, temperatures above relevant thresholds, irrigation needs assessment, soil moisture conditions);

FAO has supported the building of an integrated irrigated system to grow yams in Santo Antão island, Cabo Verde.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- long-term advisory (7-30 days) (e.g. rainfall fluctuaction, drought ending or drought persistence);
- seasonal forecast (1-3 months) (e.g. temperature and rainfall expectations); and
- agrometeorological advisory: agricultural planning (seed selection, sowing date, field operations) and management (weeding, fertilizer application, pest and diseases, etc.).

Extension services: Extension services are a key element for a capacity-building and enabling environment. Building partnerships between different stakeholders will help to identify needs and reduce gaps. In addition, more engagement between research institutions is essential for scaling up and dealing with the new challenges that will emerge as innovation advances; long-term strategy and sustained funding for extention are needed to influence policy strategies to defend the environment. It is also important that extension services be responsive to gender-specific needs.

Technology: There is also a limited technological capacity for monitoring, technology transfer and dissemination at the farm and community level. There is a need for national, local, public and private institutions to invest in climate-monitoring technologies, agroclimatic services delivery, as well as to request international funding opportunities. Increased partnerships and collaborations with climate experts, development of regional climate centres as well as improved data availability, access, and sharing, from field surveys and laboratories to end-users is needed. The NDC of Seychelles, for instance, highlights the inadequate capacity to undertake effective research on climate change modelling and risks, monitoring of climate change impacts and the implementation of adaptation measures. More so, in some cases, the technology may be available but may be overly expensive, which reiterates the need for development partners to support in that regard. In addition, gender dimensions in technology design, use, and adoption should be considered.

6. Adopting climate-smart agriculture for an integrated climate change adaptation and mitigation action

In Guinea-Bissau, FAO is supporting farmers with climate-smart techniques to grow varied fruits and vegetables for their nutrition and food security.

6.1 THE CLIMATE-SMART AGRICULTURE CONCEPT

Climate-smart agriculture, as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, contributes to the achievement of Sustainable Development Goals. It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges (FAO, 2013).

climate-smart agriculture has three objectives: (1) sustainably increase productivity and incomes; (2) adapt to impacts of climate change; and (3) reduce GGE emissions where possible. This, however, does not imply that a technology has to satisfy all three objectives to be climate-smart. A technology is also classified as climate-smart when it can result in increased productivity and lead to adaptation. A conceptual framework of climate-smart agriculture is presented in Figure 12.

6.2 THE COMMON AND PROMISING CLIMATE-SMART AGRICULTURE OPPORTUNITIES IN THE AFRICAN SIDS

In this section, existing climate-smart technologies and practices that have been identified by the climate-smart agriculture country profiles of Cabo Verde, Guinea-Bissau and Seychelles, developed by FAO and ICRISAT (2019a, 2019b, 2019c), will be discussed. The climate-smart agriculture technologies identified in the country profiles are summarized in Table 2.

One of the limitations of the climate-smart agriculture country profiles is the low emphasis on fisheries and aquaculture, which may be due to a myriad of reasons, including methodology used in the data collection and stakeholder analysis, as some countries have different ministries for agriculture and fisheries.

The country profiles considered a technology as being climate-smart if it enhanced food security as well as met at least one of the objectives of climate-smart agriculture in terms of adaptation and/or mitigation. From the various technologies identified in the country profiles, a technology is tagged as promising when it appears in two or all three of the SIDS under consideration.

The SIDS show a common trend with the climate-smart agriculture technologies and also have technologies which are country-specific. Research suggests that women have different preferences in climate-smart technologies/practices, and this should be carefully analyzed and taken into account as a critical point during project planning.

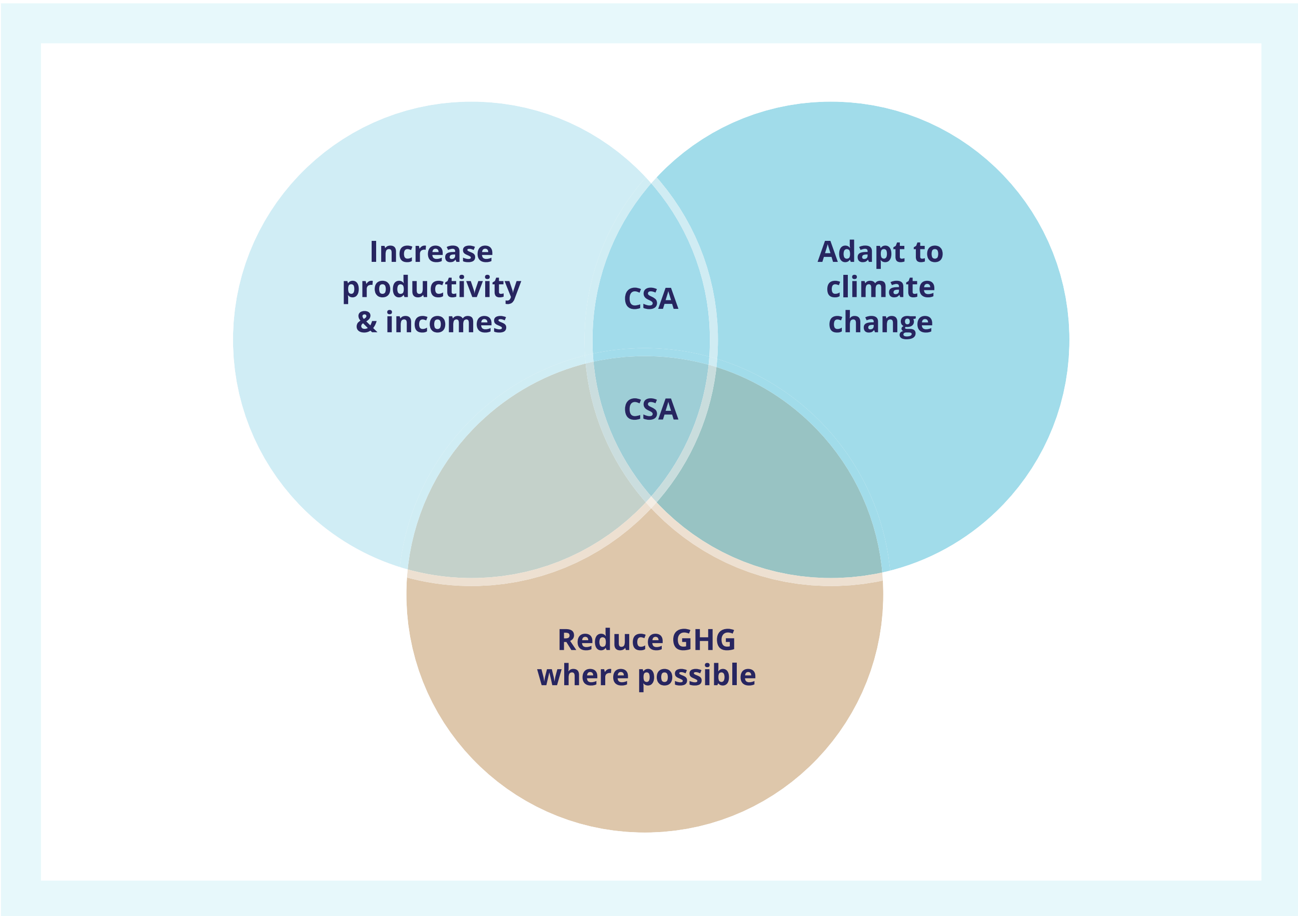

Figure 12: Conceptual framework for climate-smart agriculture

Table 2: Climate-smart agriculture technologies identified in the climate-smart agriculture country profiles

Climate-smart agriculture technology	Cabo Verde	Guinea-Bissau	Seychelles	Promising technology[3]
Anti-erosion arrangement	★	★	★	★
Conservation agriculture			★	
Crop association	★			
Crop production under shade houses			★	
Crop rotation		★		
Farm mechanization				
Forage/fodder production	★	★		★
Improved animal breeding infrastructure			★	
Integrated crop-livestock system	★		★	★
Improved drainage			★	
Intercropping			★	
Integrated pest and disease management (IPM)	★	★	★	★
Local and scientific knowledge in animal breeding			★	
Rainwater harvesting		★	★	★
Soil and water conservation (SWC) techniques	★			
Use of organic manure and mulch		★	★	★
Use of weather information	★	★	★	★
Use of climate adapted/improved seeds or breeds	★		★	★
Water use efficiency and control through innovative irrigation technique (drip irrigation, fertigation, solar powered irrigation system)	★	★	★	★
Wind break and shelter	★		★	★

3 Promising technology is a technology that is identified in two or all of the three SIDS under consideration.

6.3 PROMISING CLIMATE-SMART AGRICULTURE PRACTICES AND TECHNOLOGIES

The promising practices identified are anti-erosion arrangement, integrated pest and disease management (IPM), use of weather information and water control through irrigation. A comparison between Cabo Verde and Seychelles also indicates some common technologies; integrated crop-livestock system, use of climate adapted/improved seeds or breeds and use of wind break and shelter. In the subsequent paragraphs, the technologies will be elaborated on.

Anti-erosion arrangement: Various anti-erosion arrangements that reduce soil loss and run-off and enhance productivity and soil water recharge have been documented in the various country profiles. Among the common practices in the SIDS are contour ridges and vegetation barriers such as planting of vetiver grass at the upper or outer areas of farms and drains.

Forage/fodder production: The manipulation of diet through the utilization of high-quality forages and changing of carbohydrate composition are among the most effective approach to reduce methane emissions from ruminants. Fodder management is also very important during droughts. For instance, in the eastern agroecological zone of Guinea-Bissau, forage plants such as the Brachiaria sp., are used to improve the diets of livestock during fodder scarcity and intense drought.

Integrated crop-livestock system: This is an important approach that reduces risks related to losses due to climate change through income and food diversification while providing other benefits that can range from organic fertilizer to biogas for farm utilization. Other benefits of silvopastoral systems are: enhancement of carbon storage, improvement of cattle diet with complementary tree by-products, soil fertility improvement and weeding.

Integrated pest and disease management: Climate change continuously results in the change in distribution and aggressiveness of agricultural pest and diseases. Integrated pest management is a practice that improves production through the prevention of losses due to pest and diseases by employing natural methods such as biological control, the use of natural enemies of pests, and smaller quantities of pesticides used only as a last resort. This is a key topic for participatory management approaches, aiming to develop early warning systems to prevent the spread of pests, as well as to strengthen farmers' capacity to implement organic and sustainable methods to constain pest population.

The country profile of Cabo Verde reports the use of natural predators and approved pesticides for IPM.

Rainwater harvesting: This is the most practical yet low-cost practice that can be carried out at different scales and complexities and can benefit from increased awareness-raising and demonstration as it can be very efficient in adapting to climate change.

Use of organic manure and mulch: The use of organic manure and mulch increases the organic matter of soil and fertility. In Guinea-Bissau, organic manure use is common in vegetable production and it is prepared from the decomposition of a mixture of plant residues, animal waste, cold ash and household waste. However, in Seychelles, organic manure particularly from poultry, pigs and cows is common in most production systems and plantations.

Use of weather information: The availability and timely dissemination of weather information is key to helping to adapt to the impacts of climate change. This must be tailored to end-user needs, as the type and frequency (daily, 10-days, monthly, seasonal) of climate information requested by each agricultural system differs. For example, services requested by the crop sector are related to the sowing date, onset or offset of the dry season, evapotranspiration rates, growing degree days, soil moisture, etc. Services requested by the livestock sector are related to fodder availability, water resource availability, transhumance corridors, potential lightning zones, etc. It is also important to consider the most effective communication means (TV, radio, SMS etc) depending of the users and location and information barriers and gaps (forecast not in local languages, ambiguity of forecasts, inequitable access, timing of forecast delivery, etc.).

Through projects such as the National Adaptation Programmes of Action in Guinea-Bissau, the capacity of the National Institute of Meteorology in collecting, processing, producing and disseminating weather information has been enhanced. Peasant pluviometers were introduced to guide farmers in observing the sowing season to prevent seed losses. In addition, there is a joint working group that collaborates with the NMI, the Ministry of Agriculture and the Ministry of Environment in disseminating agrohydrometeorological information to farmers. In Seychelles, there was some support from the World Meteorological Organization and the State Agency for Meteorology in 2000 to make climate information available to farmers. The importance of analyses of the gender digital gap during project development cannot be overemphasized in order to ensure that women have access to the early warning messages.

Use of climate adapted or improved seeds or breeds: The use of improved crop varieties and animal breeds (livestock and poultry) is on the increase with elevated temperatures, salinity and intensity of rain. In Cabo Verde and Seychelles, some farmers have adopted varieties or breeds resistant to extreme weather conditions, some of which are local and many are imported and tested by the National Agricultural Research and Development Institute and the Seychelles Agricultural Agency, for Cabo Verde and Seychelles, respectively.

Water control through irrigation: All the countries under consideration have reported some sort of irrigation system. In Cabo Verde for instance, it is estimated that about 45 percent of the total irrigated land has a solar-powered drip irrigation system for the production of high-value vegetables such as cabbage, sweet pepper, onion and sweet potatoes. In the rice fields and private farms of Guinea-Bissau, solar-powered drip irrigation systems are becoming more prominent. In Seychelles, there are three main systems of irrigation. The main technologies are the equipment of inland valley bottoms and drip irrigation for vegetable production as well as the sprinkler system that exists in the alluvial plains known for the production of vegetables, rice, pineapple and banana.

It is essential during investment projects or programmes development to analyze who has access to what type of irrigation. Research shows that this can be a main element that shapes who can adopt which types of packages or solutions, even exacerbating inequalities in some cases.

Wind break and shelter: In order to minimize destruction by strong winds and heavy rains on seedlings and crops, shade trees have been used. In Guinea-Bissau, this has predominantly been used in the production of cereals whereas in Cabo Verde and Seychelles the technology has been shown to be productive during long dry spells.

6.4 BARRIERS TO THE ADOPTION OF PROMISING CLIMATE CHANGE ADAPTATION TECHNOLOGIES

The barriers to adopting promising climate-smart agriculture technologies as assessed during the validation of the country profiles are presented in Figure 13. The barriers were identified and ranked by stakeholders during validation workshops. The ranking was done according to the level of difficulty to overcome the barrier on a scale of 1 to 5 (1 being a small barrier and 5 being an extreme barrier to overcome). The corresponding technologies are presented in brackets. Further to this, the barriers identified by stakeholders in relation to capacity development were categorized into three levels:[4] individual capacities (skills, knowledge, practices, technologies); organizations, institutions, networks (producer organizations, coordination mechanisms, etc.); and policies and investments (policies in place, aligned, financed, implemented), illustrated in Figure 14.

It should be emphasized that during climate-smart agriculture investment projects development and planning, gender-related constrains should be addressed. This includes land tenure, control over natural resources and income, access to information and decision-making, and women and men's different roles in the value chains. Furthermore, the socio-political economy should be analyzed at national and subnational levels to develop projects that are based on sound gender analyses, address the contraints and develop targeted action
to include women, youth and marginalized and vulnerable groups.

[4] Adaptation barriers categorized under three capacity development levels (individual capacities designated by *, organanizational/institutions barriers designated by ** and policies and investments barriers designated by ***).

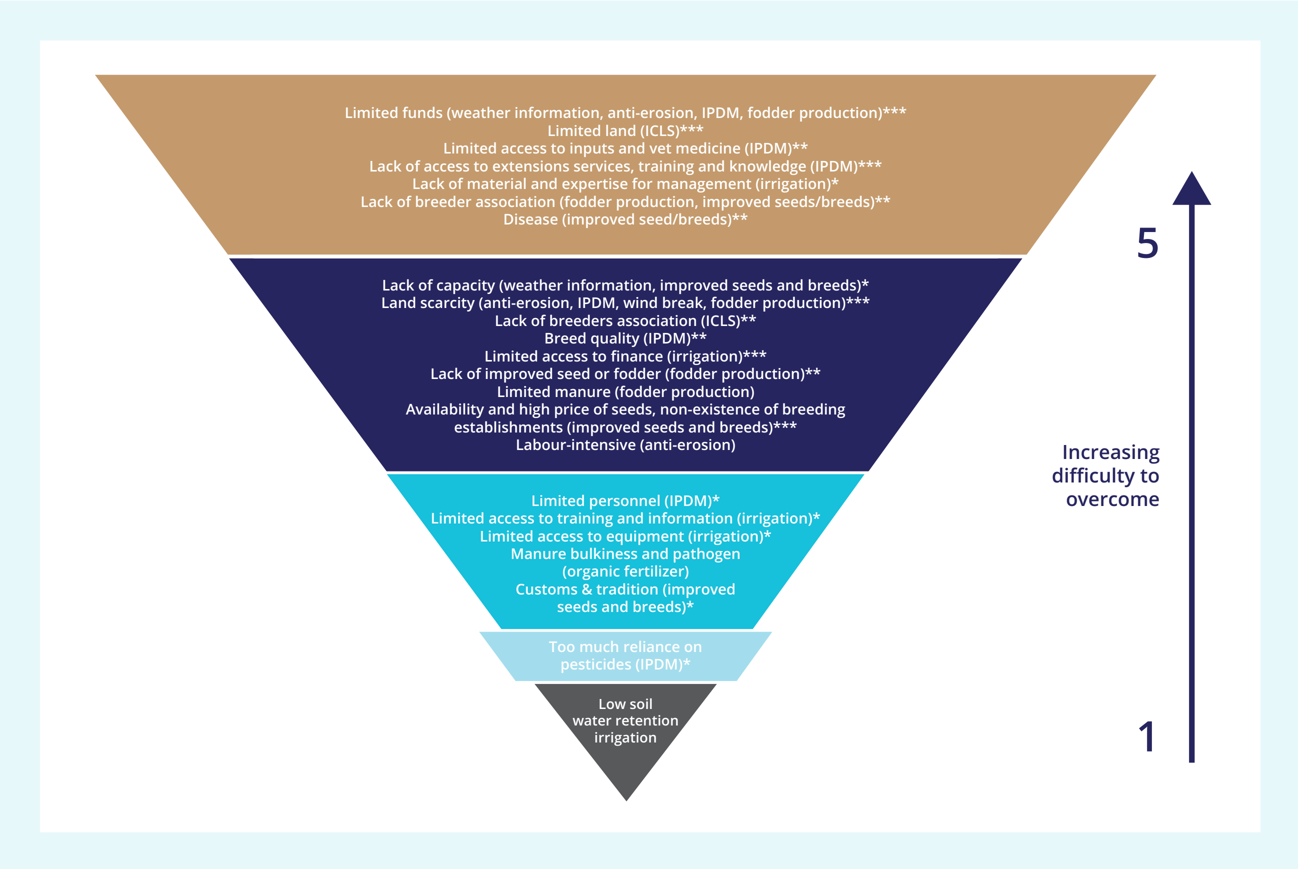

Figure 13 Barriers to adoption of promising climate-smart agriculture technologies in Cabo Verde, Guinea-Bissau and Seychelles

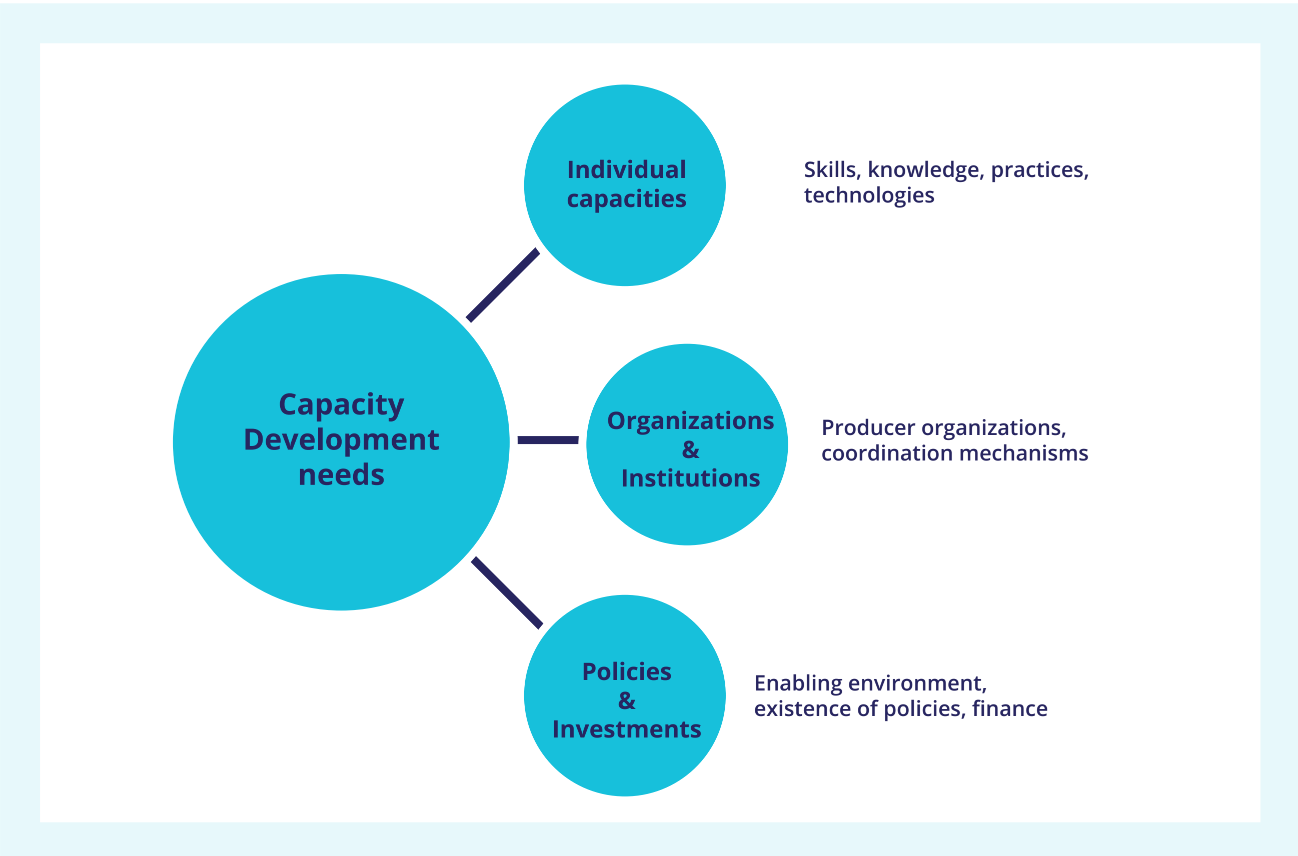

Figure 14: Capacity development needs levels

7. The way forward

Sustainable fishing with nets in the waters off Sao Pedro in Sao Vincente Island, Cabo Verde where 26.6 percent of the population lives below the poverty line and 9.4 percent is undernourished.

7.1 PRIORITY AREAS FOR CLIMATE-SMART AGRICULTURE INTERVENTIONS

Building on the country climate-smart agriculture profiles for Cabo Verde, Guinea-Bissau and Seychelles, the NDCs of the three African SIDS, as well as on other relevant technical and policy documents, some priority areas to be addressed in order to enhance adaptation and resilience of the SIDS are presented in Table 3. Also included in the table are climate change vulnerabilities, and climate smartness of promising climate-smart agriculture technologies existing in the three SIDS.

7.2 GAPS IDENTIFIED

In addition to the priority areas identified in the country profiles, other important issues have been identified during a regional stakeholders' consultation and need to be particularly considered in future investigations. In the subsequent paragraphs, the gaps identified will be elaborated upon.

Climate-smart agriculture technologies for fisheries: The climate-smart agriculture country profiles (FAO and ICRISAT, 2019a, 2019b, 2019c) made mention of fisheries although they did not discuss climate-smart agriculture practices and technologies in fisheries. For instance, the profile of Cabo Verde indicates that fisheries represent a significant source of foreign exchange. Similarly, the report for Seychelles identifies fisheries as one of pillars of the economy while the profile for Guinea-Bissau states that the coastline offers important avenues for fisheries.

Climate-smart agriculture technologies and practices for the fishery subsector include:

- Promotion of the Code of Conduct for Responsible Fisheries, e.g. ecosystem approach to fisheries and aquaculture;
- Development of sustainable aquaculture, e.g. tank aquaculture using groundwater;
- Exploration of the possibility of youth-led integrated tank aquaculture and horticulture;
- Promotion of the adoption of the international instruments, e.g the 2009 FAO Port State Measures Agreement (PSMA) and associated ones such as the Guidelines for Small-Scale Fisheries
- Promotion of the use of energy-efficient technologies in the processing of fish, e.g. the FAO Thiaroye Fish Processing Technique.

Building defence walls on a hillside to prevent erosion and ecosystem loss in Fundura on Santiago island, Cabo Verde.

Table 3: Priority climate-smart agriculture actions to address climate change vulnerabilities in Cabo Verde, Guinea-Bissau and Seychelles

VULNERABILITIES	PROJECTED IMPACT WITH CC	PROMISING CLIMATE-SMART AGRICULTURE TECHNOLOGIES EXISTING IDENTIFIED IN THE 3 SIDS	CLIMATE-SMARTNESS[5] (SCALE OF 1 TO 10)	PRIORITY CLIMATE-SMART AGRICULTURE ACTIONS/ INVESTMENTS	PRESENCE IN NDC
Epidemic (Pest and disease): direct and indirect impacts	High	Integrated pest and disease management	9.5	Increase preparedness for pest and disease outbreak (fall armyworms, desert locust)	-
				Develop a climate-smart gender-responsive food and nutrition system (African Market Garden, green house vegetable production systems, household/communal gardening/vertical farming for developing self-resilience and reliance).	-
				Strengthen domestic food security to the impacts of epidemic/pandemic.	-
Drought	High	Rainwater harvesting	ND	Encourage sustainable and efficient water resources mobilization and use solar-powered irrigation system, cisterns for rainwater harvesting.	Yes
		Use of organic mulch	6.9		
		Use of climate adapted/improved seeds or breeds	8.6	Research-based, gender-sensitive, extention service support to famers for adoption of climate-adapted seeds/ breeds.	Yes
		Water control through irrigation	7.6		
Storm	High	Wind break and shelter	ND	Provide adequate climate information services to support and capacitate producers (women and men), farmers, pastoralists and fisherfolk with updated, salient knowledge and skills for their activity management in real time.	Yes
		Use of weather information	8.1		
Flood	High	Use of weather information and best practice in sustainable management and restoration of natural ecosystems, inlcuding mangroves	8.1	Provide adequate climate information services to support and capacitate producers (women and men), farmers, pastoralists and fisherfolk with updated, salient knowledge and skills for their activity management in real time.	Yes
				Enhance the conservation, sustainable use and restoration of the coastal ecosystems to address sea-level rise, salinization, mangroves and coral reef degradation.	Yes

[5] Climate-smartness scores in relation to elements of climate-smart agriculture: yield (productivity); income, water, soil, risks (adaptation); energy, carbon and nitrogen (mitigation). Here, the scores represent the highest attained by a technology across the various production systems and the three countries. Details by production system and country are available in the country profiles. ND: No data.

Harvesting vegetables grown for nutrition, food security and income at Granja de Pessubê, Guinea-Bissau.

Mainstreaming gender into climate-smart agriculture practices: The general consensus at the regional workshop meeting held in Dakar (November 2019) was the need to mainstream gender aspects into climate-smart agriculture practices to include women, youth and marginalized groups. As men, women, youth and marginalized groups have different needs, constraints and opportunities in relation to use, access and control over resources, services and information, it is important to take this into account when designing projects and programmes so as to benefit all. Intersecting inequalities, such as gender, age disability and socio-economic status undermine people's benefits, assets, opportunities, and adaptive capacities.

In order to support women's and men's equal uptake of and benefit from site-specific climate-smart agriculture practices, gender analysis as well as equal participation and engagement of women and men are the key actions to be taken at the outset of any climate-smart agriculture intervention. In the longer term, broader changes are needed in order to reduce the constraints women and men may face in terms of accessing resources, services and information. Beyond climate-smart agriculture practices themselves, the institutions involved in climate change adaptation and mitigation will need to partner with women's community-based organizations to go beyond a focus on agricultural productivity and support income-generation, access to savings and loans, nutrition and health services. This could also be a means for tapping into women's potential as effective innovators capable of identifying and designing new technologies – and adapting existing ones – to meet their needs (Huyer *et al.*, 2015; Waters-Bayers *et al.*, 2015). Lastly, more knowledge is needed on how

gender roles shape women's and men's lives in engaging with climate-smart agriculture. Often women groups and youths are encouraged to invest in aquaculture and vegetable gardening, drying and processing of vegetables, spices and fish, which are affected by climate change. Investment in solar dryers or solar-powered dryers are often above the investment capacities of individuals and organizational capacity, for scale-up processing and marketing is often low and needs to be strengthened.

Information on existing resources on islands: All the SIDS under consideration have various islands, and there is a need to map out all resources on these islands. This will allow for comprehensive understanding of opportunities and constraints to increase the adaptation of climate-smart agriculture practices as well as to promote new practices and technologies.

Post-harvest climate-smart agriculture practices: Another gap that was identified is the need for post-harvest technologies to be introduced to enhance conservation of perishable food items. Post-harvest losses have significant negative impacts on food and nutrition security, natural resources, economy and environment, such as reduced food availability, increased food safety risks; waste of scarce resources (water, land, energy); loss of market opportunities; and negative environmental impact.

In the framework of responses to the COVID-19 pandemic, FAO highlighted the importance of reducing post-harvest losses for small-scale producers, which are likely to substantially increase due to limitations in storage facilities, transport and access to markets. This is particularly true in the African SIDS, where no sustainable transformation of agriculture can be achieved without reducing post-harvest losses along food supply chains. Socio-cultural and gender relations are significant underlying reasons for food value chain inefficiencies, which in turn directly cause food loss (FAO 2018a, 2018b). Applying a gender lens to the analysis of food loss is critical to the successful adoption of post-harvest climate-smart agriculture pratices.

Therefore, promoting climate-smart gender-sensitive food storage and processing technologies, preferably powered by renewable energy at different stages of the food supply chains that prevent and reduce post-harvest losses, are key towards transforming agriculture in African SIDS.

This would require the following actions:

- Policy measures conducive to prevent and reduce post-harvest losses, including an enabling environment for the private sector to invest in synergy or complementarity with the public sector, is key to achieving this goal.
- Promotion of women's equitable economic participation in sustainable agrifood chains in sectors such as fisheries, where smoking and salting of fish are predominantly undertaken by women;
- Awareness-raising on the issue of post-harvest losses (decision-makers, among industries, retailers and consumers, including in the education sector), coordination between actors in the supply chains, as well as regulatory measures that address issues;
- Capacity development of human resource and institutions to identify causes, measure post-harvest losses, design and implement cost effective solutions to post-harvest losses prevention and reduction;
- Improving infrastructure for well-functioning and efficient food systems, including market infrastructure, energy production, storage, small-scale processing and conservation (including cooling) of fruits, vegetables, fish, milk and meat products as well as non-timber forest products.

Integration of renewable energy options in agrifood systems: In order to make agrifood systems more resilient to climate change and weather shocks, stable access to energy needs to be supported so that production can be stabilized. Furthermore, moving out of fossil fuels and into renewable energy solutions can assist Cabo Verde, Guinea-Bissau and Seychelles meet their NDC targets, energy access and renewable energy targets and strengthen their overall sustainability and resilience to climate change shocks.

Additionally, availability of and access to energy is an enabling factor needed to implement identified climate-smart agriculture technologies. Energy in different forms is needed at all stages of the value chain. Deploying renewable energy across the food value chain can help mitigate GGE emissions while increasing production, availability and utilization of food. Substitution of diesel water pumps for solar water pumping, for instance, can help increase yields of crops while at the same time reduce GGE emissions.

Integrate nutrition-sensitive and climate-smart objectives into policy and practice: Nutrition has an impact on GGE emissions due to actions such as dietary choices, industrialization in agrifood coupled with global trends such as rapid urbanization. In order to highlight nutrition in climate-smart agriculture, it is important to emphasis the following:

- Promote gender-sensitive climate-smart agriculture practices that impact nutrition such as agroforestry, crop association, integrated crop management, use of improved varieties, crop rotation and intercropping.
- Constitute food reserves for the dry season.
- Utilize a wide range of local agrifood products (cereals, pulses, nuts, fish, meat, fruits and vegetables).
- Mention nutrient content for selected food products with high nutritional value interest.
- Integrate nutrition outcome under climate-smart agriculture pillars "productivity".
- Promote climate-smart agriculture practices that can preserve or add value to agrifood products, reduces PHL of agrifood products and valorize by-products for nutrition.

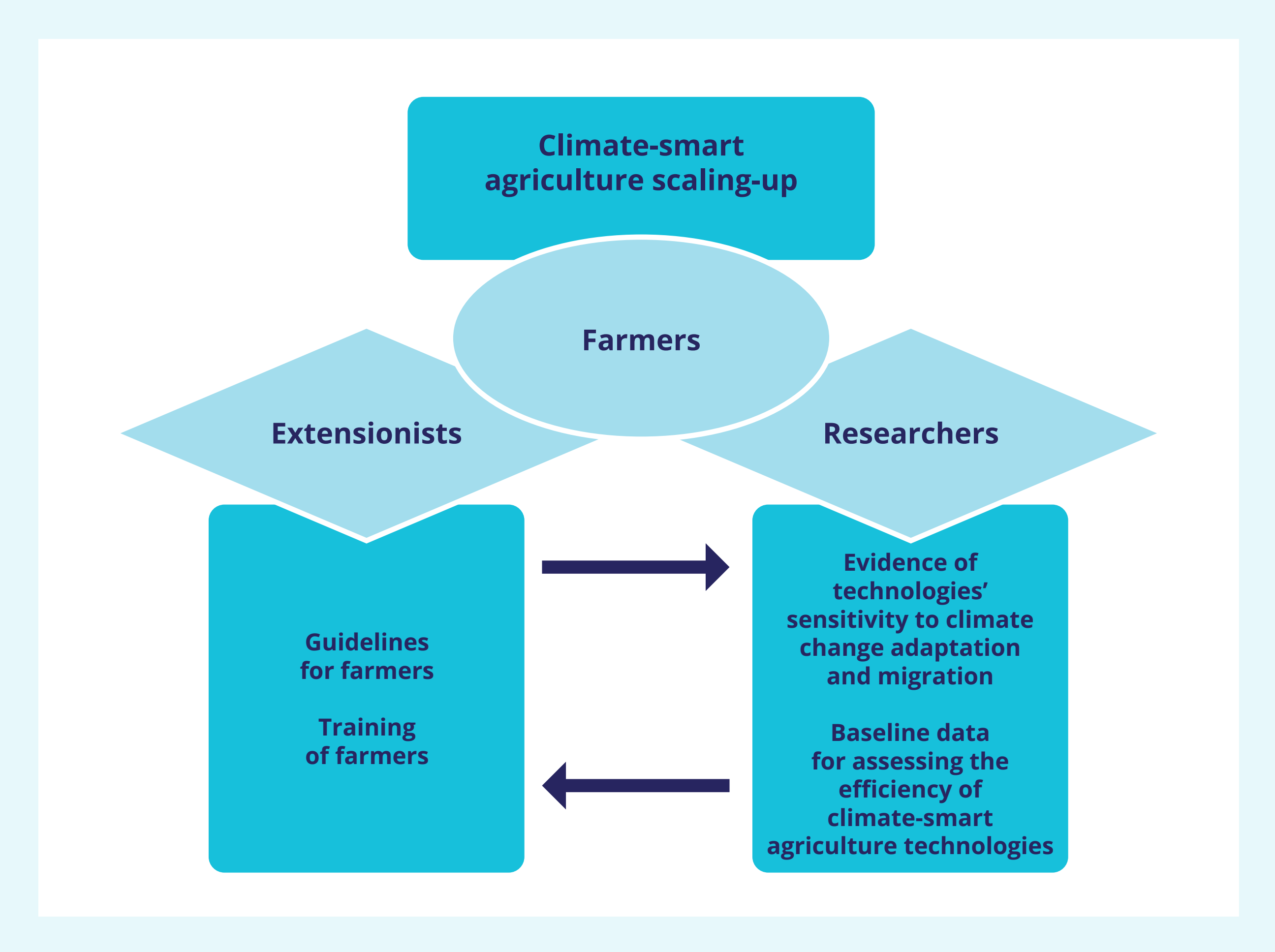

Figure 15: Farmers-extensionists-researchers synergy in climate-smart agriculture scaling-up

There is a need for **a system-wide capacity development approach** that empowers people, strengthens organizations, institutions and networks as well as fosters more resilience to climate change and weather shocks. Furthermore, stable access to energy needs to be supported so that production can be stabilized. This needs to occur so that energy, food and natural resources focused efforts are integrated across the sectors, thus enabling the implementation of the NDCs in Cabo Verde, Guinea-Bissau and Seychelles' policy environment to achieve desired transformation, sustainability and scale. Based on good climate-smart agriculture capacity-enhancement practices and tools, (examples can be found in FAO 2017), practical steps may include conducting participatory capacity needs analysis, defining contextualized capacity development strategies and rigourously tracking progress and results. One particuraly important element of a comprehensive capacity-enhancement approach consists of consolidated farmers-extension-researchers collaboration and synergy actions for scaling up climate-smart agriculture.

The findings in the country climate-smart agriculture profiles (FAO and ICRISAT, 2019a, 2019b, 2919c) clearly indicate that many good technologies are available. These technologies are either sparsely practiced or ignored because of lack of awareness and training, lack of synergy and collaboration between the research organizations, extension services and farmers. As shown in Figure 15, climate-smart agriculture adoption by farmers is subject to availability of evidence-based technologies and adequate support of extension services that can provide trainings and technical support in the field. National authorities should therefore pay special attention to the existence and operationalization of an adequate farmers-extensionists-researchers synergy to support the programmes on climate-smart agriculture scaling up.

There is also a need to consolidate collaboration between different stakeholders through platforms to catalyze and help create transformational partnerships to encourage actions that reflect an integrated approach to the three pillars of climate-smart agriculture.

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