STAPLE CROPS PROCESSING ZONEs (SCPZs): Promoting Sustainable Agricultural Value Chains.




Feasibility Studies for Togo, Senegal and Guinea: A Synthesis.

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Abbreviations and Acronyms

PATAG-EAJ	Transformation of Guinean Agriculture and Youth Agricultural Entrepreneurship
ACT	Agricultural Transformation Centers
ADAZZ	Authority for the Development and Administration of Special Economic and Industrial Zones
ADF	African Development Fund
AfDB	African Development Bank
AFOLUC	Agriculture, Forestry and Land Use Changes
AGET	Association of Large Enterprises of Togo
ANGE	Togo National Environmental Management Agency
APA	Advanced Procurement Action
APH	Agro-Processing Hub
APIP	Private Investment Promotion Agency
API-ZF	Investment Promotion Agency of Togo
APRODAT	Agency for the Promotion and Development of Agropoles in Togo
ATA	Agricultural Transformation Agency
AV	Added Value
BOAD	West African Development Bank
BoI	Bureaus of Industry
BPS	Borrower Procurement System
BWP	the Big Win Philanthropy
CC	Climate Change
CCIT	Chamber of Commerce and Industry of Togo
CDAP	Capacity Development Action Plan
CDF	Code Foncier et Domanial
CEDAW	United Nations Convention on the Elimination of All Forms of Discrimination against Women
CET	Common External Tariff
CNP	National Council of Employers
COS	Steering and Monitoring Committee
CSP	Country Strategy Paper
DG	Directorate-General
DIDS	Drip Irrigation Distribution Systems
DIT	Drip Irrigation Technology

EAS	Early Acquisition Shares
ECOWAS	Economic Community of West African States
EESS	Social and Strategic Environmental Assessment
EIA	Environmental Impact Assessment
ERR	Economic Rate of Return
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management Master Plan
ESMP	Environmental and Social Management Plan
EU	European Union
EVD	Ebola Virus Disease
FBA	Farmer Based Association
FDI	Foreign Direct Investment
FM	Financial Management
GDP	Gross Domestic Product
GEI	Gender Equality Index
GHGs	Greenhouse Gases
GNF	New Guinean Franc
GoG	Government of Guinea
GoS	Government of Senegal
GoT	Government of Togo
GOS	Gross Operating Surplus
GPHC	General Population and Housing Census in Guinea
HDR	Human Development Report
HIPC	Heavily Indebted Poor Countries
IAIPA	Integrated Agro-Industrial Park Agency
IAIPs	Integrated Agro-Industrial Parks
IBRD	International Bank for Reconstruction and Development
IMF	International Monetary Fund
INDC	Intended Nationally Determined Contribution
IPDCs	Integrated Agro-Industrial Park Development Corporations
IRAG	Guinean Institute for Agricultural Research
IRR	Internal Rate of Return
ISS	Integrated Safeguards System
JSC	Joint Steering Committee

LUCF	Land Use Changes and Forestry
MCA	Millennium Challenge Account
MMCE	Ministère des Mines, des Carrières et de l'Énergie (Ministry of Mines, Quarries, and Energy)
MoA	Ministry of Agriculture
MoF	Ministry of Finance
MOTIN	Ministry of Trade and Industry
MRA	Ministère des RessourcesAnimales (Ministry of Animal Resources)
MRSIT	Ministère de la Recherche Scientifique et de l'InnovationTechnologique (Ministry of Scientific Research and Technological Innovation)
MT	Ministère des transports (Ministry of Transport)
NAPA	National Adaptation Programmes of Action
NOS	Net Operating Surplus before Taxes
PADEC	Casamance Economic Development Support Program
PAR	Project Appraisal Report
PIU	Project Implementation Unit
PMPs	Procurement Methods and Procedures (PMPs)
PMU	Programme Management Unit
PNDA	National Agricultural Development Policy
PNDES	Plan for Economic and Social Development
PNIASAN	National Agricultural Investment, Food and Nutrition Security Plan
PNS	Action Plan for Nutrition and Health
PPIP	Portfolio Performance Improvement Plan
PPP	Public-private Partnership
PRACAS	Programme to Accelerate the Pace of Senegalese Agriculture in Senegal
PRCA	Procurement Risk and Capacity Assessment
PSC	Programme Steering Committee
RAP	Resettlement Action Plan
REDD	Reducing Emissions from Deforestation and Forest Degradation
RMCs	Regional Member Countries
RTC	Rural Transformation Centre
SCBDs	Standard Competitive Bidding Documents
SCPZs	Staple Crops Processing Zones
SESA	Strategic Environmental and Social Assessment

SSA	Sub-Saharan Africa
TF	Task Force
TSF	Transition Support Facility
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
WAEMU	West African Economic and Monetary Union
WB	World Bank

EXECUTIVE SUMMARY

The Governments of Togo, Senegal and Guinea have requested the support of the African Development Bank (AfDB) to implement the Staple Crops Processing Zones (SCPZs) Program as part of the 'Flagship' of the AfDB under its 'Feed Africa' Agenda. The goal of the entire SCPZs program in Africa is to: (i) increase food production capacity and efficiency by promoting amongst others, the use of climate resilient practices and technologies adoption; (ii) enhance value addition to agriculture; (iii) promote local, regional and international trade; (iv) promote investments in agribusiness; and, (v) increase the contribution of the agriculture sector to Gross Domestic Product (GDP), wealth and employment creation. The initial focus of the SCPZs program is on 18 priority commodities across the five agro-ecological zones of Africa considered important in these zones with set targets of raising Africa's 2015 food production by an estimated 174 million metrics. The first phase of the program is now ongoing in three Regional Member Countries (RMCs) at the request of these countries (**Togo, Senegal and Guinea**). The **next phase**s of the SCPZs program are replication and out-scaling in other RMCs requesting the interventions of AfDB.

However, prior to the program take off in the three initial pilot countries, a pre-feasibility study was carried out to assess several preparatory and readiness measures in place in the concerned countries. This report provides a summary of the major findings. The synthesis report of the three countries does so many things. First, it provides a general overview of SCPZs program and the three phases involved in the program. Second, it provides a succinct overview of the socioeconomic, environmental, political, financial, and external profiles of these countries over the last 10 years and projections for the next 5 years. This was important to set the context for the possible sustainability of the program. Next, the program context in each country is presented to give the reader an overview of the contextual underpinnings of the program in each country (Chapter 3). In Chapter four, the initial baseline program is presented including gaps identified in the initial program design that warrant additional interventions with climate rationale. These new interventions are taken up in chapter 5. They are mainly considered a '**catalyst**' in the SCPZs program aimed at '**triggering**' a **paradigm shift towards low-emission, climate-resilient measures** along the agricultural value chains in these countries: an aspect probably overlooked or missed in the initial program design.

Next, the linkages between the integrated components are highlighted in a program 'Theory of Change' (ToC), with the following expected outcomes: 1) a direct reduction of at least 512,752 tCO_2e from Solar PV, feedstock bio-digestion and Biogas replacement of diesel and about 197,000 tCO_2e indirectly from the adoption of CRA and agroforestry practices annually; 2) a direct reduction of at least 12,223,843 tCO_2e from Solar PV, feedstock bio-digestion and Biogas replacement of diesel and about 3,940,000tCO_2e indirectly from the adoption of CRA and agroforestry practices during project lifespan; 3) about 10.49 million males and females directly and indirectly benefiting from the adoption of climate resilient livelihood options including over 39,178 ha of land made more resilient to climate change; 6) construction 10 regional modules (APHs) and over 40 agricultural transformation centres (ATCs), including over 148 km new access roads resilient to extreme weather events as well as the rehabilitation of 472 km of roads to be climate-resilient; 7) improved water availability and efficient water supply for crop production and processing by providing; (i) Over 15,000 cubic meters/day from efficient and portable water supply systems, 8 new climate resilient boreholes and rehabilitation of 30 old boreholes, and 3 mini-dams with reduced sedimentation, flood control mechanisms, and reduced maintenance requirements and economic life; and (ii)14.69 MW solar for processing, drying, storage and pumping to improve irrigation efficiency up to 90%, labour, energy and water savings of up to 30%, and reduction in post-harvest losses of about 20% especially for market gardening and cereal crops; 8) over 15% increase in agricultural profit for growing horticulture practices especially in the dry season benefiting at least 2 million women directly and over 20 million indirectly; 9) Deployment of technologies to strengthen climate information services and early warning systems in all the SCPZs

In chapter seven, the economic and financial viability of the program is taken up, starting first with the program cost distribution by components. This is followed by a detailed cost/benefit analysis of the program considering all program interventions. Chapter eight discusses the expected program effects ranging from socioeconomic, environmental to other cross-cutting issues such as resettlement plans and gender considerations among others, in the target communities of the three countries. Chapter 9 takes up the potential risks associated with the program and possible risks mitigation measures. In chapter 10, the program logical framework model is presented followed by accompanying annexes to support anecdotal evidences.

1. INTRODUCTION

1.1. Programme Context and Justification

The economies and livelihoods in many African nations are highly dependent on agriculture. This is so because, majority of Africans live in the rural areas, making agriculture the main source of their livelihood. It is estimated that as much as 60% to 70% of Africans derived their incomes from agricultural related activities. Agriculture can be a source of growth for the national economy, a provider of investment opportunities for the private sector, and a prime driver of agriculture-related industries and the rural non-farm economy. Two-thirds of the world's agricultural value added is created in developing countries. In agriculture-based countries, it generates on average 29 percent of the gross domestic product (GDP) and employs over 65 percent of the labour force[1].

Agricultural production is particularly critical in several dozen African countries, with highly variable domestic production, limited access to finances, dislocation from markets and tradability of food staples, poor access to inputs, lack of advisory services and information, poor infrastructure (for example, irrigation or rural roads), and foreign exchange constraints in meeting their food needs through imports. Many of these countries are exposed to recurrent food emergencies and the uncertainty of food aid, and for these countries, increasing and stabilizing domestic production is essential for food security. Unfortunately, the agricultural systems in these countries are still largely in a subsistence stage, which is a highly risky and uncertain venture, especially because human lives are at stake. In regions where farms are extremely small and cultivation is dependent on the uncertainties of variable rainfall, average output is low, and in poor years, the peasant family is exposed to the very real danger of starvation. In such circumstances, the main Motivating force in the peasant's life may be the maximization not of income but of the family's chances of survival.

Moreover, climate change and its variability are becoming a real threat for most of the rural people in Africa. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007)[2], suggests that the African continent, which has contributed least to global warming, will be drastically affected by climate change. The main findings are that between 75 and 250 million people will suffer the consequences of increased water stress by 2020. By the same date, productive outputs from rainfed agriculture could drop by 50 percent with obvious negative consequences for food security. Thus, climate change is adding to the risk portfolio of farmers, particularly in developing countries.

Many initiatives that wish to raise agricultural productivity among smallholder farmers in Africa and elsewhere have suffered through failure to strengthen the agricultural value chains. The expectation that something bad may happen either at the production or post-harvest stages, affects farmers behaviour, causing them to avoid expending effort on risky activities, or putting their money into irreversible investments. Given the harmful effects of the risks associated with subsistence farming in Africa, innovations that reduce the adverse consequences of shocks across the entire agricultural value chains would seem to hold considerable welfare benefits for African farmers, in general. Among such innovations are ***Staple Crops Processing Zones*** (SCPZs) ***Programmes*** or **Agropoles, Agro-clusters**, **Agro-Industrial Parks and Agribusiness Parks** among others.

Staple Crops Processing Zones (SCPZs) are agro-based spatial development initiatives designed to concentrate agro-processing activities within areas of high agricultural potential to boost **productivity** and integrate **production, processing and marketing** of selected commodities. They are purposely built shared facilities, to enable agricultural producers, processors,

[1] Todaro, M.P., and Smith, S.C. (2012), *Economic Development*. 11th edition: Pearson Education, Inc.

[2] Intergovernmental Panel on Climate Change *(IPCC, 2007), Climate Change 2007: Synthesis Report.* Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate, Geneva, Switzerland.

aggregators and distributors to operate in the same vicinity to reduce transaction costs and share business development services for increased productivity and competitiveness. By bringing adequate infrastructure (energy, water, roads, ICT) to rural areas of high agricultural potential, they attract investments from private agro-industrialists/entrepreneurs to contribute to the economic and social development of rural areas[3].

The SCPZs programme is being widely promoted by African governments, with financial and technical support from regional and multilateral organizations, such as the African Development Bank (AfDB), the United Nations Industrial Development Organization (UNIDO) and the World Bank. For example, it is now a flagship programme under the AfDB's "Feed Africa" Agenda with the ultimate goal of transforming the African agricultural landscape towards commercial agriculture within 10 years (2016–2025). Central to the agenda is to modernize and revitalize the food sector in Africa, while simultaneously reinvigorating strategies that would boost agricultural productivity and keeping GHGs low. The initial focus of the SCPZs is on 18 priority commodities across the five agro-ecological zones of Africa with set targets of raising Africa's 2015 food production by an estimated 174 million metrics (Table 1).

[3] AfDB (2016): Feed Africa- Strategy for Agricultural Transformation in Africa 2016-2025 | African Development Bank - Building today, a better Africa tomorrow (afdb.org)

Table 1. Total African supply and demand of key commodities in 2015

(Projected demand for 2025 and additional production to reach self-sufficiency)

Commodity	Supply 2015	Demand 2015	Demand 2025	Additional production to reach self-sufficiency
	---------- x 1000 metric tons ----------			
Rice	17,477	26,047	34,925	17,448
Cassava	137,765	137,937	167,873	30,108
Sorghum	32,142	32,018	42,370	10,228
Millet	21,323	20,877	27,179	5,856
Cowpea	5,928	5,669	7,521	1,593
Beef	7,332	7,545	11,138	3,806
Maize	58,863	78,529	103,417	44,554
Soybean	1,428	2,797	3,531	2,103
Milk (dairy)	41,725	51,598	64,165	22,440
Poultry	4,595	5,420	7,725	3,130
Cocoa	3,272	632	902	-2,370
Coffee	981	741	1,035	54
Vegetables	44,500	48,491	68,691	24,191
Wheat	23,707	24,645	32,419	8,712
Fish	1,485	2,706	3,545	2,060
Total	**402,524**	**445,652**	**576,436**	**173,912**

Source: AfDB 2016

1.2. Programme Objectives

The broad objective of the SCPZs programme is to turn the African rural landscape into economic zones of prosperity thereby, lifting millions of Africans out of poverty. More specifically, the programme aims to: (i) increase food production capacity and efficiency by promoting amongst others, the use of climate resilient agriculture (CRA) practices and technologies adoption; (ii) increase value addition to agriculture while simultaneously reducing GHG emissions; (iii) promote local, regional and international trade; (iv) promoting investments in agribusiness; and (v) increase the contribution of the agriculture sector to GDP, wealth and employment creation.

Programme Phases

The programme has three phases:

Phase 1: studies of the preliminary evaluation of the SCPZ programme in Regional Member Countries (RMCs) that have requested AfDB's interventions, together with detailed programme evaluation reports assessing the technical viability of the programme in the countries of intervention;

Phase 2: implementation of the pilot SCPZs programme in appraised countries identified in phase 1 (Togo, Senegal and Guinea); and,

Phase 3: replication and out-scaling of the SCPZs programme in other RMCs requesting for AfDB's interventions.

2. BACKGROUND INFORMATION ON SCPZs PILOT COUNTRIES

2.1. General Contexts of the Pilot Countries: Synthesis Reports from Countries Strategy Papers (CSPs)

2.1.1. Togo4

Political Outlook: The Togolese President was re-elected for a third 5-year term in the 25 May 2015 presidential election. Intensified dialogue between the ruling party and the opposition helped to calm the political climate. This relative political stability was conducive to implementing an economic recovery policy and public service reforms, as well as improving the country's transport network. Since mid-August 2017, the upsurge in demonstrations - sometimes marked by violence - to limit the number of presidential terms has aggravated political tensions. Political crisis is an important fragility factor in implementing the country's development policies as it exerts a significant constraint on economic activities, resource mobilization, public procurement and related expenditures, redistribution and social protection reforms and policies.

Economic Outlook: There have been no significant structural changes in the transformation of the Togolese economy during the last five years. The economy continued to be dominated by agriculture (47% of GDP). The share of value added of extractive industries in GDP remains modest (3.3% and 3% of GDP in 2016 and 2017 respectively). Driven by investment in infrastructure and good agricultural performance, GDP grew at an average of 5% per year from 2012, but posted a net decline in 2017 to 4.4% and 5% in 2018 well below the projected estimates for these years (5.5 and 6.1% respectively). The two main causes are the 46% drop in public investment expenditure to avoid over-indebtedness, and the resurgence of political tensions in the country since August 2017, disrupting economic activities, with a negative impact on businesses. Significant investment expenditure on transport and energy infrastructure between 2012 and 2016 increased the State's debt ratio from 47% of GDP in 2012 to 82% of GDP in 2016, above the maximum threshold of 70% of GDP agreed under WAEMU Guidelines. The programme concluded with the IMF in 2017 (2017-2019) aims to reduce the debt ratio from 82% of GDP in 2016 to 71% of GDP in 2019, by stopping non-concessional external financing and realigning the budget on expenditure to reduce the deficit. This situation led the government to place emphasis on investment prioritization, which helped to reduce the primary balance from -7.2% of GDP in 2016 to -0.3% in 2017. More specifically, the most recent analysis of debt sustainability conducted by the IMF and the Togolese authorities indicates that the debt is sustainable and the risk of unsustainability is moderate. The current account deficit of the balance of payments improved in 2017 from 9.9% to 8.7% of GDP. This is attributable to the trade balance (CFAF 11.4 billion, 0.42% of GDP) and the balance of both primary (CFAF 19.2 billion, 0.47% of GDP) and secondary revenue (CFAF 3.6 billion, 0.13 of GDP).

Macroeconomic Outlook: Growth is projected at 4.7% in 2018, 5% in 2019, and 5.3% in 2020, based on assumptions that the political crisis would be resolved and that public and private investment would resume. In line with the anticipated recovery in activity and investment, the budget deficit was projected to increase to 4.3% of GDP in 2018, before falling to 0.9% of GDP in 2019. The current account balance is also expected to continue improving (-7.6% and -5.3% of GDP), driven by robust exports (phosphates, clinker, cotton).

Governance: The Government has successfully initiated a structural governance reforms package, supported by an IMF Programme as well as partners' budget and institutional support (the AfDB, the World Bank -WB and the European Union -EU). The Government has launched a major programme for revenue expansion and public expenditure efficiency, including the removal of exemptions and a public procurement review process. The main reforms concern, among others: the implementation of a new public finance management plan, including the

[4] Synthesised from Togo Country Strategy Paper (2016-2020) available at: Togo - 2016-2020 Country Strategy Paper | African Development Bank - Building today, a better Africa tomorrow (afdb.org)

establishment of the fiscal policy unit; the conclusion of a 2017-2019 macro-economic programme with the IMF backed by budget support from the AfDB, the WB and the EU; the creation of a business climate unit, spearheaded at the highest level of State, dedicated to enhanced follow-up on improving business environment performance indicators; adoption of the new Customs Code, the Land Code, **the National Strategy for Agropoles (with the creation of a dedicated agency)**, the establishment of a "Front-Middle-Back-Office" organization within the Public Debt Directorate, and the start of a process of re-profiling Togo’s domestic debt to sustainably reduce debt service; and the Public Investments Planning, Selection and Programming Manual. These actions have enhanced the governance reform agenda, resulting in improved fiscal and governance indicators. After falling to -9.6% of GDP in 2016, the budget deficit stood at 4.8% of GDP in 2017, and reach 4.6% of GDP in 2018. This takes account of the improved primary balance (due to expenditure adjustment), which went from a deficit of 4% to a surplus of 1%, despite the decline in revenue collection resulting from the economic slowdown induced by socio-political tensions. These dynamics are reflected in the improvement of the Mo Ibrahim Foundation's governance indicators that pushed Togo from 33rd position in 2016 to 26th in 2017, out of 54 countries.

Private Sector and Business Environment: The Chamber of Commerce has registered about 28,000 companies between 2016 and 2018, including 9,913 in 2016, 8,199 in 2017, and 7,187 in 2018. With backing from partners, mainly the Millennium Challenge Account (MCA) and the EU, data collection operations are under way for the redesign of databases and a business census. The main stakeholders are the authorities, Chambers of Commerce, Association of Large Enterprises of Togo (AGET), which brings together companies in the industrial sector (agri-food and industrial products) and services (banks, insurance, control companies, hotels, transit and logistics, port handling). The small size of the entrepreneurial fabric places most of the tax burden on large companies. Togo has moved up 19 positions under the "Doing Business 2019" classification, leaping from the 156th to 137th position. The most significant improvement this year is the country being ranked among the ten economies that have best improved their regulatory framework in the world during the year. The reforms that have led to this improvement include starting a business, dealing with construction permits, getting electricity, registering property, and enforcing contracts. A 2017 survey of 912 companies by the Togolese Chamber of Commerce and Industry shows that 82.8% of them have recently reported a decline in results since the beginning of the crisis. A Business Climate Unit was created in 2017 with the objective of establishing optimal conditions for implementing strategic economic reforms. The Investment ProMOTINon Agency (API-ZF) created in 2017 is not yet operational, but its reporting and approval expertise is provided by the Ministry of the Economy and Finance.

Financial Sector Outlook: Togo's financial system comprises 15 banking institutions, 76 decentralized financial institutions (DFIs), 12 insurance companies, 2 pension funds, 2 financial management and intermediation companies, and a Stock Exchange Branch. The State’s withdrawal from the capital of the two public banks - *Union Togolaise de Banques (*UTB) and *Banque Togolaise du Commerce et de l’Industrie*(BTCI), which began in 2010, advanced in 2017, as the government authorized the strategic merger of both banks in March 2017. The application for the new structure's approval is in progress. The banking sector has been more open to competition over the past two years, with their total capital at CFAF 111.7 billion end-2017, up 5%. The sector is held by non-nationals (62.2%), national private individuals (17.6%) and the State (20.2%). According to available information, Togo's bank coverage rate in 2015 was 19.6%, ranking it second among WAEMU countries after Côte d'Ivoire with 20.4%.

Infrastructure: Total infrastructure investments planned in the budget between 2012 and 2017 amounted to about CFAF 1043 billion. Transport infrastructure accounts for 88.5% of total investment, followed by water and sanitation for 5.23%, internet and telecommunications for 4.01%, and energy for 2.15%. Road infrastructure was largely financed over this period by the State, through a pre-financing mechanism for investments, with the State acting as guarantor for construction companies that accessed bank credit to finance the investments. The Togolese national road network was estimated at 11,875 km in 2011, of which only 52.2% was in good condition. According to available data, from 2011 to 2016, the total length of paved national roads (RNR), which represented 14.9% of the total national road network, increased from 1,738.8 km to 2,130.7 km. While the plateau region is more quantitatively and qualitatively endowed overall, the road network of the maritime region was, between 2011 and 2016, the densest in Togo, with an average of 43.17 km per 100 km2. The least dense was the central region with an average of 12.6 km per 100 km2.

Social and Human Development Context: Togo ranks 166th out of 188 countries in the world with a human development index (HDI) of 0.487 in 2016 according to the 2017 Human Development Report (HDR). The latest available data are from the 2015 QUIBB survey. They reveal that the incidence of poverty has been declining over the past decade or so. From 61.7% in 2006, it fell to 58.7% in 2011, 55.1% in 2015, and 53.5% in 2017. In general, this is reflected in the incidence of poverty in the regions, with a decrease in the rural poverty rate from 73.4% to 68.9% between 2011 and 2015. However, it must be noted that the maritime region is an exception to these dynamics with an incidence of 52.6% in 2017 compared to 45.3% in 2011, with an impact specifically in Lomé of 30.3% (against 27% in 2011). This trend reversal must be linked to rural exodus, which means that additional social measures do not have the same impact as in other regions. Moreover, inequalities continue to widen with the Gini index rising from 0.380 in 2015 to 0.427 in 2017.Togo has made progress in terms of gender equality through legislative reforms. However, it ranks 166th out of 188 countries on the Gender Inequality Index in the 2016 HDR. Gender discrimination and inequalities persist. The percentage of women parliamentarians stands at 18.68% in 2018. Moreover, the incidence of poverty is higher for female-headed households (57.5%) than those headed by males (54.6%), and increased for the former while decreasing for the latter between 2011 and 2015.

2.1.2. Senegal[5]

Political Outlook: Senegal has provided an exemplary lesson of democracy in Africa. The Presidential elections of March 2012 resulted in the accession of President Macky Sall to the country's highest political office. The Constitutional referendum on 20 March 2016 resulted in 15 changes to the Constitution including: modernization of the role of political parties, recognition of the rights of the Opposition and its leader, restoration of the five-year Presidential term as well aspromotion of local governance and territorial development. The next elections were the legislative elections in 2017 and the Presidential elections in 2019. The threat to political stability represented by the Casamance separatist movements appears to have waned.

Economic Outlook: Economic growth has significantly improved since 2011. However, it not only remains erratic but is too weak to sustainably reduce poverty. The growth rate recovered from its low point of 1.8% in 2011, due to the negative impacts of drought and power outages, to 3.5% in 2013 and 4.3% in 2014. It reached as high as 6.5% in 2015 and 6.6% in 2016 respectively. Growth is mainly driven by the primary sector which has grown by 18.2% compared to 2.7% in 2014 mainly due to high levels of rainfall in 2015. Growth rates in the secondary and tertiary sectors were 7.1% and 3.8% respectively. Generally, analysis of the

[5] Synthesised from Senegal Country Strategy Paper (2016-2020) available at: https://www.afdb.org/en/documents/document/bank-groups-country-strategy-paper-for-senegal-2016-2020-90889.

growth drivers over a long period shows that weak growth is linked to the narrowness of its base. Indeed, the two drivers which account for 70% of economic growth are telecommunications and financial services. This is why, under the ESP, the country wants to broaden its growth base from 2 to 6 growth sectors. The 4 new growth sectors targeted are: agriculture and agri-food, housing, mines and tourism. Medium-term growth is expected to be more robust with projected annual rates of 7-8%. These projections take into account the implementation of the Programme to Accelerate the Pace of Senegalese Agriculture (PRACAS) and the road sector improvement programmes. With regard to public finance, the fiscal deficit narrowed from 6.7 % of GDP in 2011 to 5% in 2014 and to 4.7% in 2015 and was projected at 4.2% in 2016 with the objective of lowering it to 3% in 2018. Public debt rose from 23% of GDP in 2007 to 54% in 2015 but remains below the standard of 70 % retained under the WAEMU convergence criteria. The Government's objective was, however, to maintain that ratio at 53% by 2018 under the programme with the IMF entitled 'Economic Policy Support Instrument' (2015-2017 EPSI). According to the debt sustainability analysis conducted by the IMF and World Bank for the 2015-2035 period, Senegal has a low risk of debt distress.

Macroeconomic Outlook: Growth Diagnostic for Senegal shows that the structural transformation of the Senegalese economy was slow. Over the 1980-2009 period, workers migrated from the primary and secondary sectors to the informal urban sector. Most of the country's work force (80%) depends on agriculture. The economy is dominated by the tertiary sector which contributes 62 % to GDP, followed by the secondary (22%) and primary (16%) sectors in 2016. Traditionally, telecoms and financial services have represented 70% of growth. The narrowness of the growth base coupled with a mostly rural population raises the problem of inclusiveness and its implications for the lives of the poor. Agriculture is one of the 4 additional growth drivers identified by the ESP to broaden the growth base. Moreover, the country holds significant opportunities for growth, especially in horticulture for export, rice farming and other commercial crops in order to develop value chains and agribusiness. The fact that agriculture is one of the new drivers and that the majority of the population lives in rural areas provides opportunities for inclusive growth.

External Debt Sustainability: On the external front, there was a structural current account deficit at an annual average of 9% of GDP over the 2011-2015. It narrowed slightly from 8.8 % of GDP in 2014 to 8% in 2015. This deficit was due to a structural trade deficit to the extent that the average annual trade deficit represented 18% of GDP over the 2011-2015 period as a result of very poor export performances, which represented an annual average of 19% of GDP. Reserves have been pooled at the WAEMU level in order to finance the current account. The current account deficit is mainly financed by transfers of public capital, portfolio investments and other public investments as well as FDI.

Regional Integration*:* Senegal has played a major role in the integration process within the Economic Community of West African States (ECOWAS). After hosting the ECOWAS Summit in October 2013, the country pursued dialogue with the member countries culminating in the introduction of the Common External Tariff in 2015. It is also implementing an infrastructure programme in order to reinforce its position as a sub-regional hub. Thus, the cross-border corridors and structures financed by the Bank (Dakar-Bamako by the South, Dakar-Conakry in particular) have improved Senegal's connectivity with its neighbours, in particular The Gambia, Guinea, Guinea-Bissau and Mali thereby contributing to the growth in trade between Senegal and these countries. In addition, the Bank's budget support operations have facilitated the transposition of the WAEMU Directives into national law. The Bank will continue these support operations in order to strengthen Senegal's positioning in ECOWAS.

Environment, Sustainable Development and Climate Change: Senegal wishes to reverse the trend towards degradation of the ecosystem and natural resources. The sectors hardest hit are those of water resources, forest resources, agriculture and in coastal areas. The country's climate vulnerability is reflected in a resurgence of the phenomena of flooding and coastal erosion as well as the loss of agricultural and forest areas due to desertification (estimated at 5 % of agricultural potential) and Stalinisation. In response to the impacts of these climate changes, Senegal established a National Climate Change Committee (NCCC) in 2003 grouping together several public and private structures. A National (Climate Change) Adaptation Plan of Action (NAPA) was prepared in 2006 and was supported, in particular, by the United Nations, Nordic Development Fund, the World Bank and African Development Bank.

Social and Human Development Context: The number of people living below the poverty threshold was estimated at 42.5% in 2014 compared to 46.7% in 2011 and 57.1% in 2000. The drinking water access rate was 90% in 2014 compared to 81% in 2000. The sanitation access rate is 44%. According to data from Senegal's National Employment Survey, published in November 2015, the unemployment rate for people aged 15 years and more was estimated at 13.4%, 40% of whom do not have a diploma. Women are more affected by unemployment (16/7%) than men (9.5%). Regarding gender policy, Senegal has ratified the international treaties, in particular, the United Nations Convention on the Elimination of All Forms of Discrimination against Women (CEDAW). Several laws and regulations have been adopted to punish violence against women, in particular sexual harassment, female genital mutilation with aggravated sentences in the case of rape on the one hand and, on the other hand, to ensure full fiscal autonomy for the spouse and equality between spouses in the calculation of the tax rate. According to the Gender Equality Index (GEI) published for the first time by the AfDB in 2015, Senegal was ranked 30th out of 54 African countries. Women's political and economic empowerment remains a key challenge for sustainable and equitable development.

2.1.3. Guinea[6]

Political Outlook: Guinea is still experiencing socio-political tensions. A review of its fragility spectrum in 2018 revealed the persistence of fragility factors in its institutions and political process. Demands for the organisation of legislative and local council elections, as well as strikes by various trade unions, have sometimes been violent, causing significant loss of human life and material damage in Guinea. The country's Mo Ibrahim Governance Index rating of 45.5/100 in 2016 is below the African average (50.8) and the average for West African countries (53.8). Although the accountability score remains particularly low at of 18.5/100, the national security score of 89.2 is among the best in Africa. According to World Bank governance indicators (Graph 1), Guinea has made significant progress since 2011 in terms of political stability, but still ranks in the bottom decile in terms of rule of law. In July 2018, the 25% increase in the pump price of petroleum products, continued to spark unrest in the country, characterised by a series of strikes and ghost town campaigns. Dialogue efforts are underway between trade unions, GoG and employers' associations.

Economic Outlook: The Ebola virus disease (EVD) epidemic slashed the growth rate from 5.9% in 2012 to 3.8% in 2015 but economic recovery was strong in 2016 and 2017.Thanks to economic recovery efforts made after the EVD epidemic and the robust performance of the mining sector, Guinea's GDP surged by 10.5% in 2016 and 8.2% in 2017. This growth rate is expected to range from 5.3% to 5.8% over the 2018-2022 period, supported mainly by reforms to

[6] Synthesised from Guinea Country Strategy Paper (2018-2022) available at: Guinea - Country Strategy Paper 2018-2022 | African Development Bank - Building today, a better Africa tomorrow (afdb.org).

improve the business environment and governance in the extractive industries, as well as support for agribusiness modernisation and improved energy availability. In 2016, services accounted for 45% of national GDP and 34.3% of total employment. Industrial activities generated 31% of GDP, compared to 20% for agriculture. These two sectors respectively generated 13.7% and 52% of jobs. The decline in industry contribution to GDP, from 34% in 1988 to 31% in 2016, is indicative of a slight structural transformation of the Guinean economy. Significant investments in extractive industries over the last five years are expected to reverse this trend by 2022.

Macroeconomic Outlook: Recent and significant infrastructure spending has aggravated the budget deficit. The overall budget deficit (net of grants) deteriorated from 1.3% of GDP in 2016 to 3.6% in 2017. This deficit is expected to drop gradually to 3.5% of GDP in 2018 and 2.6% of GDP in 2022, thanks to an investment policy that is increasingly geared towards public-private partnership (PPP) as well as Government of Guinea's (GoG's) efforts to enhance control of the budgetary impact of such PPPs. In 2017, tax revenue amounting to GNF 12,443 billion was raised compared to GNF 10,930 billion in 2016, representing an increase of 14%. The tax burden stood at 13.4% of GDP in 2017 with 2.3% coming from mid-term tax revenue. Despite an increase in collected revenue, the yield remains far below Guinea's real fiscal potential and the tax burden average for Sub-Saharan Africa (16% of GDP). Such low yield partly stems from the limited population of taxpayers and inadequate tax controls. In terms of Public Debt, public investment, financed by loans, raised the debt level from 27.2% of GDP in 2012 to 37.2% in 2017.In December 2010, Guinea reached the completion point of the Heavily Indebted Poor Countries (HIPC) Initiative, thus reducing its debt ratio from 58.1% of GDP in 2011 to 27.2% in 2012. Due to significant loans contracted from 2013 onwards to finance backbone and priority energy and road infrastructure, the public debt ratio gradually rose to 39.8% of GDP in 2016 before dropping slightly to 37.2% in 2017.Although the inflation rate has been relatively contained, recent trends show that it has worsened relatively from 7.3% in 2015 to 9.5% in 2017due to food price hikes caused mainly by an insufficient supply of vegetables and fish on the local market.

Private Sector and Business Environment: The private sector is characterised by a strong predominance of the informal sector, which creates about 95.2% of jobs in the economy, mainly in the agricultural sector. The formal sector employs 4.8% of the labour force, mainly in government services. Credit to the private sector remains low, owing to the tight liquidity conditions of banks and the crowding-out effect created by high investment demand from the public and para-public sectors. In 2017, credit to the private sector peaked at USD 912.7 million, compared to 1.2 billion for the public sector. According to the World Bank's 2018 *Doing Business* report, Guinea has moved up 26 spots in the rankings relative to 2012. It is currently 153rd/190. This progress mainly stems from reforms implemented in terms of obtaining building permits and facilitating the creation of businesses. However, the business climate still lags behind in terms of paying taxes, getting electricity and trading across borders. The corruption perception index of *Transparency International* was 27 in 2017 compared to 24 in 2012, ranking Guinea at 148th out of 180 countries.

External Debt Profile: The current account balance showed a surplus, but did not translate into an improvement in foreign exchange reserves**.** In 2017, the current account balance recorded a surplus 5% of GDP following a surge in mining exports. However, this surplus did not lead to an increase in external assets, owing to the low repatriation of export earnings from mining products. Thus, the overall deficit of USD 44 million was financed through drawdowns from the IMF and other donors. This led to the replenishment of foreign exchange reserves up to USD 76.50 million, albeit without making provision to cover the three months of imports as required by ECOWAS convergence standards.

Regional Integration: Guinea actively participates in regional integration efforts, but its level of trade with the sub-region remains very low**.** Since January 2017, it has applied the common external tariff (CET) adopted by ECOWAS in 2014. Exports to ECOWAS accounted for only 0.5% of its total exports in 2017, mainly to Ghana (89.1%), Mali (5.8%) and Senegal (3.0%). Imports from ECOWAS represented 4.3% of the total in 2017 and remain dominated by automobile products or spare parts (46.5%), followed by petroleum products (13.2%), food and beverages (11.1%), and machinery and equipment (8.5%). They come mainly from Senegal (13.4%), Sierra Leone (10.5%), Côte d'Ivoire (9.9%), Mali (3.0%) and Ghana (2.4%).

Social and Human Development Context: Guinea is in the bottom quintile in terms of quality of life**.** The 2017 Human Development Report ranked Guinea in the 183rd position out of 188 countries with a human development index (HDI) of 0.414. Poverty levels remain high with an incidence that increased from 41.9% in 2002 to 53.7% in 2007 and then to 55.2% in 2012. The informal sector employs 95.2% of the population. The majority of informal sector jobs (77.5%) are generated by rural development in the broadest sense of the term (agriculture, hunting, forestry and fishing). The unemployment rate was 5.2% in 2014, higher for men (6.3%) than for women (3.9%), with significant disparities between urban (11.1%) and rural (2.25%) areas. These unemployment rates mask serious challenges related to underemployment (12.8%). According to the GPHC 2014 results, unemployment affects 34.7% of university graduates and 27.7% of technical education graduates. Gender equality and equity is still a concern in Guinea although encouraging measures are being implemented**.** The National Gender Policy has been updated, validated and disseminated in 2017. There are no legal restrictions on women's access to the labour market, education and health. However, in March 2018, female representation was only 22% in Parliament, 18% at the Supreme Court (3 women out of 17 judges), 24% at the Economic and Social Council, 14% of ministers in 2017, 2% of mayors and 18% of household heads. Only 26% of civil servants are women, most of them with limited responsibilities. Results from the General Population and Housing Census (GPHC) carried out in 2014, indicates that early marriage (ages 12-14) significantly affects girls at a prevalence of 5.5%, regardless of where they live.

Environment and Climate Change: Apart from the coastline that is subjected to various types of aggression, climate change is a major concern**.** With over 300 km of coastline, a surface area of 47400 km² and a breadth of 40 to 100 km, Guinea’s continental shelf is the largest in West Africa. However, the coastal area is gradually being degraded, mainly by coastal erosion and the discharge of domestic and industrial waste into the sea, which causes significant pollution. In response to climate challenges, the government in September 2015 developed an Intended Nationally Determined Contributions (INDC) document to promote climate-sensitive economic development. In 2017, its implementation led to the reforestation of 650 ha, compared to the annual target of 1000 ha.

3. ESTABLISHMENT OF AGROPOLES AS ECONOMIC GROWTH DRIVERS IN PILOT COUNTRIES

3.1. Key Characteristics of Agropoles

- **Agro-Processing Hub (APH):** Usually a well-defined, centrally managed tract of land developed, subdivided and dedicated to supporting firms and other stakeholders engaged in agro-processing and related activities located throughout the production area surrounding the hub. The hub offers adequate infrastructure, logistics and specialized facilities and services (e.g., electricity, water, cold chain facilities, laboratory and certification services, business services, ICT, waste treatment, etc.) required for agro-industrial activities. The ownership and management of the hub is controlled by a dedicated and independent entity, often in a public private partnership arrangement.

- **Agricultural Transformation Centers (ATC):** For each SCPZ, a number of Agricultural Transformation Centers (ATCs) are strategically located within the production area to serve as aggregation points to accumulate products from the community to supply the Agro-Processing Hub for further value addition or send to centres of great demand for distribution and retail to consumers. The ATC is a physical complex of facilities centrally located in the middle of a farming community, where required services are offered to farmers, including crop drying facilities, cold stores and warehouses, farm equipment rental and maintenance services, crop handling, grading, storage, and processing for increased shelf life; livestock handling, slaughtering and meat packing; fish handling, grading and processing; food quality and safety control and certification; distribution and marketing platforms.

3.2. Background and Context of the Agropoles in Togo, Senegal and Guinea

3.2.1 Togo Agro-food Processing Zones (PTA-Togo)[7],[8]

Despite the strong contribution of agriculture to the country's GDP, estimated at 40% on average and bringing together 60% of the population, with 87% of assets often family-owned and revolving around agriculture, Togo's level of investment in the agricultural sector remains weak compared to its needs. Public spending, including that of donors, remains low: it went from CFAF 25 billion in 2010 to CFAF 50 billion in 2013-14 and CFAF 44 billion in 2016. Private investments are quite insufficient compared to the needs and potential of the agricultural sector, owing to, among other things, a less-than-enticing environment, lack of infrastructure and poor structuring of agricultural sectors. Investment and management weaknesses explain to a large degree the low agricultural productivity and insufficient access to domestic (import substitution) and export markets. The agricultural potentials of the country in terms of livestock and fishery production as well as major cash crops are presented in Table 2 and Table 3. As observed in Table 3, the yields for most of the major cash crops are quite low as well as fish production.

Table 2. Livestock (in 000 Heads) and Fishery Productions (Tonnes)

Cattle	Chickens	Goats	Pigs	Sheep	Fishery
442,219.00	30,305.00	2,844,748.00	490,122.00	2,334,166.00	24,124.00

FAO Statistics (2017)

Table 3. Crops Production, Harvested Area and Yields in 2017

[7] Togo - Agro-Food Processing Zone Project - (PTA-TOGO) (afdb.org).
[8] Togo - Togo Agro-Food Processing Zone Project (PTA-TOGO) - Appraisal Report | African Development Bank - Building today, a better Africa tomorrow (afdb.org).

Crops	**Area harvested (Ha)**	**Yield (Hg/Ha)**	**Production (Tonnes)**
Cassava	267,020.0	39,011.0	1,041,682.0
Maize	694,422.0	12,308.0	854,689.0
Yams	90,643.0	91,188.0	826,553.0
Sorghum	315,542.0	8,752.0	276,167.0
Beans, dry	369,567.0	5,394.0	199,359.0
Oil palm fruit	18,109.0	85,624.0	155,058.0
Rice, paddy	84,395.0	16,650.0	140,519.0
Vegetables, fresh nes	26,867.0	50,788.0	136,454.0
Seed cotton	160,152.0	7,805.0	125,000.0
Groundnuts, with shell	59,008.0	7,371.0	43,493.0
Bananas	2,180.0	125,123.0	27,279.0
Fruit, fresh nes	4,372.0	59,891.0	26,185.0
Millet	43,912.0	5,931.0	26,044.0
Cocoa, beans	23,634.0	9,529.0	22,522.0
Bambara beans	26,702.0	7,571.0	20,217.0
Coffee, green	56,334.0	3,280.0	18,476.0
Taro (cocoyam)	6,434.0	22,920.0	14,746.0
Oranges	3,046.0	46,482.0	14,158.0
Coconuts	4,379.0	32,024.0	14,025.0
Karite nuts (sheanuts)	3,083.0	41,093.0	12,668.0
Cashew nuts, with shell	6,513.0	15,197.0	9,897.0
Sweet potatoes	34,446.0	8,732.0	6,434.0
Tomatoes	1,286.0	43,272.0	5,564.0
Cereals, nes	3,693.0	9,883.0	3,650.0
Chillies and peppers, dry	8,580.0	4,234.0	3,633.0
Soybeans	4,864.0	4,429.0	2,154.0
Pineapples	242.0	80,606.0	1,953.0
Tobacco, unmanufactured	4,346.0	4,406.0	1,915.0
Sesame seed	5,958.0	3,170.0	1,889.0
Chick peas	2,319.0	7,593.0	1,761.0
Roots and tubers, nes	150.0	53,333.0	800.0
Cabbages & other brassicas	72.0	110,474.0	793.0
Spices, nes	245.0	10,422.0	255.0
Castor oil seed	1,027.0	802.0	82.0
Nutmeg, mace & cardamoms	32.0	10,071.0	32.0

FAO Statistics (2017)[9]

In response to the poor performance of the agricultural sector, the Togo Agro-Food Processing Zone Project (PTA-Togo) was initiated as part of the Togo Agropoles Strategic Development Plan 2017-2030 and the Feed Africa Initiative 2016-2025. The overall objective of the project is to promote inclusive agricultural growth that creates jobs and reduce food imports. The specific objectives of the project are to[10]: (i) facilitate private investments in key areas thanks to policy support, governance and incentive measures; (ii) promote the development of priority value chains through the establishment of infrastructure to support production, storage and processing; and (iii) build the capacity of stakeholders in priority agro-industrial areas. The main outcomes expected from the Project are as follows: **(i)** increase in the productivity and agricultural production of import substitutes (rice, maize, soybean, broiler meat) and exports (cashew nuts and sesame); **(ii)** increase in the share of agricultural products processed in situ (from 19% to

[9] FAOSTAT:www.fao.org/faostat/en/#data/QC.

[10] Togo - Togo Agro-Food Processing Zone Project (PTA-TOGO) - Appraisal Report | African Development Bank - Building today, a better Africa tomorrow (afdb.org).

40%) through private investment in the Agro-park (90,000 tons/year of rice paddy, 15,000 tons/year of maize, 10,000 tons/year of soybean, 20,000 tons/year of feed, 10,000 tons/year of cashew nuts and 10,000 tons/year of sesame, production of 3 million chicks per year, slaughtering of 2 million broilers/year); **(iii)** Strengthening of the people's food and nutritional security; **(iv)** creation of wealth and employment, including for young people and women; **(v)** Preparatory studies funded by the Project Preparation Fund (PPF).

In the 2016-2020 Agricultural Development Programme, 10 'agropoles' were identified among the priorities to be financed over the next 15 years. However, the GoE focused on the Kara region (Figure 1), considering the current level of poverty, the high agricultural potential (rice in particular), the opportunities in terms of synergy offered by ongoing projects (PARTAM, PBVM, PDRI-Mô and PDRD) and the presence of a dynamic private sector (including the Kalyan Group). The project covers the Bassar, Doufelgou, Dankpen and Kéran prefectures in the Kara region, located between latitudes 9° 00' and 10° 00' North and between longitudes 0°15' and 1°45' East. The population of the Kara region comprises 769,940 inhabitants distributed as follows: 184,693 inhabitants in urban areas and 585,247 inhabitants in rural areas. The activities envisaged for the project will affect about 303,419 people directly, of whom 151,710 will be women. The population that would be indirectly affected is estimated at around 769,000 people (51% women).

Figure 1. Map of SCPZ Intervention Area in the Kara Region

Togo and the Kara region are facing severe deforestation related to tree-cutting for farming and alternative income-generation needs. The rate of deforestation is about 15,000 hectares/year, compared with a reforestation rate barely exceeding 3,000 hectares/year. This situation compounds the problem of climate change by depleting carbon stock. The PTA also has the potential to contribute to greenhouse gas emissions, owing to tree-cutting for farmland development, rice production and building of dams.

3.2.1.1 Land Policy in Togo[11]

Since 1960, land ownership in Togo is private property. Togo land management laws make provision for who can own, use and manage land resources. The tenure law guarantees the existence, recognition, and protection of land rights. Under the Customary land law, land is communally owned even if not formally registered. Under the National land law, the government owns all unregistered land that is without houses farms or grazing and can freely allocate such unregistered land to other alternative uses. This may include mining activities, Free Zone, Agropoles, logging or national parts. Under the international land law, communities have right over land, territories and resources that they have traditionally owned, occupied or used including customary claims.

3.2.1.2 Rationale for AfDB's Involvement in the SCPZ Project in Togo

Togo's average GDP growth over the 2011-2015 period was 5.3%, compared with 2.7% for the 2006-2010 period. However, in the Human Development Index (HDI) rankings for 2015, Togo was ranked 162nd out of 188 countries with a score of 0.484. The incidence of poverty fell from 61.7% in 2006 to 58.7% in 2011 and 55.1% in 2015, but the level of poverty remains high. The rate of extreme poverty did not improve tangibly, going from 28.6% in 2006 to 30.4% in 2011 and then to 28.7% in 2015. In 2015, the incidence of poverty in rural areas stood at 68.9%, compared with 34.3% in Lomé and 37.8% in other urban areas. The rate of under-employment rose from 22.1% in 2011 to 24.9% in 2015, according to data from the 2011 and 2015 QUIBB1 surveys. The breakdown of that rate by social category indicates a level of unemployment, and even under-employment, of about 53.2% for women and about 59% for young people. In 2014, the prevalence of chronic malnutrition among children under 5 was 28% at the national level and 32% for the Kara Region.

Despite the political and economic progress made, Togo remains a fragile country, because its average score following the Country Policy and Institutional Assessment (CPIA) of the AfDB and the World Bank is 3.2 out of 6. Despite structural reforms undertaken by the Government between 2006 and 2015, the country's environment remains tense, with political protests since 2017, notwithstanding the intensification of dialogue between the Government and the opposition. Another source of fragility concerns the economy's high level of dependence on the phosphate sub-sector (+40% of export revenue) and income from seaport and airport traffic, on the one hand, and socio-economic spatial disparities, on the other.

The country's economy remains largely dominated by agriculture which, in 2015, employed 72.6% of the population and accounted for 47.6% of GDP, while services accounted for 36.2%, and industry 16.2%. There are barely 22 large agro-industrial enterprises in the country and they supply less than 5% of the products processed and sold on the domestic market. According to customs statistics for 2014, Togo imported the equivalent of USD 160 million dollars of food products (including 100,000 tonnes of rice), but only exported the equivalent of USD 50 million. Over the period 2011-2014, the agricultural trade balance recorded a deficit of about CFAF 60 billion, owing primarily to growing imports of food products.

The constraints analysis shows that agriculture remains unproductive and not integrated into the markets, owing to limited access to agricultural equipment, inputs, financing and land, especially for women and young people. These challenges are compounded by low level of support infrastructure for agricultural production, storage, processing, packaging and marketing. This is

[11] https://www.afdb.org/en/documents/togo-projet-de-transformation-agro-alimentaire-du-togo-pta-togo-p-tg-aag-002-rapport-cges.

true for the products targeted by the project in terms of import substitution (rice, maize, soybean, broiler meat) or export (cashew nuts, sesame).

The Bank has a comparative advantage in the implementation of this project financed through the public sector window and designed to create favourable conditions for private investors (the main one being the Kalyan Group, which is interested in cashew nuts and sesame, and has submitted a financing request to the private sector window that is currently being reviewed). Moreover, the Bank's intervention, which is aimed at helping in the implementation of the Agropoles Strategic Development Plan 2017-2030, is perfectly in line with the Feed Africa Strategy 2016-25,whose goals are to: (i) help eliminate extreme poverty; (ii) end hunger and malnutrition; (iii) make Africa a net food exporter; and (iv) move Africa to the top of export-oriented global value chains where it has a comparative advantage. The project will also help to achieve the objectives of the Bank's Ten-Year Strategy (2013-2022), especially its operational priorities concerning the development of infrastructure, the private sector and inclusive growth.

3.2.1.3 Lessons Learned from AfDB's Involvement in Togo's SCPZ Project

Lessons learned from the implementation of the previous CSP, the IDEV long-term evaluation report (sixth selectivity criterion) and periodic reviews of the CSP brought to light recurring difficulties relating to counterpart resource mobilisation, slow pace of the procurement process, disbursement red tape, and weaknesses in quality-at-entry of operations. Several project design measures were therefore taken, including: (i) mobilisation of PPF resources to finance the feasibility studies; (ii) allocation of an amount of CFAF 206 million in the State budget for 2018; (iii) signing of a decree establishing the APRODAT and appointing the Board of Directors; (iv) use of advance procurement action; (v) inclusion of poor people (including women) and protection of the environment; and (vi) synergy of inter-sector interventions (energy, transport, water, telecommunication).

3.2.2. Senegal Agro-Industrial Processing Zone (Agropole South)[12,13]

Despite the country's efforts as highlighted in section 2.1.3, the acute malnutrition rate exceeds the emergency threshold (10%) and food imports continue to weigh on the trade balance. Among the reasons cited are the low level of processing of agricultural products following industrial processes of quality (barely 13%), the low productivity of the sector and its high vulnerability to climate change. Thus, Senegalese products are not very competitive in the national and international markets due to the weakness of private investment in the processing of agricultural products and services due to the unfavourable business environment (land, taxation, etc.), low technological capacity, inadequate infrastructure (energy, transport, etc.) and poor structuring/organization of the agricultural sector (which employs 60% of the active population)[14].

In view of all these challenges, the Government of Senegal (GoS), launched the Plan Sénégal Emergent (PSE) or Emerging Senegal Plan in 2014 with a view to guide the country's transformation towards "an emerging country in 2035. The PSE targets the expansion of the country's major growth drivers notably agriculture and agro-food in order to unlock Senegal's industrial potential to generate inclusive and sustainable economic growth. The Special Agro-Industrial Transformation Area Project (PZTA) in the Southern Region of Senegal (Casamance) is one of the 27 flagship projects under the PES and consistent with the CSP 2016-2020 and the

[12] Senegal - The South Agro-Industrial Processing Zone Project (PZTA-Sud, or Agropole Sud) (afdb.org).
[13] Programme for Country Partnership Senegal | UNIDO.
[14] Senegal - South Agro-Industrial Processing Zone Project (PZTA-SUD) or Agropole Sud - Project Appraisal Report | African Development Bank - Building today, a better Africa tomorrow (afdb.org).

'Feed Africa' Initiative of the African Development Bank 2016-2025. The overall goal of the project is to create added value on agricultural products and sustainably increased production of the priority agro-industrial sectors while reducing GHG emissions from agriculture. The PZTA project will cover a total land area of 105,000ha inhabited by over 1,872,668 people in the Casamance Natural Region (Figure 3) corresponding to the administrative regions of Ziguinchor, Sédhiou and Koldaqui as follows:

Ziguinchor Region, which is made up of: (i) 3 departments: Bignona, Oussouye and Ziguinchor; (ii) 8 districts; (iii) 5 Urban Communes and 25 Rural Communes; and, (iv) about 502 villages.

The population of Ziguinchor region was estimated in 2015 (ANSD projection) at about 583,525 inhabitants, i.e., 4.1% of the national population with a regional average density of 79 inhabitants per square kilometre slightly above the national average. Data from the 2002 General Population and Housing Census provide information on the great ethnic diversity of the region. In fact, it emerged that the main ethnic groups are: the Diolas ethnic group (57.8%), the Mandingos (11.10%), the Pulaars group (10.5%), the Wolofs (3.9%), Manjacks (3.5%), Ballantes (2.9%), Serer (2.70%) and Mancagnes (2.4%). This ethnic mix makes this region one of the most cosmopolitan areas in Senegal. The dominant religions are Islam (78%) and Christianity (18%), nevertheless, there is a strong presence of animists and pagans in the Oussouye department (32.7%). The age pyramid in the Ziguinchor region is an expanding pyramid, typical of developing regions where fertility is high and relatively constant and mortality is falling. It has a wide base and steep sides, which reflects a large percentage of children and young people, and a small proportion of older people. In fact, people aged 65 and over make up 5% and young people less than 15 years old 40% of the population, while children under 5 represent 13% of the total population. The sex ratio is 105.5 with a predominance of men (299,553) compared to women (283,972)[15].

Available statistics reveal a disparity in the distribution of the population by department. Indeed, Bignona which gathers 46% of the regional population and a density of 48 inhabitants/ km2 is the largest population pole in the region, followed by Ziguinchor with 45.2% and Oussouye with 8.8% only. Analysis of the geographical distribution according to the area of residence of the population shows that the rate of urbanization of the region of Ziguinchor is about 45,94 %, which is above the national average (45,2%). The department of Ziguinchor pulls the middle-region upwards with an urbanization rate of 37.38% while Bignona and Oussouye are respectively 7.67% and 0.88%. Sedhiou Region, which is made up of: (i) 3 departments: Boukiling, Goudomp and Sedhiou; (ii) 9 districts; (iii) 10 urban communes and 33 rural communities; and, (iv) 920 official villages.

The population of Sedhiou region was estimated in 2015 (ANSD projection) at around 483,768 inhabitants, or 3.7% of the national population with a regional average density of 66 inhabitants per km2. The population of Sedhiou region of 2013 is characterized by youth. Indeed, 60.2% of the workforce is under 20 years old and only 4.8% is 60 years old or older. Men represent the majority of the population at a rate of 50.63%. Unemployment in the region is quite high, with a rate of 21.7% in 2013, of which 16.5% are men and 12.1% are women and is a fairly frequent phenomenon. However, the rate is slightly below the national average. This proportion is higher in the rural areas (22.6%) than in the urban area (18.3%). In addition, unemployment rates are higher in the department of Goudomp (27.3%), followed by Sédhiou (20.10), and Bounkiling (17.4%). The activity rate for the Sedhi region is 56.5%. The highest activity rates in the

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[15] Senegal - South Agro-Industrial Processing Zone Project (PZTA-SUD) or Agropole Sud - Project Appraisal Report | African Development Bank - Building today, a better Africa tomorrow (afdb.org).

Mediterranean (60.2%) and in the suburban area (42.6%) are practically in Sédhiou and the Goudomp departments with 53.7% and 53.1%, respectively. Bounkiling has the highest activity rate in the region at 63%. Kolda Region, consisting of: (i) 3 departments: Kolda, Medina Yoro Foula and Vélingara; (ii) 9 districts; and (iii) 9 urban communes and 31 rural communes.

The population of the KOLDA region was estimated in 2015 (ANSD projection) at around 703,779 inhabitants or 4.9% of the national population with a regional average density of 51 inhabitants per km2. The age pyramid is characterized by a large proportion of children and young people but also by a small percentage of older people. Children under five represent 17% of the region's population, under-15s (including under-5s) account for 48%, and those aged 65 and over represent 3% of the regional population. The General Census of Population and Housing, Agriculture and Livestock in 2013 reveals in the Kolda region, an uneven distribution of the population between rural and urban areas. Nearly three quarters of the population live in rural areas (74% of the total population) and only 26% in urban areas. While in 2002, the rural population represented 84% of the total population and urban only 16%. The rate of urbanization in the Kolda region rose to 26% in 2013. This increase reflects progress in urbanization of the region. In 2013 in the Kolda region, the working-age population was 329,421, or 49.7% of the total workforce in the region. In terms of distribution by sex, there is a slight domination of women (51% of the total number of women) compared to men at 49%. The participation rate is 55.6% for men and 60.0% for women. According to residence, it is 42.5% in urban areas and 46.5% in rural areas.

The project was designed under the guidance of the Operational and Monitoring Bureau (BOS) of the PES and the Ministry of Industry on the basis of the following principles: (i) the targeting of sectors with national or international market potential; this led to the choice of two priority sectors (mango and cashew) and two complementary sectors (maize, banana and non-timber forest products); (ii) the presence of a high-potential agricultural production basin; (iii) the interest of the private sector to invest , confirmed with the creation of SOCAAS (Cooperative Society of Agro-Industry). Its design followed a process of prior consultations, feasibility studies (carried out with UNIDO) and maturation of sub-projects-SP (which allowed to classify them into 3 categories: (i) Public SPs (funded on the ADB and IDB public windows) (ii) Public-Private SPs (financed through the Souverain Strategic Investment Fund-FONSIS), and (iii) Private SPs, to be mobilized notably with the support from FONSIS. At the spatial level, the value chain includes: (i) a central module for the industrial processing of agricultural products (national and international markets); (ii) 3 regional modules for secondary packaging and primary processing (local and regional market); (iii) aggregation, cleaning, sorting and primary packaging platforms; and iv) collection points. Thus, the Project will provide the necessary resources to attract IP in particular in the processing of agricultural products, the supply of agricultural inputs and services.

3.2.2.1 Land Tenure in Senegal and Casamance Natural Region[16]

Access to land in Senegal is governed by the following laws:

- 64-46 of 17 June 1964 relating to the national estate;
- 72-1288 of 27 October 1972 on the organization of rural communities;
- 76-66 2 July 1976 on the Government estate code; and,
- 96-07 of 22 March 1996 on the transfer of powers.

[16] https://www.afdb.org/en/documents/senegal-projet-dimplantation-dune-zone-de-transformation-agroindustrielle-sud-pzta-sud-ou-agropole-sud-p-sn-aag-004-rapport-ees

Lands have been classified into Government estate and national estate placed under the control of the State. The law of 1964 abolishes the customary rights of lineages and families over lands and considers that land is inalienable and cannot be subject to any form of commercial transaction. The law of 1972 created rural communities and entrusted the allocation of the national estate to rural councils. Lands are classified under four categories:

- Community lands that are regularly used for rural dwellings, crop cultivation and stock raising;
- Reserves such as forest areas or classified protected areas;
- Urban areas that are located on territories of communes; and,
- Pioneer areas that correspond to other types of lands.

With regard to access to land, a new policy is under preparation and a reform of the land law is currently undergoing discussions at the grassroots level (locally elected representatives, farmers' organization, private sector, etc.) prior to its submission to the National Assembly. The land policy aims at preserving peace and stability, fostering economic growth through private investments, promoting equitable social development that takes into accounts the rights of women and the poor, and enhances the rational management of resources. In preparation towards these future reforms, the Bank is financing the Cadastral Survey Modernization Project aimed specifically at contributing to the digitization of the land registry for better land supervision, with a view to improving access to property and generating tax revenue[17].

Community lands (95% of the national estate) are placed under the authority of rural councils that allocate them to users. This allocation does not confer right of usage on the recipient. The period of the allocation made through deliberation by the rural council is indeterminate so long as the beneficiary continues to fulfil the development conditions. Rural councils are empowered to reallocate undeveloped lands. Although this system enables the full participation of local actors in the management of lands, it is hampered by the weak representation of women in the rural councils, inadequate training of rural councillors and the lack of human, financial and material resources. Under the project, the definition of rural land, recognition and potentiation of women's groups, information and support to local land authorities should facilitate the implementation of land security measures, particularly for the predominantly women's communal gardens. The absence of rigid definitions also makes for flexibility in adapting to circumstances; the notion of land development can change through support and the professionalization of the rural world. By linking the withdrawal of the allocation to the absence of development, by organizing the compensation of those whose allocations have been withdrawn in the general public interest, the law guarantees the stability of the rural dweller on the land. The priority right of allocation of heirs complements the system in a coherent manner. Difficulties encountered are corrected de facto and consensually between the communities and the rural councils.

3.2.2.2 Existing Agricultural Infrastructures in the Casamance Natural Region

Here, the focused is on infrastructure related to the agricultural value chains in the region. In 2014-2017, during a needs assessment carried out by the IRD (International Relief and Development), 16 operational cashew processing units were identified in the region with respective production capacities of 1,200 tons, 1,000 tons, 750 tons and less than 100 tons each.

[17] https://www.afdb.org/en/documents/senegal-projet-dimplantation-dune-zone-de-transformation-agroindustrielle-sud-pzta-sud-ou-agropole-sud-p-sn-aag-004-cpr.

All of these units, although with a total capacity of 4,150 tonnes, have so far managed to process only 350 tonnes (8% of their capacity or less than 1% of domestic production). Although small and medium-sized treatment units are supported by the Casamance Economic Development Support Program (PADEC) and the IRD, the bulk of Senegalese cashew nut production is exported as raw nuts via The Gambia by Indian trading companies. Local units say they are having trouble sourcing raw material because of the high purchase prices offered by their Indian competitors. Similarly, a total of 27 mangoes processing units were identified in the southern regions as shown in Table 4. Small-scale and semi-industrial Mango processing units by distribution in the Region Table 4 with total production capacity of 15,366kg and total yearly volume of 105,042kg. Post-harvest infrastructure available in the South region also consists of storage depots for rice (15 units) and mini-platforms (5) serving as grouping centres for fruits and vegetables at the level of Nyassia to Dioher communes.

Table 4. Small-scale and semi-industrial Mango processing units by distribution in the Region

Région	Nos of Unis	Production Capacity (kg)	Volume of Production (kg)
Kolda	4	7,100	28,400
Sédhiou	7	3,571	25,000
Ziguinchor	16	4,695	51,642
Total	**27**	**15,366**	**105,042**

3.2.2.3 Rationale for AfDB's Involvement in the SCPZ Project in Senegal

Support for the Agro-Industrial Transformation Area Project (PZTA) is all the more justified as it is in line with the priorities of the Bank's Country Strategy Paper 2016-2020 for Senegal. The project site is located in the South Agropole in Senegal (Figure 2), particularly its Pillar I relating to support for agricultural transformation. It aligns with 3 of the 5 operational priorities of the Bank's 2013-25 Decennial Program in (i) the Feeding Africa 2016-2025 Strategy; (ii) the Bank's Africa Industrialization Strategy 2016-25; and (iii) the Strategy for Improving the Living Conditions of African People. With its experience in the development of PZTA, and the strategic partnership with Senegal in the implementation of the three 'Competitive Integrated Agropoles' of the PES, the Bank proves to be the best equipped to support the Government in the formulation of this first PZTA. Finally, the Bank has a comparative advantage for this project to be financed through a public window in order to increase private investment in this innovative initiative.

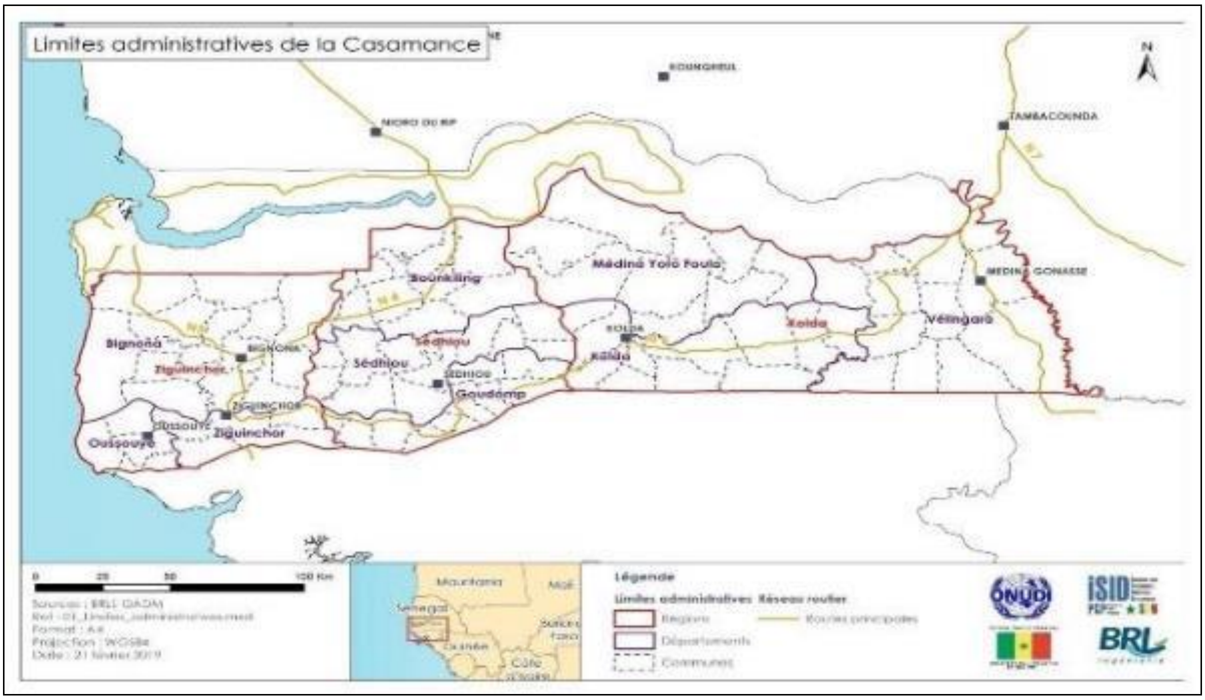


Figure 2. Map of South Agropole in Senegal

3.2.2.4 Lessons Learned from AfDB's Involvement in the SCPZ Project in Senegal

The key lessons learned from AfDB's involvement in the SCPZ project in Senegal as well as from previous AfDB's portfolio in the country are:(i) Strengthen the Bank's support to the private sector in order to improve its competitiveness and competitiveness; contribution to growth; (ii) Improve the quality of projects in preparation through the use of the Project Preparation Fund (PPF); (iii) Increase the role of the Bank's office in Senegal in project supervision and assistance to reduce file processing times; (iv) Raise the level of domestic resource mobilization, in a context in which 50% of AfDB's public project financing must come from the counterpart; (v) Support Agropole development projects; (vi) Improve the country's absorptive capacity by removing bottlenecks in project implementation (procurement, disbursement, M & E, etc.); and, (vii) Strengthen project monitoring by the Borrower (Ministries of Economy, Finance, etc.)[18].

3.2.3. Agro-Industrial Processing Zones Development Programme in Guinea (PDZTA-BK)[19]

The Republic of Guinea covers an area of 245,857 km² with an estimated population of about 11,555,061 in 2017, comprising 51.61% women and 48.39% men. The rural population, estimated at 64.41%, derives most of its income (79%) from agricultural activities. There is, however, a marked contrast between the country's economic situation and its natural potential. In addition to its mineral wealth, there are significant surface water resources (188 km^3) and 72 km^3 of groundwater. Estimated arable land potential is 6.2 million hectares, of which 25% are cultivated annually. According to 1993 estimates, there were 70,000 km² of rich and varied grazing land composed of almost 350 fodder species. The country has about 300km of coastline with significant artisanal and industrial fisheries potential. However, Guinea's imports of fresh food products are valued at almost USD 745 million (2016), most of which can be produced locally, in particular, cereals with an import value of USD 339 million in 2016. In order to

[18]https://www.afdb.org/en/documents/senegal-projet-dimplantation-dune-zone-de-transformation-agroindustrielle-sud-pzta-sud-ou-agropole-sud-p-sn-aag-004-pgpv.

[19] Guinea - Special Agro-Industrial Processing Zones Development Programme (PDZTA-BK) (afdb.org)

reverse this trend and boost sustainable development, the Government has launched many development initiatives on the basis of growth sources and lessons learned from past decades, including Vision 2040, reflected in the Plan for Economic and Social Development (PNDES). The PNDES is being implemented through the National Agricultural Development Policy (PNDA) whose implementing instrument is the National Agricultural Investment, Food and Nutrition Security Plan (PNIASAN)[20].

PDZTA is the 1st phase of a programme of ten (10) Agri hubs under the PNIASAN and is intended to strengthen economic activity in the Boké and Kankan regions (Figure 3) particularly in agriculture, livestock, fisheries, forestry, industry, mines, handicrafts, trade, catering, hotels, banks, etc. Over 80% of these activities are carried out in the informal sector. Cereal production is very important as well as market garden and food crops. These regions are considered to be cereal basins and provide real opportunities for the supply of maize, the manufacture of cattle and poultry feed but also of fortified cereals to reduce chronic malnutrition. The establishment of storage facilities and a processing zone for aggregating cereal products, in particular maize and sesame, might boost the agricultural sector in these two regions that lack commercial and road infrastructure and have limited opportunities for reaching outlets. Other crops such as mangoes and cashew nuts are becoming increasingly important. Since there is no processing unit in the region, most of the output is exported as raw products.

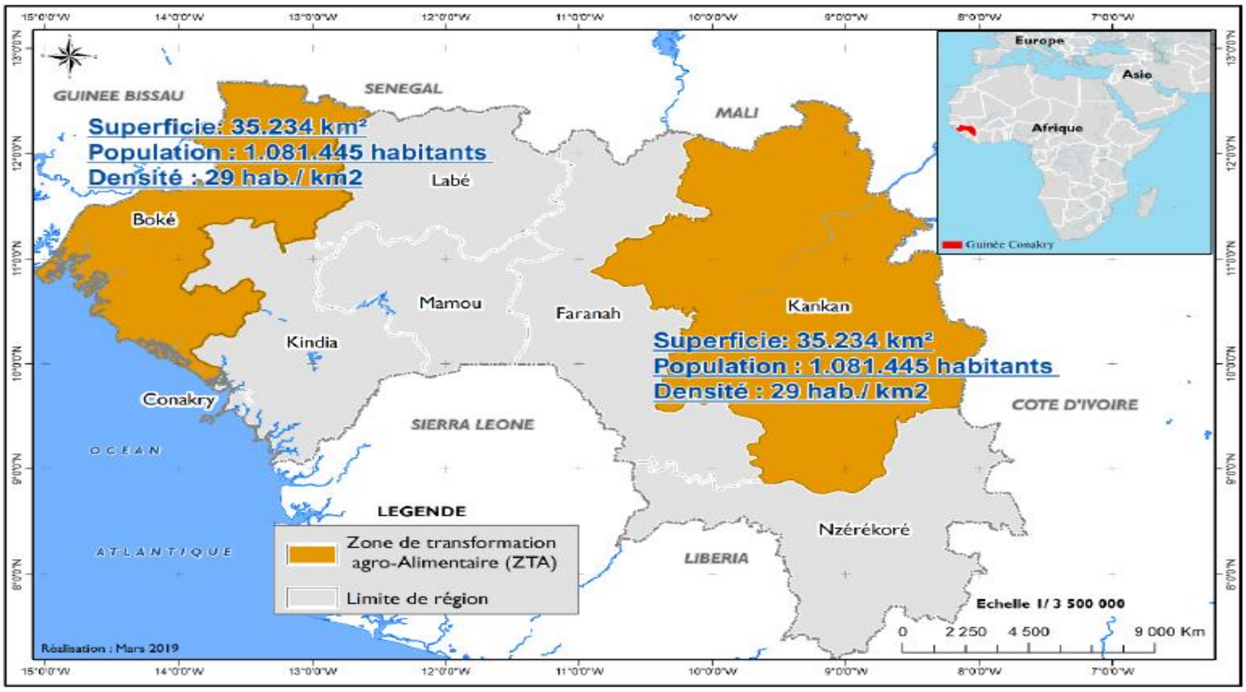


Figure 3. Map of PDZTA-BK SCPZ

The administrative area of the Boké and Kankan regions consist of about 103,333 km², of which 31,186 hectares lie in the Boké Region with an arable land area of about 2,720,000 ha (800,000 ha lie in the Boké Region alone). The project will cover about 110,000 ha throughout the entire programme area (PA) and have a significant impact on about 220,000 direct beneficiaries and 670,000 indirect beneficiaries, 50.7% of who will be women. The main crops and stock farming activities of concern are: (i) cash crops such as cashews, oil palms, sesame and soya; (ii) food products such as rice, fonio, groundnuts, maize, potatoes, yams and cassava; (iii) fruit such as

[20] Guinea - Special Agro-Industrial Processing Zones Development Programme (PDZTA-BK) - Project Appraisal Reports | African Development Bank - Building today, a better Africa tomorrow (afdb.org).

oranges, mangoes and pineapples; (iv) market garden products, in particular, tomatoes, onions, okra and chillies; (v) poultry and sheep breeding; (vi) fishery products from fish farming; (vi) non-wood forest products such as honey, leaves, wild seeds and fruit, oils and resins, infusions, among others. As shown in Table 5 and Table 6, Guinea has strong agricultural potential, particularly in terms of livestock and fishery production, including a wide variety of cash crops such as Rice, paddy; Cassava, Oil palm fruits, Maize, Groundnuts, Fonio, Plantains and many other cash crops as shown in Table 6.

Table 5. Guinea Livestock Productions (in 000 Heads) and Fish Production (Tonnes) in 2017

Cattle	Chickens	Goats	Pigs	Sheep	Fishery
7,108,328.0	31,541.0	2,920,000.0	133,031.0	2,522,019.0	114,800.0

FAO Statistics (2017)

Table 6. Crops Production in Guinea, Harvested Area and Yields in 2017

Crops	Area harvested (Ha)	Yield (Hg/Ha)	Production (Tonnes)
Rice, paddy	1,707,622.0	13,057.0	2,229,649.0
Cassava	178,674.0	77,484.0	1,384,447.0
Oil palm fruit	315,053.0	26,727.0	842,045.0
Maize	608,919.0	12,614.0	768,082.0
Groundnuts, with shell	650,000.0	8,308.0	540,000.0
Fonio	665,113.0	7,732.0	514,233.0
Plantains and others	90,028.0	52,220.0	470,127.0
Sugar cane	5,698.0	536,904.0	305,950.0
Maize, green	129,023.0	23,258.0	300,078.0
Vegetables, fresh nes	64,557.0	39,859.0	257,316.0
Fruit, citrus nes	43,664.0	53,312.0	232,778.0
Bananas	41,840.0	51,104.0	213,818.0
Sweet potatoes	59,991.0	33,812.0	202,839.0
Millet	194,070.0	10,443.0	202,668.0
Mangoes, mangosteens, guavas	87,932.0	20,186.0	177,499.0
Taro (cocoyam)	22,648.0	62,935.0	142,534.0
Roots and tubers, nes	31,966.0	42,229.0	134,989.0
Pineapples	31,966.0	42,229.0	134,989.0
Yams	13,433.0	90,428.0	121,474.0
Potatoes	5,616.0	105,080.0	59,012.0
Pulses, nes	63,273.0	9,233.0	58,421.0
Coconuts	14,645.0	38,563.0	56,478.0
Fruit, tropical fresh nes	8,244.0	62,358.0	51,407.0
Seed cotton	45,453.0	9,551.0	43,412.0
Sorghum	42,111.0	9,744.0	41,033.0
Coffee, green	39,077.0	4,558.0	17,813.0
Rubber, natural	12,887.0	12,931.0	16,665.0
Cocoa, beans	21,619.0	4,921.0	10,638.0
Cocoa, beans	21,619.0	4,921.0	10,638.0
Cashew nuts, with shell	9,000.0	11,667.0	10,500.0
Sesame seed	14,744.0	1,981.0	2,920.0
Melons, other (inc.cantaloupes)	285.0	100,874.0	2,874.0
Tobacco, unmanufactured	1,964.0	12,247.0	2,406.0
Sisal	2,007.0	991.0	199.0
Nuts, nes	58.0	28,657.0	166.0

FAO Statistics (2017)[21]

[21] FAOSTAT:www.fao.org/faostat/en/#data/QC.

3.2.3.1 Land Tenure Policy in Guinea[22]

Prior to 1992 before the new, and still official, framework land tenure law (Code Foncier et Domanial [CFD]) was passed in law in Guinea, there was very little protection or encouragement for private property. With the signing of the new land law in 1992, land privatization and registration system came into existence, at least on paper. As recently as April 2008, a regional assessment of land policy in West Africa observed that the lands commissions established by the CFD and responsible for the implementation of much of the new legislation are not active in rural areas (USAID, 2008)[23]. As stressed in the USAID Report,

> *'The government remains the property owner for all unregistered land (which includes virtually all rural land) prior to its registration. In addition to lacking institutional capacity for registration of land and implementation of the CFD on a wide scale, the Guinean government is also extremely limited in its ability to actively manage the extensive government-owned land holdings established by the land code' (USAID, 2008).*

In 2001, the Déclaration de la Politique Foncièreen Milieu Rural was adopted by the Guinean Government to address critical land challenges in the country. The new land reform builds upon previous reforms but differs from others in a number of ways[24].

- First, in the Déclaration de la Politique Foncièreen Milieu Rural, customary property rights to land are explicitly recognized. It therefore, recognises and protects the rights of vulnerable or socially marginalized groups.
- Second, the new land law promotes an approach to the registration of property rights that begins with an inventory of existing rights, both formal and informal.
- Third, the new policy outlines an action plan that, among other things, targets specific articles of the CFD for revision, and addresses existing institutional shortcomings.
- Private property rights are recognized and protected by the Guinean constitution. The state, as well as all physical and corporate legal entities, may hold titles to land as property (CFD, Article 17).

The definition of "Property" is covered in (**Article 2**) of the Guinea Constitution. According to **Art.2**, to become 'Property', the resource must be registered in a land tenure plan that is maintained by a "public collective," i.e., a decentralized governing unit vested with legal authority (Article 3). In addition, the property holder must register the land with the national land tenure registry (la conservation foncière – **Article 3**). Satisfaction of this second requirement confers legal property rights to the title-holder (**Article 10**). The registration process is defined in Articles 135-151 of the CFD (USAID, 2018). Other Articles of the constitution that is relevant to land reforms include[25]:

- Article 49 that deals with the establishment of a land tenure commission in each prefecture, as well as in each commune.
- The land commission has the purgatives of deciding whether all the requirements have been fulfilled by an applicant before the issuance of a land title (Article 52). The same article states

[22] https://www.afdb.org/en/documents/guinee-programme-de-developpement-de-zones-de-transformation-agro-alimentaire-pdzta-p-gn-aag-004-rapport-cges

[23] USAID (2008). https://www.land-links.org/wp-content/uploads/2016/09/USAID_Land_Tenure_PRADD_Guinea_Policy_Review.pdf.

[24] https://www.afdb.org/en/documents/guinee-programme-de-developpement-de-zones-de-transformation-agro-alimentaire-pdzta-p-gn-aag-004-rapport-cges.

[25] Ibid.

that in rural areas, "investment" is to consist of structures and infrastructure, irrigation development, plantations, and plant production.

- Vacant or "vacant or unclaimed lands" (vacants et sans maître) is covered under (Article 119) and a property of the government.

3.2.3.2 Rationale for AfDB's Involvement in the SCPZ Project in Guinea

Like most RMCs, Guinea imports most of its fresh food products which are valued at almost USD 745 million (2016), most of which can be produced locally, in particular, cereals with an import value of USD 339 million in 2016. As highlighted in Table 5 and Table 6, Guinea has strong agricultural potential, particularly in terms of its abundant land and water resources, a 43,000 km^2 continental shelf and enjoys mild temperatures providing it with significant opportunities for the development of a varied range of agro-silvo-pastoral products and significant potential for the development of a blue economy. The Bank has defined 5 operational priorities for such a situation, one of whose four objectives is to reduce imports and make Africa a net exporter. Guinea has, therefore; followed in the Bank's footsteps with different strategies aimed at addressing this situation by developing Guinea's agricultural potential, by establishing long-term infrastructure in the areas of transport, energy, agricultural production, marketing and processing with private sector involvement in the sector.

The Bank's interventions, through the PDZTA-BK, which is the first phase of a programme of ten (10) agro-hubs, are consistent with the Bank's CSP (2018-2022) and Hi-5s. The programme will help to effectively boost economic development since it is consistent with the Bank's strategies by consolidating the role of the private sector and communities in rural development, a guarantee of inclusiveness in Africa, and in Guinea, in particular. It was, moreover, designed on the basis of complementarities with ongoing operations and those under preparation, especially those relating to implementation of the Boké-Québo Road Project and the Support Programme for the Transformation of Guinean Agriculture and Youth Agricultural Entrepreneurship (PATAG-EAJ), with a view to seeking synergies. This programme will, therefore, seek to leverage the ongoing actions in the Boké and Kankan Regions to ensure the operation's relevance and effectiveness.

3.2.3.3 Lessons Learned from AfDB's Involvement in the Project in Guinea

The PDZTA's formulation incorporates the lessons learned from the Bank's previous and ongoing operations in Guinea and through the RMCs taking into account issues concerning portfolio performance and the country's fragility. These lessons were reiterated in the most recent July 2018 review following which portfolio performance was considered to be satisfactory. However, the review noted that efforts should be continued in order to improve: (i) the effectiveness period (11 months instead of the Bank's recommended 6 months); (ii) mobilisation of programme management teams; (iii) procurement periods considered to be too long; (iv) mobilisation of counterpart funds; (v) the programme personnel performance monitoring system by the systematic establishment of performance contracts and renewal of staff contracts on the basis of the results of the annual staff evaluation; and (vi) the time taken to update the baseline situation and establish the monitoring and evaluation system.

The Portfolio Performance Improvement Plan (2018 PPIP) also recommended that specific measures be taken to accelerate the programme implementation rate. This recommendation, which has been taken into account in this proposal, is reflected in: (i) the maintenance of stakeholder dialogue and close monitoring by the Bank's Country Office (COGN) in order to mitigate risks relating to delays in the PDZTA-BK implementation and administration period and process and the fulfilment of conditions precedent to effectiveness; (ii) improvement of quality at entry by using advance procurement action for preparing bidding documents and management tools (Manual of Accounting and Financial Procedures-MAFP, Computerised Accounting and Financial Management System – SIGCF, and of monitoring and evaluation prior to Programme commencement; and, (iii) capacity building for programme management teams in procurement and financial management. It is also worth noting that the ongoing portfolio has been considerably rejuvenated in recent years, that the average age for operations fell from 5.5 years in 2011 to 2.7 in 2017 and that it contained no problematic programme (PP) or potentially problematic programme (PPP) in 2017. 2.7.3 The PDZTA design, therefore; took into account the lessons learned from previous operations and incorporated in the 2018 Portfolio Performance Improvement Plan (PPIP) in order to meet the design and implementation criteria contained in Presidential Directive 002/2015.

3.3. Conclusion

The Staple Crops Processing Zones (SCPZs) are critical in AfDB's agenda for the transformation of African's agriculture. They present a tool that can help to boost increased agricultural productivity and strengthen the capacity of Regional Member Countries (RMCs) to create added value to agriculture, livestock and fisheries, with a view to reduce food imports, initiate a structural change in the agricultural sector and diversify the national economy. SCPZs as a flagship program are already attracting the interest of many RMCs.

Prior to rolling out the pilot programme in Togo, Senegal and Guinea (Phase II), a status study of Africa's SCPZs was conducted to draw up lessons learned, identify the challenges, risks, success and failure factors, and assess how African SCPZs have contributed to economic development goals. Such knowledge would not only help to inform the formulation of the AfDB's strategy to assistance these three countries but would also support prospective RMCs interested in establishing SCPZs as part of their agricultural transformation programs. It would also help RMCs to better plan, design and implement their SCPZ programs.

The results of the status analysis show that the SCPZs approach has been implemented in Africa for about 20 years compared to over 50 years elsewhere in the world. The pioneers of this approach in Africa are Morocco and Tunisia, and are even beginning to offer their expertise to other African countries. The study noted that the models of SCPZs sampled vary in form and content: their designs, implementation arrangements, financing and management modalities. The disparities in the findings led to the identification of the following key success factors that would trigger sustainable SCPZs:

- Adequate policy and regulatory framework and supportive business environment sustained by legislation and official documents describing the national development strategic framework in which they fit.
- Private sector leadership based on state facilitation in SCPZs' animation and mobilization of investments. This requires continuity in political will despite changes in government and active promotion of the initiative by very senior level champions in the public and private sectors.
- Important, patient and inclusive financing accessible to all actors, including small producers and small and medium enterprises operating in the SCPZs.
- Quality infrastructure (energy, water, roads, ICT) conducive to well managed agro-industrial development maintained in carefully chosen locations.
- Uninterruptible power supply at competitive cost, good roads, clean water, telecommunications, waste treatment, as well as proximity to administrative and regulatory offices.

- Inclusion of smallholder producers and SMEs in the SCPZ model is essential for sustainability. SCPZ initiatives should identify challenges faced by smallholder farmers and SMEs along the value chain and endeavour to build their capacity and improve their performance so that products from the SCPZ can be competitive on the market.
- Support farmers in ways that will enable them to invest in new and cost-effective climate resilience technologies and agricultural practices.
- Access to affordable financing to smallholder farmers especially women who are most involved in low-returns agricultural activities such as vegetable gardening and forest products gardering.

4. SCPZs BASELINE PROGRAMME AND FINANCING

The SCPZs baseline programme is structured around the following three components: (i) development of SCPZs access infrastructure such as roads, water and waste management and support for Agro-Industrial Parks (AIPs) management governance; (ii) capacity building of value chains agents/communities' and development of agricultural processing support infrastructure; and, iii) program coordination and management. The issues of gender, socioeconomic and environmental concerns are transversely integrated in all components.
In Figure 4, we present the thematic areas of intervention of the SCPZs programme in the three pilot countries (baseline investments), and the additional interventions sort from the GCF to **'trigger' a paradigm shift towards low-emission, climate-resilient measures** along the agricultural value chains in these countries.

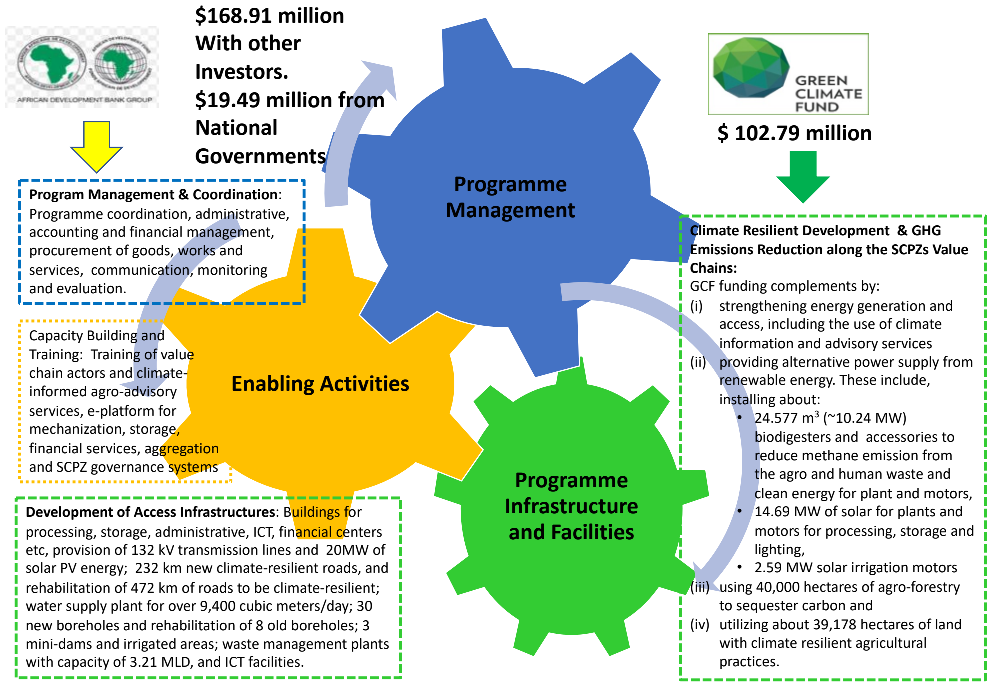


Figure 4. SCPZs Baseline Programme and GCF Intervention Areas

4.1. Location of the SCPZs Programme Activities and Selection Criteria

(i) Togo

In Togo, the SCPZ programme covers the Kara region (Figure 1), which consists of seven (7) Prefectures namely: Assoli, Bassar, Bimah, Dankpen, Doufelgou, Kéran, and Kozah, with an estimated population of approximately 769,940 inhabitants. The area of intervention covered by the SCPZs program in Togo is estimated at about 165,000ha.

A detailed assessment of the processing requirements needed at the Kara IAIP were carried out by the Ministry of Agriculture, Livestock and Water (MAEH). This help informed the selection of activities to be undertaken for supporting the development of the Kara IAIP, which described in sub-section 4.2. below.

These include:

- Stakeholder consultations and viewpoints
- Diagnosis of agricultural activity in the project area: identification of the potential of the area, both in terms of natural, human and technical resources; choice of promising sectors

such as rice, maize, soybean, broiler meat, poultry, cashew nuts and sesame, which are widely cultivated by both peasant and commercial farmers.

- Estimation of market needs;
- Collection of information on potential private sector investors.
- Market study for the identified sectors;
- Proposal for an Agropole concept for Togo, based on good practices in this area and guidelines defined by the ordering parties; and,
- Preparation of studies relating to the various arrangements.

The findings of these studies and all supporting annexes that help informed the choice of project activities described in sub-section 4.2 at the Kara IAIP, are available at:

https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/TOGO_-__APPROVED__-_Agro-Food_Processing_Zone_Project__PTA-TOGO_.pdf .

https://www.afdb.org/en/documents/togo-projet-damenagements-hydro-agricoles-pistes-et-approvisionnement-en-eau-potable-dans-lagropole-du-bassin-de-la-kara-volume-22-p-tg-aag-002-eies

https://www.afdb.org/en/documents/togo-projet-damenagements-hydro-agricoles-pistes-et-approvisionnement-en-eau-potable-dans-lagropole-du-bassin-de-la-kara-volume-21-p-tg-aag-002-eies

https://www.afdb.org/en/documents/togo-projet-damenagements-hydro-agricoles-pistes-et-approvisionnement-en-eau-potable-dans-lagropole-du-bassin-de-la-kara-volume-1-p-tg-aag-002-eies

https://www.afdb.org/en/documents/togo-projet-damenagements-hydro-agricoles-pistes-et-approvisionnement-en-eau-potable-dans-lagropole-du-bassin-de-la-kara-p-tg-aag-002-pcr

https://www.afdb.org/en/documents/togo-projet-damenagements-hydro-agricoles-pistes-et-approvisionnement-en-eau-potable-dans-lagropole-du-bassin-de-la-kara-volume-4-p-tg-aag-002-eies

https://www.afdb.org/en/documents/togo-projet-damenagements-hydro-agricoles-pistes-et-approvisionnement-en-eau-potable-dans-lagropole-du-bassin-de-la-kara-volume-3-p-tg-aag-002-eies

https://www.afdb.org/en/documents/togo-projet-de-transformation-agro-alimentaire-du-togo-pta-togo-p-tg-aag-002-rapport-cges

https://www.afdb.org/en/documents/togo-projet-de-transformation-agro-alimentaire-du-togo-pta-togo-p-tg-aag-002-cpr

https://www.afdb.org/en/documents/togo-projet-de-transformation-agro-alimentaire-du-togo-pta-togo-p-tg-aag-002-pgpp

(ii) Senegal

In Senegal, the program activities will focus in the Casamance Natural Region corresponding to the administrative regions of Ziguinchor, Sédhiou and Koldaqui (see Figure 2). The SCPZ project in Senegal covers a total land area of 105,000ha inhabited by over 1,872,668 people. The administrative breakdown of the three (3) regions is as follows:

Ziguinchor Region:
- 3 Departments: Bignona, Oussouye and Ziguinchor,
- 8 districts,
- 5 Urban Communes and 25 Rural Communes, and
- about 502 villages

Sedhiou Region:
- 3 Departments: Boukiling, Goudomp and Sedhiou;
- 9 districts;
- 10 urban communes and 33 rural communities; and,
- 920 official villages.

Kolda Region:
- 3 Departments: Kolda, Medina Yoro Foula and Vélingara;
- 9 districts; and
- 9 urban communes and 31 rural communes.

A detailed value chain analysis assessment of the 3 IAIPs (North, Central and South Agropoles),and their specific requirements for establishing the IAIPs was carried out by UNIDO. The value chain analysis help informed the selection of activities to be undertaken at the 3 IAIPs described in sub-section 4.2 below.

These include:

- Stakeholders consultation and viewpoints,
- Proximity to raw materials,
- Proximity to markets and connectivity to logistics and transport networks. The main or central module would house production infrastructure but also administration and related services (trade, logistics, maintenance, skills development and training, financing, communications and basic social services, etc.). Modules of regional modules consisting of processing and service infrastructures which will be gradually developed there and departmental platforms equipped with infrastructures for collecting and packaging materials.
- Existing agro-processing infrastructures that are in place. and,
- The agricultural potentials of the region. In view of the production potential of mango (55% of national production) and cashew (80% of national production) in the southern region, the opportunities for valuing the two products with gains of 933 billion FCFAf for the 'cashew nut and 42 billion CFA francs for mango, for the creation of wealth and jobs, the two speculations were validly put forward for the pilot phase of the SCPZ project in the region.

Detailed findings of these studies and all supporting annexes that help informed the choice of project activities described in sub-section 4.2 for Senegal SCPZ project, are available at:

https://www.afdb.org/en/documents/senegal-south-agro-industrial-processing-zone-project-pzta-sud-or-agropole-sud-project-appraisal-report.

https://www.unido.org/programme-country-partnership/senegal.

https://www.afdb.org/en/documents/senegal-projet-dimplantation-dune-zone-de-transformation-agroindustrielle-sud-pzta-sud-ou-agropole-sud-p-sn-aag-004-rapport-ees

https://www.afdb.org/en/documents/senegal-projet-dimplantation-dune-zone-de-transformation-agroindustrielle-sud-pzta-sud-ou-agropole-sud-p-sn-aag-004-cpr

https://www.afdb.org/en/documents/senegal-projet-dimplantation-dune-zone-de-transformation-agroindustrielle-sud-pzta-sud-ou-agropole-sud-p-sn-aag-004-pgpv

(iii) Guinea

In Guinea, the focused is on the Boké and Kankan regions, which covers a total land area of about 103,333 km², of which 31,186 hectares lie in the Boké Region with an arable land area of about 2,720,000 ha, about 800,000 ha of which lie solely in the Boké Region. The SCPZ programme will cover about 110,000 ha throughout the entire programme area and have a considerable impact on about 220,000 direct beneficiaries and 670,000 indirect beneficiaries, of whom 50.7% will be women.

A detailed assessment of the IAIP project in Guinea and specific requirements needed for establishing the 2 IAIPs in the Boké and Kankan regions, was carried out by the host country in collaboration with AfDB. The assessment help informed the selection of activities to be undertaken at the 2 IAIPs described in sub-section 4.2 below for Guinea. These include:

- The agricultural potentials of the 2 regions. These two regions have significant resources and potential for multiple economic activities (agriculture, animal breeding, fisheries, forestry, mining, etc.). Broadly speaking, agriculture is the population's main sector of activity with the following main crops and stock farming activities extensively carried out: (i) cash crops such as cashews, oil palms, sesame and soya; (ii) food products such as rice, fonio, groundnuts, maize, potatoes, yams and cassava; (iii) fruit such as oranges, mangoes and pineapples; (iv) market garden products, in particular, tomatoes, onions, okra and chillies; (v) poultry and sheep breeding; (vi) fishery products from fish farming; (vi) non-wood forest products such as honey, leaves, wild seeds and fruit, oils and resins, infusions, etc.
- Existence of other ongoing activities in the region. The programme will build on production activities as well as those concerning the establishment of access and marketing infrastructure for operations that are currently ongoing in the region. In Boké Region, these programmes are the Bank’s PTAG-EAJ programme (UA 8.99 million), the Bank (UA 40.04 million) and European Union (EUR 20.38 million) Boké-Québo Programme and the World Bank’s Enclave Programme for Agribusiness Development (USD50.00 million). In the Kankan region, these are the IFAD AgriFarm (USD61 million) ABEDA (USD20 million) and OFID (USD15.00 million) Programmes.
- Proximity to local and international markets, transport networks and telecommunications. The regions have access to over 200km of Atlantic coastline, and
- Stakeholder consultations and viewpoints.

Detailed findings of these assessments and all supporting annexes that help informed the choice of project activities described in sub-section 4.2 for Guinea, are available at:

https://www.afdb.org/en/documents/guinea-special-agro-industrial-processing-zones-development-programme-pdzta-bk-project-appraisal-reports.

https://www.gtai.de/resource/blob/165206/1383305e35747ff7252b6840f96073f6/pro201910215011-data.pdf.

https://www.afdb.org/en/documents/guinee-programme-de-developpement-de-zones-de-transformation-agro-alimentaire-pdzta-p-gn-aag-004-rapport-cges.

https://esa.afdb.org/sites/default/files/RAPPORT%20FINAL%20%20EESS%20%20PROGRAMME%20DE%20DEVELOPPEMENT%20DES%20ZONES%20DE%20TRANSFORMATION%20AGROALIMENTAIRE%20PDZTA%20GUINEE.pdf.

4.2. SCPZs Programme Components

As highlighted under Section 3.3, one key lesson learned by AfDB from the review of SCPZs models is that, existing pilot models vary in form and content, their designs, implementation arrangements, financing and management modalities. This was taken into account while supporting the design of the programme interventions in the three pilot countries. The processes involved in the selection of programme interventions were very rigorous. It entailed several site visits by key stakeholders, national and international teams of the Consultant, donor partners, communities etc, round table discussions and validation workshops.

4.2.1. Component 1: Strengthening of critical SCPZs value chain infrastructure and management governance

As earlier indicated and defined under sub-section 3.1, the two essentials components of a Staple Crops Processing Zone (SCPZ), are: i) **Establishment of Agro-Processing Hubs (APHs)** that offers adequate infrastructure, logistics and specialized facilities and services (e.g. electricity, water, cold chain facilities, laboratory and certification services, business services, ICT, waste treatment, etc.) required for agro-industrial activities; and ii) **Creation of Agricultural Transformation Centres (ATCs)** that are strategically located within the production area to serve as aggregation points to accumulate products from the community to supply the Agro-Processing Hub.

These two essential components must be supplemented with access to basic infrastructure such as feeder roads, electricity, ware houses, water and water storage facilities, cold chain facilities, produced storage facilities, laboratory and certification services, business services, ICT, waste treatment, among others. Component was specifically designed for this purpose as well as to help in reforming the regulatory and institutional frameworks necessary for attracting private sector investments. The sub-components vary from countries to countries as follows:

(i) Togo[26]

The project formulation was facilitated by the establishment of an Inter-Ministerial Steering Committee involving all stakeholders. Discussions between the key players (private sector, OPAs, banks, etc.) and the Bank's mission continued during private investment promotion days in the Kara region, held on 5 and 6 April 2018 by the Chamber of Commerce and Industry of Togo (CCIT) and the National Council of Employers (CNP). Targeted meetings were held with the private sector, including with the Kalyan Group, which has applied for a loan from the Bank's private sector window to finance its planned investments in the Agro-park for sesame and

[26] For more details, see, for example, Togo - Togo Agro-Food Processing Zone Project (PTA-TOGO) - Appraisal Report | African Development Bank - Building today, a better Africa tomorrow (afdb.org)

cashew nuts. Several meetings were also held with TFPs including the World Bank, the French Development Agency, GIZ, UNIDO and FAO. At the local level, the people and local chiefs were involved and their expectations on major issues have been addressed including the issue of compensation for impacted persons. Awareness and information campaigns for various social groups (men, women and young people) were conducted throughout the project formulation process.

Sub-component 1.1: This sub-component is specifically designed to develop the key Agro-park infrastructure through: (i) Architectural, detailed engineering design/bidding documents studies and supervision of construction work; (ii) Site development works & roads and sundry networks (roads, drinking water supply, sanitation, electricity, telecommunication, fencing, etc.); drinking water supply station, water treatment, etc.; (iii) Construction of buildings (administrative and residential block, services block such as training centre, conference centre, and laboratories, etc., socio-collective infrastructure block such as school, health centre, hotel, etc.; (iv) Installation of MV electricity supply (CEET) and fibre optic telecommunication work; and, (v) Assistance for the establishment of a business incubator (provider).

Sub-component 1.2: This sub-component will enhance access to infrastructure for aggregation and access to agricultural inputs and services through: (i) Establishment of basic infrastructure for 10 CTAs located in 10 village centres covering the three agricultural production areas (irrigated, lowlands, rain-fed); (ii) Technical studies and supervision of the construction of CTAs; (iii) Construction works on 10 CTAs (harvest storage stores, input storage hangars, cooperative offices); (iv) Procurement of agricultural, cleaning and logistical equipment; (v) Detailed design study of the main road (100 km) and secondary roads (50 km); (vi) Work on the rehabilitation of roads (100 km) including ancillary structures; and, (vii) Control and supervision of rehabilitation works on the main road.

Sub-component 1.3: This component will support access to infrastructure for agricultural production through: (i) Detailed engineering design/bidding documents studies for three mini-dams and irrigated areas (1,500 hectares); (ii) Supervision of the construction of two mini-dams (Vol >15 Mm^3); (iii) Full technical and economic studies on the B9 dam with irrigated areas; (iv) Construction of two mini-dams for agricultural use (potential of 1,500 hectares) and industrial use (4,000 - 5,000 m^3/day for the Agro-park); and, (v) Development of 600 ha of irrigated land downstream of agro-park dam No. 2.

(ii) Senegal[27]

The preparation of the Project was done in a participatory way with the involvement of stakeholders (including women and youth) of the project especially during feasibility studies. As such, an innovative approach (with the Labs) that has already been proven in Malaysia (PIMANDU), has been put into practice including during the structuring of the sub-projects (public, private, PPP), with the participation of 150 people representing 90 structures (PO, local authorities, private sector, etc.). This approach will be pursued during the appraisal mission and the project implementation through: (i) A steering structure that will bring together the representatives of all the parties, (ii) the continuation of the participatory approach in the implementation of project activities; (iii) implementation of a communication plan at all levels (national, regional, and local).

Component is divided into 3 sub-components, which are:

[27] For more details, see for e.g., Senegal - The South Agro-Industrial Processing Zone Project (PZTA-Sud, or Agropole Sud) (afdb.org).

Sub-component 1.1: Improving the regulatory and institutional framework for IP through: (i) Support to the functioning of the Steering Committee (COPIL) of the three PES Agropoles: meetings, field missions, organization of forums, etc.; (ii) Assistance to the establishment of the Construction and Operating Company-SCE and its subsidiaries by FONSIS, including the one-stop shop (land security, business creation, tax & customs services, certification / certification, etc.); (iii) Strengthening capacities of State structures in charge of quality, standardization, certification, metrology and promotion of exports (equipment, laboratories, targeted training, etc.): MDIPMI, ASEPEX, etc; (iv) Technical assistance for the upgrading of regulatory texts for the promotion of IP in agribusiness; and, (iv) Support for the formulation / implementation of incentives (tax, customs, etc.) for PI in Southern Agropole (based on studies)

Sub-component 1.2: Support for the establishment of the industrial superstructure. This includes: (a) Implementation of the central module (industrial park) at Adéane including: (1) roads and various networks-VRD (drinking water, electricity, sanitation, etc.); (2) an administrative block (conference room, offices, parking, etc.); (3) a social space block (nursery, gym, medical center, restaurants, green spaces, etc.); (4) a block of services (training center, rural economy management center-CGER, business incubator, etc.); (5) a logistics block (weighing platform, storage / conditioning sheds, loading / unloading dock, etc.); (6) 4 Enterprise blocks of 3 ha (serviced plots, covered car parks, etc.); (vii) a technical block (borehole, water tower, treatment EP et EU units, GE generator set shelter, boiler, etc.); (b) Construction works of 3 regional modules of 10 ha each (Kolda, Sédhiou and Bignona) including: (1) a serviced site (earthworks / clearing, VRD, etc.); (2) logistics block and services (administrative building, CGER antenna, financial services, plot serviced for private, market place, loading / unloading platform, weighbridge, storage / conditioning shed, etc.); (3) a technical zone block (water tower + borehole, generator shelter, boiler, waste treatment area, etc.); (c) Work to set up aggregation platforms and services (5 sites of approximately 2-3 ha each) integrating: (1) servicing of the site; (2) a service block (administrative building, weighbridge, loading / unloading dock, etc.); (3) a technical block (sorting space, primary storage, etc.); Control and supervision of infrastructure works in the agropoles; (d) rehabilitation of 372 km of access tracks to modules and aggregation platforms, and agricultural production areas, etc., water tower, borehole, generating set, waste treatment.

Sub-component 1.3: This component will improve the supply of financial and non-financial services through: (i) Support for the implementation of a digital platform for access to A-I services (mechanization, storage, inputs, financing, etc.); (ii) Facilitating access to SME/OPA financing: guarantee funds, financing lines, warehouse receipts, etc.; and, (iii) Capacity building of SFD/Banks networks (based on calls for proposals): training, equipment for decentralized offices, etc.

(iii) Guinea[28]

A consultation-based participatory process was the guiding principle for the project's design. It was adopted for discussions and consultations with officials from the Ministries concerned (agriculture, industry, transport, energy, trade, etc.), public administrations, the private sector, local authorities (of Kankan and Boké), producer organisations, civil society and TFP (World Bank, AFD, IFAD, European Union, Chinese and Japanese Cooperation and the Abu Dhabi Fund). It was implemented in the following stages: (i) preparation and proposal by the country

[28] For more details, see for e.g., Guinea - Special Agro-Industrial Processing Zones Development Programme (PDZTA-BK) - Project Appraisal Reports | African Development Bank - Building today, a better Africa tomorrow (afdb.org)

team of terms of reference for the programme feasibility studies; (ii) preparation by the AfDB team of a report on the establishment of a Programme Preparation Facility (PPF); (iii) preparation of the PPF by the AfDB until its approval by the country team; (iv) broad-based consultation of stakeholders during project appraisal in Conakry, Boké and Kankan, especially during the assessment of environmental safeguard measures required for environmental categorisation and publication of the summary of the Strategic Environmental and Social Assessment (SESA) Report; (v) continuation of consultations during the appraisal mission during field visits to Kankan and Boké, consultations with all the stakeholders and key actors (civil society, public administration, private sector and technical and financial partners) in Conakry.

This proposal is also a response to strong demand from grassroots communities, due to inconsistencies between the potential of the regions concerned and weak agricultural development in the zones concerned. This participatory process will continue during the programme's implementation through: (i) a steering structure that will bring together representatives of all parties, (ii) capacity building for institutions and communities on the participatory process, (iii) community involvement in the implementation of activities; and (iv) the establishment of a programme results-based monitoring and evaluation system. In addition, the AfDB's Country Office in Guinea will constantly ensure that the consultation mechanism is operational throughout the programme's implementation.

In Guinea, component 1 of the programme is subdivided into 3 sub-components as follows:

<u>Sub-component 1.1:</u> Establishment of a governance system for APZ management in Guinea. This includes: (i) Support for the establishment of agribusiness hubs (Agro-parks); (ii) Support for the preparation of agro-park specifications; and, (iii) Feasibility study for new APZ in Guinea.

<u>Sub-component 1.2:</u> **Support for APZ management governance through: (i) S**upport for the preparation of implementing texts for the Land Law and operationalization of the one-stop-shop for land registration; (ii) Support for the preparation of legal, regulatory and operational framework for the Strategic Environmental and Social Assessment (SESA); (iii) Support for the structures in charge of quality standards and norms as well as food fortification with micronutrients; (iv) Technical assistance for the implementation of measures to promote private investment in agro-parks (instruments, incentives, etc.); and, (v(Holding of fora to promote APZ investments.

4.2.2. Component 2: Promotion of climate resilient agricultural practices and technologies adoption among smallholder farmers

This component aims at strengthening the capacity of value chains agents and communities to adapt to the new Agropole approach, as well as to provide other Agropole incentive measures needed to sustain the model.

(i) Togo

<u>Sub-component 2.1</u>: *Designed to support the Improvement of the policy, regulatory and operational framework of the Agropole. This includes**: (i)*** Technical assistance for the preparation of instruments for implementation of the Land Code (voted by the National Assembly on 5 June 2018), the specifications of the Agro-park management company and operationalization of the single window; (ii) Support for the development of a legal, regulatory and operational framework for the Strategic Environmental and Social Assessment (SESA); (iii)

Support for the national departments responsible for quality, standards and metrology (facilities, training) at the Ministry of Industry; (iv) Technical assistance for the implementation of private investment promotion measures in the Agro-park (including instruments and incentives), financial and management procedures and support for project management (APRODAT); and, (v) Convening of an investment promotion forum for the ZTA (2)

Sub-component 2.2: *Establishment of the ZTA governance system. This includes*: **(i)** Institutional support for APRODAT's capacity building (staff, legal, technical and management assistance, training, etc.); (ii) Support for the preparation of the specifications of the Agro-park management company, its recruitment (CAT) and monitoring of performance quality; and, (iii) Feasibility study for two new ZTAs (OTI and Haut Mono regions)

Sub-component 2.3: Targeted at s*trengthening State and non-State public institutions.* This includes: (i)Support for non-financial institutions (computer and laboratory equipment and training): research institutes (Togo Institute for Agronomic Research (ITRA)), consulting (Technical Advice and Support Institute (ICAT)), training (CIDAP, INFA-Tové), Technical Advice and Support Institute (ICAT), universities, etc.) and seed control/certification; and, (ii) Support for financial institutions: Establishment of a risk insurance fund, procurement of equipment (computer hardware and software), and capacity building for banks and financial institutions (including in agribusiness).

Sub-component 2.4: *Capacity building for agricultural producers.* This includes: (i) Networking of sub-sectors (rice, maize, soybean, sesame, cashew nuts and broiler meat) and development of consultation frameworks; (ii) Building of the technical and management capacity of 10 CTAs of villages situated in the three agricultural zones (irrigated, lowlands, rain-fed); (iii) establishment of an information system for use by FOs (e-farmers, e-aggregation, e-inputs, e-services, etc.,); (iv) Increased access to financing by FOs (guarantee fund); and, (v) Training and TA of state workers on the Saemaul Foundation approach.

Sub-component 2.5: *Capacity building for village communities* through:(i) Restoration of vegetation cover, protection of natural habitats around dams and hydro-agricultural structures; (ii)Manufacture of 5 000 improved stoves (fight against deforestation); (iii) Facilitating access to vital civil status documents (approximately 50,000 people, including at least 70% women and young people); (iii) Construction of 4 mini-DWS networks, 30 new boreholes equipped with manually operated pumps, and rehabilitation of 8 boreholes (households and SMEs/producer organizations - OPs), for about 2,195 households; and (iv) Support for the implementation of priority sub-projects for 2 CTAs: (i) acquisition and input management (see ITRA/OCP soil survey); (ii) input procurement and management of equipment; (iii) crop storage and management; (iv) agricultural services (Saemaul Foundation); etc

Sub-component 2.6: Targeted at strengthening central and decentralised services. This includes: (i)Training and technical assistance from State services (with ICAT) in the participatory, gender, nutrition and local development approach; (ii) Implementation of the safeguards included in the SESA such as: (1) Preparation of a resettlement policy framework; (2) Preparation of a wastewater and solid waste management blueprint; (3) Preparation of an environmental best practices manual; (4) Implementation of the Environmental and Social Impact Assessment Plan (ESMP) and pesticide management plan; (5) Environmental and social baseline situation; (6) Monitoring implementation of the Environmental and Social Management Plan ESMP (ANGE), RAP (ANGE) and PGPP (ANGE); (6) Procurement of motorcycles and computer equipment (agricultural regional administration).

(ii) Senegal

Sub-component 2.1: *Technical assistance and capacity building of producers of agro-industrial sectors through:* (i) Support to institutional actors in the value chains such as: (1) structuring/operation of the key sectors (mango, cashew) and complementary (maize, banana, NTFP);(2) strengthening OP/SME capacities (organizational, technical and management);(3) primary storage/conditioning infrastructure;(4) support for contractualization and implementation of PPPs; and, (5) establishment of an information system on agricultural markets; (ii) Support to farmers, including: (1) support for certified seed multiplier networks (maize, mango, etc.);(2) Strengthening the technical, financial and managerial capacities of farmers;(3) support for access to index insurance for farmers of the project;(4) agricultural census and update of key sector statistics

Sub-component 2.2: *Building of Community Resilience Capacity through:* (i) Organization of stakeholder sensitization rounds on the Agropole approach, including social marketing and conflict prevention / management; (ii) Implementation of additional production tracks (if necessary); (iii) Assistance in the implementation of the Environmental and Social Management Plan (ESMP) and the Resettlement Action Plan (RAP); (iv) Support for the implementation of the Action Plan for Nutrition and Health (PNS); and, (v) Support to the functioning of the 3 Regional Monitoring Committees of the Southern Agropole.

(iii) Guinea

Sub-component 2.1: *Establishment of servicing infrastructure for the Boké and Kankan agro-parks.* This includes: (i) Site development works and roads and other networks (roads, DWS, sanitation, electricity, telecoms, enclosure, etc.), DWS station, WTPP, etc.; (ii) Construction of buildings of administrative and residential block including services unit (training centre, conference centre, laboratories, etc.), as well as social community infrastructure unit (school, health centre, guest house, etc.); (iii) Works on laying the LV and MV power transmission and fibre optic lines; (iv) Assistance for the establishment of a business incubator (service provider); (v) Works implementation, control and monitoring studies; and, (vi) the establishment of a single window for start-ups in Kankan.

4.2.3. Component 3: Programme Management and Coordination

This component follows a two-tier approach to coordination and management. First and the AfDB's level and second, at national level. The aim is to provide an effective and efficient management of the program, at the level of AfDB and by each country for the national components towards the expected results of the program. It includes the implementation of a central (coordination) and national coordination of the program, the technical and financial management, the supervision of activities, the monitoring-evaluation as well as the annual audits. Table 7 presents the program implementation and monitoring schedule.

Table 7. Project Implementation Timetable

COMPONENTS/OUTPUTS	Year1				Year2				Year3				Year 4				Year5			
	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 1	Q 2
Ouput 1: Output 1.1: Improved access to drip irrigation distribution systems (DIDS) powered by solar pumps to support climate resilient agricultural (CRA) practices.																				
Activity 1.1.1: Support access to small-scale agricultural water management (AWM) infrastructure (Irrigation of a total of 39,250 ha of land with 2-inch-diameter drip irrigation distribution systems (DIDS)																				

Issuance of International Competitive Bidding (ICB), short listing, and selection of firm for training, supply and installation of DIDS																				
Mapping exercise and selection of DIDS sub-project beneficiaries and including the identification of 39,250 ha of land																				
Grant work plan for DIDS sub-project beneficiaries including management committees determined																				
Capacity building and training of sub-project beneficiaries in the use of DIDS																				
Distribution and installation of DIDS to selected sub-project beneficiaries																				
Output 1.2: Enhanced resilience of SCPZs energy supply through increased access to renewable energy																				
Activity 1.2.1 Improving agricultural cooperatives, FBAs value chain infrastructure for food processing (Installation of 14.69MW of solar energy for lighting, processing, drying and packaging of staple food crops)																				
Issuance of ICB, short listing, and selection of firm for the training, supply and installation of 14.69MW of solar energy																				
Mapping exercise and selection of sub-project beneficiaries of 14.69MW of solar energy installations																				
Sub-project loans and grants financing work plan determined including management committee																				
Capacity building and training of sub-project beneficiaries of 14.69MW of solar energy																				
Distribution and Installation of Solar PV equipment to sub-project beneficiaries																				
Activity 1.2.2: Deploying low-carbon energy technologies (installation of 24,577 m3 of biogas digester with an estimated genset power output of about 10.24 MW)																				
Issuance of ICB, short listing and selection of firm for the installations of 10.24MW of clean energy (24,577 m3 of biogas digester)																				
Mapping exercise for the selection of eligible beneficiaries of bio-digesters																				
Biogas grants and loans work plan, including biogas management committees determined																				
Capacity building and training in Biogas digesters, Bio-slurry, safety standards etc.,																				
Construction and bio-digester handover to sub-project beneficiaries																				
Output 2.1: Adoption of CRA and agro-forestry practices among smallholder farmers																				
Activity 2.1.1 Promoting CRA practices among smallholder farmers (A total of 39,178 ha will be for CRA practices).																				
Mapping exercise and selection of sub-project beneficiaries of GCF loans and grants																				
Work plan for sub-project grants and loans for CRA practices determined																				
Capacity building and training of sub-project beneficiaries in CRA and agro-forestry practices																				
Implementation of CRA activities																				
Activity 2.1.2 Promoting Agro-forestry practices among smallholder farmers (A total of 40,000 ha will be for agro-forestry practices)																				
Mapping exercise and selection of sub-project beneficiaries of GCF loans and grants																				
Work plan for sub-project grants and loans for agro-forestry practices determined																				
Capacity building and training of sub-project beneficiaries in agro-forestry practices																				
Implementation of agro-forestry activities																				

Output 2.2:Increased community resilience through capacity building, awareness and institutional strengthening on climate information and early warning systems (CIEWS) for risks preparedness and readiness.																				
Activity 2.2.1: Capacity Building of Value Chains Agents/Communities' & Development of Agricultural Processing Support Infrastructure																				
Capacity building and training of value chains agents/communities', institutions & ESCOs on O&M																				
Training of Project Executing Agencies (PEAs), Project Implementing Units (PIUs), and the Agro-industrial Parks (AIPs) staff etc.																				
Activity 2.2.2: Establishment of climate information and early warning systems in SCPZs ((i) Expansion of agrometeorological and rain stations by establishing 10 automated agrometeorological and 50 rain gauge stations in each of the SCPZ region; (ii) Procure and maintain 2 four-wheel project vehicles per region (i.e., a total of sixteen (16) project vehicles); (iii) Deploy technologies to strengthen climate information services and early warning systems in all the SCPZs; (iv) Capacity building and awareness raising)																				
Issuance of ICB for site identification and procurement of agrometeorological and rain gauge stations in the SCPZs																				
Issuance of ICB, short listing and selection of firm for the establishment of climate information and early warning systems in SCPZs																				
Procurement of project vehicles for site supervision and sensor maintenance																				
Mapping exercise for the selection of eligible beneficiaries of CIEWS																				
CIEWS grants and loans work plan, including CIEWS management committees determined																				
Capacity building and training on key aspects of the CIEWS																				
Setting up and commissioning of CIEWS																				
Output 3.1 Project management, monitoring and evaluation																				
Activity 3.1.1 Project management, evaluation and coordination																				
*In addition to this monitoring requirements, the Funded Activity is also subject to financial reporting per the AMA/FAA, such as Unaudited/Audited Financial Statements, Financial information reports, and other reports as defined in the FAA.																				

** APR=Annual Performance Report

*** MTE=Mid-term Evaluation

**** TE=Terminal Evaluation

(i) Togo

<u>Sub-component 3.1</u>: Implementation, *Management and Coordination of the Project*. The PTA-Togo will be implemented by the Agency for the Promotion and Development Agropoles in Togo (APRODAT) which was established by Decree No. 2018-036/PR of 27 February 2018 to steer the implementation of the Togo Agropoles Strategic Development Plan. The Ministers responsible for Agriculture and Industry respectively will provide joint supervision of APRODAT which has two organs: (i) a Board of Directors, chaired by the Prime Minister, and comprised of seven active members (public and private) and observer members, and (ii) a Directorate General (DG). The Board of Directors will meet quarterly to review and approve the

work programme and activity reports. The Directorate General to be set up with project support will eventually comprise five Directorates: The Directorate of Legal, Administrative and Financial Affairs, the Directorate of Forecasting, Planning, Monitoring and Evaluation, the Directorate of the Promotion of Financing and Investments, the Directorate of Facilities and Works Control and the Directorate of Training, Research and Development. A team of experts will be recruited to build APRODAT's capacity, particularly in the implementation of the PTA. This team, under the responsibility of the Director General, PTA Coordinator, will include: an Administrative and Financial Officer, an Accountant, an Agro-Industry Specialist, an Investment Specialist, a Monitoring and Evaluation Specialist, a Procurement Specialist, a Rural Infrastructure Specialist, an Agronomist (Development), an Environment and Social Specialist, a Social Development Specialist, a Legal Officer, an Internal Auditor and Specialist in Organisation Management, Gender and Capacity Building. The PTA implementation team will be supported by a Project Assistant and Drivers. Similarly, the Project will support APRODAT in partially covering equipment and personnel costs and in setting up the administrative, financial and accounting management system required for the project financed by the Bank. In accordance with the provisions of the Presidential Decree establishing APRODAT, the entity in charge of promoting and managing the Kara Agro-park will be managed as a semi-public company involving the State and the private sector and will therefore have administrative, financial and accounting management autonomy.

Procurement: The procurement of goods (including non-consultancy services), works and consultancy services, financed by the AfDB as part of the project, will be carried out in accordance with the **Procurement Framework for AfDB-Funded Operations, October 2015 edition** and the provisions set out in the Financing Agreement. More specifically, the procurements will be carried out as follows:

- **Borrower's Procurement System (BPS):** Procurement methods and procedures (PMP) based on Togo's procurement system including its laws and implementing decrees (Law No. 2009-013 of 30 June 2009 and implementing Decree No. 2009-277/PR of 11 November 2009 relating to the Public Procurement Code as well as its subsequent implementing decrees and texts), based on standard national competitive bidding documents (SNCBDs) or other bidding documents as approved during project negotiations for works and low-complexity goods contracts provided for in the project and generally available in Togo.

- **AfDB Procurement Methods and Procedures (BPM):** The AfDB's standard BPM, based on the relevant standard competitive bidding documents (SCBDs) for major and more complex works and goods contracts, as well as consultancy services, deemed to be the most appropriate. Given the delays in procurement and in order to limit their impact on project implementation, the Government submitted to the Bank a request to use advanced procurement action (APA) to make procurements for: (i) the recruitment of APRODAT's key project implementation staff (Director General, Administrative and Financial Officer, Accountant, Agribusiness Specialist, Investment Officer, Procurement Specialist, Legal Officer And Internal Auditor, Specialist in Environmental and Social Issues, Rural Infrastructure ,Specialist, Specialist in Organisation Management, Gender and Capacity Building); (ii) procurement of APRODAT furniture and office equipment provided for under the project; (iii) the recruitment of a consulting firm for the development of a summary preliminary design and a detailed preliminary design of Agro-Park facilities; and (iii) the recruitment of a consulting firm for the development of the detailed preliminary designs for studies on small dams/irrigated areas and roads ; and (iv) procurement of office furniture for APRODAT and the Kara Agro-Park Management Company.

Procurement Risk and Capacity Assessment (PRCA): The assessment of country, sector and project risks as well as of the capacity of the executing agency (EA) for procurement purposes was conducted1 for the project and the outcomes served to guide the decision on the choice of procurement system (Borrower or Bank) used for specific activities or for all similar project activities. The Project Executing Agency is the Agency for the Promotion and Development Agropoles in Togo (APRODAT) which is a public institution with legal personality and management autonomy. It is under the joint supervision of the Ministries responsible for Agriculture and Industry. APRODAT is not fully operational because only the Board of Directors and the acting Director General have been appointed and therefore the procurement risk is deemed "high". In fact, APRODAT does not yet have procurement bodies (Procurement Officer, Public Procurement Board and Procurement Control Board), while staff members have not yet been appointed or recruited, particularly the Procurement Specialist, dedicated to the Project and having the required qualifications and experience. In order to reduce the risk to "low", APRODAT will have to recruit a Procurement Specialist and set up procurement bodies. Moreover, the Bank will finance technical assistance in which procurement will be taken into consideration. The Borrower and the Bank will agree on a procurement plan for the first 18 months of the Project, which will be updated annually or as needed, in order to reflect the actual project implementation needs. Any revision of the plan will be subject to prior approval by the AfDB.

Financial Management and Disbursement Arrangements: Established on 27 February 2018, APRODAT is in the process of being set up. Whereas the Board of Directors which will act as the PTA Steering Committee has been appointed pursuant to Decree No. 2018/036/PR of 27 February 2018, and its Chairman appointed Acting Director General, it will be necessary to wait for the recruitment of financial management staff and the establishment within APRODAT of an operational financial management system to ensure full transparency, traceability and accountability in the use of PTA funds. To this end, the Togolese Government will have to take the following actions:

- Completion of the organisation chart in accordance with the principles of internal oversight, particularly the separation of incompatible functions, and the appointment of the heads of services making up the directorates mentioned in the Decree, especially those of the directorates involved in the implementation of the SCPP (Administrative and Financial Officer, Accountant, Procurement Officer, etc.);
- Development of the administrative, financial and accounting procedures manual, on which its internal oversight system will be based, covering all management cycles: expenditure management cycle (procurement procedures for goods and services), asset management cycle (fixed assets, inventories, etc.), cash management cycle (scheduling, disbursement, cash monitoring and control, etc.), resource mobilisation cycle (fund raising, direct payments, etc.), accounting, financial and budgetary information cycle, personnel management cycle, control and internal audit cycle;
- Development, where appropriate, of an Operations Manual for facilitation and financial intermediation activities (access of processing units to financing);
- Establishment of an integrated multi-project and multi-user management system to ensure the keeping of budgetary, analytical and general budget accounts. General accounting has to be a private accrual accounting system, applying the SYSCOHADA standards and taking into account the specific features of development projects;
- Establishment of internal audit mechanisms, with the recruitment of an Internal Auditor who will ensure that the SCPP control system is operational and effective; and,
- Establishment of external audit mechanisms through the hiring of independent external auditors on a competitive basis and in accordance with the terms of reference agreed with

the Bank, in line with the Bank's requirement that audit reports be submitted no later than 30 June of the year following the year audited.

Pending the establishment and operationalization of APRODAT, the overall fiduciary risk, incorporating the inherent risk and the risk of non-control resulting from the evaluation of the agency’s financial management capacity, will remain high.

It is noteworthy that the first step is to encourage the establishment of APRODAT to mitigate the risk mentioned and to take the advantage of fluidity in current financial markets.

Disbursements: AfDB financing will be mobilised in accordance with the rules and procedures of the Bank Disbursement Manual through the three disbursement methods: (i) direct payment (for the procurement of works, goods and services and other relatively high-cost expenditure...); (ii) the special account (mainly for operating expenditure); and (iii) reimbursement, where appropriate.

Project Monitoring and Evaluation: Technical and Financial Monitoring. The Project Monitoring and Evaluation Officer appointed from within the project management unit will be responsible for collecting, analysing and compiling information on physical achievements and financial execution. For this purpose, he/she will have a roadmap with quantitative indicators on Project progress, relating to implementation of the sub-components. Such monitoring will make it possible to obtain, every six months, the following information for each activity: physical objective, achievement level, expected costs, actual costs, differences and explanations for possible deviations. This information will be used to prepare the half-yearly project progress reports. Moreover, in Pending the establishment and operationalization of APRODAT, addition to the Steering Committee’s review work, the Bank will carry out two supervision missions per year, to which should be added a mid-term review mission.

Impact Assessment: The Project impact assessment will be conducted through participatory studies. The first step in this assessment will be the study of the baseline situation which will aim at determining the level of the following indicators at Project year zero: (i) current average household income; (ii) major crop yields (t/ha); (iii) current production levels; (iv) industrial processing rates; (v) level of organisation of supply of inputs and delivery of agricultural services (including mechanization and electronic payments); (vi) level of organisation of marketing; and (vii) volume of funding mobilised. The same study will be conducted at project completion based on the same sample.

(ii) Senegal

Sub-component 3.1: Implementation, Management and Coordination of the Project. The Project Executing Agency (AGEX) will be the Ministry in charge of Industry through a Project Implementation Unit (PIU). Thus, a Steering Committee (COPIL) chaired by AGEX will be set up to (i) review and approve the AWPB; (ii) analyze activity reports (including financial reports) and audit reports. It will include representatives of the Ministries in charge of: Plan and Cooperation, Finance, Agriculture, Trade, Gender and Social Affairs, Environment, Spatial Planning, Health and Nutrition; as well as representatives of the Private Sector, Federations of Farmers' Organizations, Local Authorities, Consular Chambers and BOS / PES. The Coordinator of the PIU will provide the secretariat of the COPIL.

The PIU will be responsible for the coordination, implementation and monitoring of Agropole Development (PZTA). The PIU will be based in Dakar and will be in charge, of 3 Agropole projects (PZTA); it will have 3 regional antennas corresponding to the 3 Agropoles (South, Center and North). The composition of the PIU, which will be confirmed during the evaluation mission, should include at least: (i) a National Coordinator; (ii) a Lawyer, Private Sector Specialist and PPP; (iii) an agribusiness engineer; (iv) an Infrastructure Engineer; (v) an Agricultural Engineer; (vi) a specialist in organizational development; (vii) a Monitoring and Evaluation Specialist; (viii) an Acquisition Specialist; (ix) an Administrative and Financial Officer; (x) 3 Regional Coordinators; (xi) 2 accountants; (xii) 2 Procurement and Administration Assistants; and (xiii) support staff (computer scientist, cashier, secretaries, drivers, etc.).

Procurement Procedures: Acquisitions will be in accordance with the 'Procurement Policy and Methodology for AfDB-financed Operations', October 2015 edition. The next project appraisal mission will be the following: opportunity to assess procurement risks and capacities at the country, sector (Ministry) and other actors to guide the mission in making decisions on the choice of procurement system to be used for the project. Detailed information on the acquisition modality will be defined during this mission, together with the Government, including the possibility of using the national procedures and the use of Early Acquisition Shares (AAA).

I'm not conversant with the procurement procedure of AfDB, but can I add the following to it; all tenders must be on competitive advantage basis - costs of delivery, ease and cost of maintenance, including repairs, training and actual plan in place for complete technology transfer programme.

Financial Management Arrangements: In line with the provisions of the Paris Declaration on Aid Effectiveness, the AfDB, like most other PTFS, has agreed to maximize, to the extent possible, the use of national systems for project and program management including financial management. An evaluation of the existing financial and accounting management system will be made during the evaluation mission. It will cover, in particular, the Ministry of Supervision, the Ministries in charge of Economy and Finance and the other institutions involved in the implementation of the project.

Monitoring Mechanisms: For this project, a results-based and impact-based monitoring-evaluation-M & E mechanism will be defined during the evaluation mission. It will have to integrate an internal M & E system (including physical and financial aspects) and external, involving all actors (including the private sector). Internal M & E will be managed by the future PIU and Executing Agency, while external M & E will be overseen by COPIL and Government partners. Specific capacity building needs of actors will be covered by the Project to enable them to play their respective roles. Finally, the Bank will ensure, in accordance with its procedures, the regular supervision of the Project.

(iii) Guinea

Sub-component 3.1: Implementation, *Management and Coordination of the Project*. At national level, programme management will be placed under the oversight of the Authority for the Development and Administration of Special Economic and Industrial Zones (ADAZZ), attached to the Presidency of the Republic. This institutional arrangement is due to the multi-sector nature of the programme and the need for strong leadership to provide coordination among all the programme’s actors. For this purpose, ADAZZZ will be strengthened institutionally through the PDZTA Programme Management Unit (PMU). The PMU will be lightly structured and responsible mainly for coordination, financial management, procurement and programme monitoring and evaluation activities. It will comprise: (i) a national coordinator; (ii) a monitoring and evaluation officer; (iii) a procurement officer; (vi) an environmental specialist, (vii) an administrative and financial officer; and (ix) an accountant.

The PMU will also be supported by periodic technical assistance (international and national consultants). On the ground, it will be assisted by partner organisations, in particular, administration structures, the Guinean Institute for Agricultural Research (IRAG), the Private Investment Promotion Agency (APIP) as well as the Ministries and technical agencies involved in the programme. The signing of agreements with these partner structures, including IRAG, will be one of the loan and grant conditions under ‘other conditions. The documentation on these agreements will have to be included as soon as possible and prior to effectiveness in order to facilitate the programme implementation no-objection process. A Steering and Monitoring Committee (COS) will be established to monitor and guide the programme’s activities in order to more closely supervise the innovations introduced by the programme, to ensure the relevance of the main choices to be made during implementation. It is justified by the involvement of several sector Departments. The COS will be composed of representatives of the General Secretariat at the Presidency, Ministry of Planning and Cooperation, Ministry of the Economy and Finance, Ministry in charge of Agriculture, Ministry in charge of Investment and SME Promotion, Governors of Regions, Employers, the Association of Economic Operators, etc. COS will be chaired by the Secretary General of the Presidency or his/her designated representative and Secretariat services provided by the ADAZZ Director. It will meet regularly on the basis of a schedule defined in the programme procedures manual, and exceptionally as required.

The Programme Steering Committee (PSC) of the PDZTA will be chaired by the oversight Ministry or its representative and composed of representatives of the Ministry of the Economy and Finance, Ministerial Departments and representatives of all the stakeholders concerned by the Programme. The PSC will meet at least twice a year in ordinary session to approve the Annual Work Programme and Budget and to validate the programme performance results. The Planning Department of the oversight Ministry will provide Secretariat duties to the PSC. The PSC responsibilities are to: (i) ensure periodic monitoring of the Programme’s activities; (ii) review external evaluation reports and (iii) give guidelines to the PMU on any possible refocusing of the Programme. It will be composed of all the actors involved in the Programme, in particular, the Ministry of Agriculture, Ministry of Finance, Ministry of Industry and Ministry of Planning.

Procurement and Disbursement Arrangements: The procurement of goods (including services other than consulting services), works and the acquisition of consulting services financed by the Bank under the programme will be carried out in accordance with the Procurement Framework for Bank Group-financed operations, 2015 edition, and in compliance with the provisions of the financing agreement. More specifically, procurements will be made in accordance with the Bank’s Procurement Methods and Procedures (BPP), on the basis of the relevant standard bidding documents (SBDs) for goods and works contracts as well as consulting services for which the BPP are considered to be the most appropriate. Indeed, following an analysis of the Guinean procurement system as presented in Technical Annex B5 of this report, the procurement risk was considered to be substantial. As a result, for the implementation of this programme, the Bank’s Procurement Methods and Procedures will be used, since a capacity building action plan will be the subject of dialogue with the Guinean Authorities in order to rapidly ensure use of the national procurement system following the reforms identified as necessary.

Procurement Risks and Capacity Assessment (PRCA): The assessment of procurement risks at country, sector and programme level as well as the capacity of the executing agency (EA) was carried out and the results were used to influence the decision to choose the BPM for all activities planned under the programme.

***Organisation of Procurement Implementation*:** Programme procurement will be carried out by the Programme Executing Agency. In light of the conclusions of the assessment of the executing agency's capacity, a management unit including a procurement expert will be recruited to implement the procurement process but also to build the capacities of the different actors involved in procurement.

Advance Procurement Action (APA): The Government intends to submit to the Bank for approval a request for the use of APA in order to recruit consultants to conduct studies on agro-park infrastructure and irrigation schemes. This request shall be submitted to the Bank prior to the programme's presentation to the Bank's Board of Directors.

Disbursement: The disbursement methods to be used to mobilise the ADF loan financing are: (i) the direct payment method; (ii) the special fund/revolving fund method and (iii) the reimbursement method. Direct payments will be made in respect of contracts for works, goods and services signed between the Borrowers and suppliers, in accordance with the Bank's procurement rules and procedures and national procurement legislation. The special account method will be used to settle operating expenditure, training costs, field mission costs etc. It will require the opening of a Special Account at the Central Bank of Guinea, which will, in turn, pay all the funds received from the ADF into the PMU bank account opened in a bank acceptable to AfDB. The opening of the Bank account will be a condition precedent to the first disbursement. The reimbursement method will be used when eligible expenditure on ADF loan resources are pre-financed with the Bank's prior approval. These disbursements will be made in accordance with the list of goods and services and the Bank's rules and procedures as described in the Disbursement Handbook.

Financial Management: The Programme Management Unit (PMU) will be responsible for the programme's overall coordination and financial management. Its financial management staff will comprise the programme coordinator, the administrative and financial officer, the accountant and cashier, all of whom will be recruited in accordance with the programme's procurement arrangements.

The financial management systems of the ADAZZ management unit whose structures will be used under the PDZTA are not satisfactory on the whole and the overall fiduciary risk is substantial because of the absence of: (i) financial coordinator and personnel as mentioned above; (ii) an administrative, financial and accounting procedures manual; (iii) operational accounting and financial management software; and (iv) financial management tools and reference framework. As a result, the PMU should take the following measures: (i) as soon as the programme is launched, prepare a budget plan coupled with the indicative activities schedule; (ii) when the programme is launched, recruit a consultant to prepare the administrative, financial and accounting procedures manual (AFAPM), and another responsible for establishing the computerised accounting and financial management system (SIGCF) ; (iii) assign financial tasks as soon as the financial staff are recruited; (iv) establish the financial management framework and instruments in accordance with the Programme Appraisal Report.

Audits: Once a year, a competent and independent firm of external auditors will verify the reliability of the consolidated financial statements prepared by the PMU and will assess the operation of the internal control system of the entire programme. It will be recruited in accordance with the terms of reference and bidding procedures recommended by the Bank. Audit costs will be financed by the ADF loan. The audit reports must be forwarded to the Bank each year, no later than six months after the closure of the audited period. Audits will be performed in accordance with SYSCOA international audit standards and the Bank's comprehensive terms of reference which will be communicated to the programme.

Monitoring: Internal monitoring and evaluation will be carried out by the Programme Monitoring and Evaluation Unit, while external monitoring-evaluation will be the responsibility of the Ministry of Planning and the Ministry in charge of Finance. The objective of external monitoring and evaluation is to assess the efficacy and efficiency of the programme's outputs and their contribution to the achievement of the development objectives which are the programme outcomes and impacts. It will be carried out with the involvement of the other stakeholders in addition to two annual supervision missions organised by the Bank. The mid-term review will be carried out in year 3. Following the programme's closure, the Bank and Government will produce a completion report within the required timeframe.

4.3. Programme Expected Outcomes/Achievements, Performance Monitoring Framework and Timeline

(i) Togo

For Togo, the main outcomes expected from the programme are as follows:

- Increase in the productivity and agricultural production of import substitutes (rice, maize, soybean, broiler meat) and exports (cashew nuts and sesame);
- Increase in the share of agricultural products processed in situ (from 19% to 40%) through private investment in the Agro-park (90,000 tons/year of rice paddy, 15,000 tons/year of maize, 10,000 tons/year of soybean, 20,000 tons/year of feed, 10,000 tons/year of cashew nuts and 10,000 tons/year of sesame, production of 3 million chicks per year, slaughtering of 2 million broilers/year);
- Expansion of developed lowlands and irrigation areas from 10,000 to 15,000 ha;
- Improvement of sesame yields per hectare from 250 to 800 kg;
- Increase in the number of agro-industry companies from 0 to 3;
- Increase in the drinking water access rate from 25% to 55%.
- Strengthening of the people's food and nutritional security;
- Creation of wealth and employment, including for young people and women;
- The project will bring direct benefits to about 303,000 people in the Bassar, Doufelgou, Kéran, Bastar and Dankpen Prefectures, 51% of whom are women, and indirect benefits to the estimated 769,940 people of the Kara region. The main impacts expected from the project for the direct beneficiaries are as follows: improved food and nutritional security and incomes thanks particularly to better access to markets, agricultural inputs, agricultural services and financing.
- It is expected that the project would lead to: (i) an increase in private investments thanks to a more favourable business environment for the establishment of infrastructure in the Agro-park (roads and sundry networks, single window, training room, maintenance centre, incubation centre, etc.);
- Increase in agricultural production capacities resulting from rural infrastructure (dams, irrigated areas, roads, etc.);
- Capacity building for operators in the 10 multipurpose agricultural transformation centres (ATCs) (inputs, farm equipment, technologies, financing, harvest aggregation, etc.).
- Construction of a transmission line of about 50 km from Sarakawa to Agbassa to supply electricity for the Agropole Park activities and electrification of the chief towns of districts and localities situated within its vicinity.
- Construction of over 400 km of rural roads and rehabilitate 28.2 km of road on the Avépozo-Aného section to reduced transport cost for agribusiness ventures around the growth poles.

Rehabilitation of this road will include an environmental component to protect communities against the advance of sea water.

See Annex 2 for Togo's Performance Monitoring Framework and Timeline for the implementation of the baseline components are presented in Annex 1

(ii) Senegal

In Senegal, some of the anticipated outcomes will include:

- At the economic level, the project should double or even triple the household income from the exploitation of the main targeted sectors (mango, cashew, maize, banana and forest products).
- At the social level, approximately 14,500 people will be directly affected by the project, while the number of indirect beneficiaries is estimated at 350,000 people (51% of whom are women). The project will target the private sector likely to invest in the project.
- At the level of fragility, the conflict in the natural region of Casamance deepened the social divide dug by years of crisis and rekindled identity / ethnic tensions and land conflicts. Despite a return to calm, rising growth rates, the construction of infrastructure and state efforts for peace, the local population suffers from a certain impoverishment and the social fabric remains fragile. The result is the need to continue efforts for sustainable reconciliation, a return to social cohesion, and inclusive growth as a guarantee of stability and prosperity for all. Thus, efforts must take into account the regional, rural and gender (youth and women) dimension of fragility and consider concerted economic, humanitarian and social responses.

See Annex 3, for Senegal's Performance Monitoring Framework and Timeline for the implementation of the baseline components are presented in Annex 1

(iii) Guinea

- At the project level in Guinea, it is expected that the programme will have:
- Considerable impact on about 220,000 direct beneficiaries and 670,000 indirect beneficiaries, of whom 50.7% will be women.
- Considerable impact on additional 110,000 ha of land that will be under improved effective management.
- Considerable impact on improved crops yields particularly cashews, oil palms, sesame and soya; rice, fonio, groundnuts, maize, potatoes, yams, cassava, oranges, mangoes and pineapples, tomatoes, onions, okra and chillies, poultry and sheep breeding, fishery products from fish farming, as well as non-wood forest products such as honey, leaves, wild seeds and fruit, oils and resins among others.
- Impact on the productivity and agricultural production of import substitutes such as rice, fonio, groundnuts, maize, potatoes, yams and cassava, oranges, mangoes and pineapples.
- Considerable impact on skills acquisition along the agricultural value chains.
- Crowding-in effects on private sector investors among others.

4.4. Programme Baseline Investments

In this section, we present the baseline investment of the SCPZs programme in the three pilot countries. The total baseline investment is estimated at **$168.912.536,95** as shown in Table 8.

Table 8. SCPZs Programme Financing and Major Sources

SCPZs Program Sources of Financing			
Togo	Financial Instrument	Sector	Amout USD (M)
African Development Fund (ADF)	Loan	Public	$11.308.822,80
African Development Fund (ADF)	Grant	Public	$6.519.451,95
Transition Support Facility (TSF)	Loan	Public	$11.702.662,40
West African Development Bank (BOAD)	Loan	Public	$17.600.000,00
Korea Fund (KF)	Grant	Private	$5.000.000,00
Nigeria Trust Fund (NTF)	Loan	Public	$5.619.480,00
Government of Togo (GoT)	Counterpart (Inkind)	Public	$10.856.000,00
GCF Financing	Grant	Public	$28.898.630,19
GCF Financing	Loan	Public	$9.999.987,18
Total Financial Cost TOGO			***$107.505.034,53***
Senegal			
AfDB	Loan	Public	$47.448.790,42
Islamic Development Bank (sIDB)	Loan	Public	$31.063.890,00
Government of Senegal (GoS)	Counterpart (Inkind)	Public	$5.000.000,00
GCF Financing	Grant	Public	$22.333.773,65
GCF Financing	Loan	Public	$10.999.948,59
Total Financial Cost SENEGAL			***$116.846.402,23***
Republic of Guinea			
African Development Fund (ADF)	Loan	Public	$4.091.336,60
African Development Fund (ADF)	Grant	Public	$4.022.919,60
Transition Support Facility (TSF)	Loan	Public	$5.049.174,60
Government of Guinea (GoG)	Counterpart (Inkind)	Public	$3.630.009,00
GCF Financing	Grant	Public	$24.517.751,83
GCF Financing	Loan	Public	$5.999.896,21
Total Financial Cost GUINEA			***$47.311.087,84***
Total costs of ESS translation			
GCF Financing	Grant	Public	*$41.000,00*
Grand Budget (GCF + Co-financing)			$271.703.525,01

(i) *Togo*

For Togo, the project financing comprises: **(i)** the initial financing for the PTA-Togo Project namely, an ADF loan and grant, a TSF loan, funding from BOAD and the Korean Fund, to the tune of UA 8.04 million (116.7%), UA 4.635 million (9.6%), including the PPF refund of UA 995,000; UA 8.32 million (17.2%), CFAF 10 billion (UA 12.8 million or 26.5%), USD 5.068 million (UA 3.52 million (UA 12.8 million or 26.5%), respectively, and the Togolese Government to the tune of CFAF 6.046 billion; and **(ii)** the NTF additional financing, which is to the tune of UA 4 million (6.6%). The breakdown of the revised cumulative costs (including NTF funding), by source of funding, is as follows (Table 9).

Table 9. Estimated Summary of Project Costs by Components for Togo

COMPONENTS	(CFAF Million)			(UA '000)			%	%
	L.C.	F.E.	Total	L.C.	F.E.	Total	F.E.	CB.
A. Support Policy, Governance & Institutional Capacity Building	**2 379.97**	**1 457.20**	**3 837.17**	**3 047.53**	**1 865.94**	**4 913.47**	**38**	**11**
Improvement of ZTA operational framework	633.97	583.20	1 217.17	811.79	746.79	1 558.58	48	4
Establishment of ZTA governance system	488.00	672.00	1 160.00	624.88	860.49	1 485.37	58	3
Strengthening of State and non-State public institutions	1 258.00	202.00	1 460.00	1 610.86	258.66	1 869.52	14	4
B. Devt. of Processing & Access Infrastructure	**7 762.79**	**16 771.49**	**24 534.28**	**9 923.67**	**21 436.13**	**31 359.80**	**68**	**67**
Agro-park infrastructure	2 150.81	4 896.06	7 046.87	2 754.10	6 269.37	9 023.46	69	21
Infrast. for access to inputs agric services	1 279.64	2 975.84	4 255.48	1 638.57	3 810.54	5 449.11	70	13
Production support infrastructure /b	4 332.34	8 899.59	13 231.93	5 531.00	11 356.23	16 887.23	68	36
C. Stakeholder Capacity Building	**2 785.56**	**1 885.18**	**4 670.74**	**3 556.04**	**2 387.84**	**5 943.88**	**30**	**10**
Producers of key sectors	2 144.77	657.45	2 802.22	2 746.36	841.86	3 588.22	23	8
Rural communities	449.74	955.78	1 405.52	565.04	1 197.76	1 762.80	80	1
Central and decentralised services	191.05	271.95	463.00	244.64	348.23	592.87	59	1
D. Project Management & Coordination	**2 797.70**	**1 244.84**	**4 042.55**	**3 582.44**	**1 594.01**	**5 176.45**	**31**	**12**
Total Base Cost	15 726.03	21 358.71	37 084.74	20 109.68	27 283.92	47 393.60	57	100
Physical contingencies	187.83	380.95	568.78	239.97	486.52	726.49	67	2
Financial contingencies	284.13	455.84	739.96	363.31	582.67	945.98	62	2
Total Project Cost	16 198.00	22 195.51	38 393.51	20 712.97	28 353.09	49 066.06	58	104

L.C = Local Costs; F.E = Foreign Exchange; B.C = Base Costs

(ii) Senegal

In Senegal, the total cost of the programme is estimate at $80.0 with financing from: (i) AfDB loan facility of US$ 45 million (56.25%); (ii) Islamic Development Bank (IDB) to the tune of US$ 30.0 million (37.5%); and, (iii) Government of Senegal Counterpart funding $5.0 million (6.25%). The breakdown of the total project costs is shown in Table 10, while by the estimated project costs by components for Senegal is presented in Section 4.5.

Table 10. Estimated Summary of Project Costs by Components for Senegal

COMPONENTS	(XOF Million)			(USD '000)			Percent	
	L.C	F.E	Total	L.C	F.E	Total	F.E	B.C
A. Support for the Establishment of an Ecosystem favourable to Private Investment (PI) in Agribusiness								
- ***Improving the regulatory and institutional framework for Agro-parks***	1,078.60	3,325.15	4,403.75	1,843.76	5,684.02	7,527.78	76	9
- ***Establishment of the industrial superstructure***	7,006.76	17,998.07	25,004.83	11,977.37	30,765.93	42,743.30	72	51
Subtotal	*8,085.36*	*21,323.22*	*29,408.58*	*13,821.13*	*36,449.94*	*50,271.07*	*73*	*60*
B. Support for the Sustainable Improvement of the Productivity of Agro-Industrial Sectors								
Capacity Building of Producers in Agro-Industrial Sectors	431.78	3,739.42	4,171.20	738.09	6,392.17	7,130.26	90	9
Strengthening Community Resilience	3,091.10	7,010.70	10,101.80	5,283.93	11,984.10	17,268.03	69	21
Subtotal	*3,522.88*	*10,750.12*	*14,273.00*	*6,022.02*	*18,376.27*	*24,398.29*	*75*	*29*
C. Coordination, Management, Monitoring and Evaluation								
Project Coordination and Management	3,784.54	1,602.54	5,387.08	6,469.30	2,739.38	9,208.68	30	11
Subtotal	*3,784.54*	*1,602.54*	*5,387.08*	*6,469.30*	*2,739.38*	*9,208.68*	*30*	*11*
Total Baseline Costs	15,392.78	33,675.87	49,068.66	26,312.45	57,565.59	83,878.05	69	100
Physical Contingencies	350.15	896.71	1,246.86	598.55	1,532.84	2,131.39	72	3
Price Contingencies	488.46	778.44	1,266.90	834.98	1,330.67	2,165.64	61	3
Total Project Costs	16,231.40	35,351.03	51,582.42	27,745.98	60,429.10	88,175.08	69	105

L.C = Local Costs; F.E = Foreign Exchange; B.C = Base Costs

(iii) Guinea

The total programme cost for the ten (10) agro-hubs is estimated at around UA 550 million (about USD 758 million). The total cost of the first phase which fully covers Boké and partly Kankan, is estimated at **UA 12.29 million** (GNF 156.14billion). The programme will be financed by an ADF loan of UA 2.99 million (24.30%), an ADF grant of UA 2.94 million (23.9 %), a TSF loan of UA 3.69 million (30.00%) and a contribution by the Government of Guinea equivalent to UA 2.67 million as shown in Table 11.

Table 11. Estimated Cost of Programme by Components Guinea

COMPONENTS	GNF billion			UAthousand			% F.E.	% BC
	L.C.	F.E.	Total	L.C.	F.E.	Total		
A. ESTABLISHMENT OF APZ GOVERNANCE	8.35	20.40	28.76	657.27	1 605.25	2 262.52	71	19
B. DEV. OF PROCESS. AND ACCESS INFRASTRUCTURE	33.54	53.72	87.26	2 639.33	4 226.86	6 866.19	62	59
Agro-park infrastructure	33.54	53.72	87.26	2 639.33	4 226.86	6 866.19	62	59
D. PROGRAMME MANGEMENT AND COORDINATION	19.21	13.22	32.43	1 511.31	1 040.18	2 551.49	41	22
TOTAL BASE COST	61.11	87.34	148.45	4 807.91	6 872.29	11 680.21	59	100
Physical Contingencies	1.24	1.98	3.22	97.49	155.55	253.04	61	2
Financial Contingencies	2.08	2.40	4.48	163.80	188.64	352.44	54	3
TOTAL COST OF 1st PHASE	64.43	91.72	156.14	5 069.20	7 216.49	12 285.69	59	105

4.5. Existing Gaps in the Baseline Programme and the Need for GCF Intervention

In this section, some of the current gaps associated with the SCPZs baseline programme in the three pilot countries are highlighted, which necessitate the additional programme interventions sort from the GCF.

- As observed under the description of the programme components (sub-section 4.2), many of the baseline components are not well-tailored to address the respective adaptation and mitigation targets set for these countries in their respective NDCs and National Adaptation Plan of Action (NAPA), particularly in the key sectors of agriculture, forestry and land use (AFOLU), energy, waste, and water. As noted above under chapter 2, the entire SCPZs programme entails improving the agricultural value chains of these countries. Important to note that agriculture alone in these countries is the main culprit of GHGs emission. For example, it is estimated that the agricultural sector emits close to 19MtCoeq yearly in the three countries as shown in Figure 5 below. Therefore, it is highly imperative to introduce additional new components into the baseline programme that can lead to a reduction in GHGs across the entire agricultural value chains such as, access to affordable financing for agricultural value chains actors to invest in climate resilient agriculture and agroforestry practices, adoption of low-carbon energy technologies such as biogas technology, biodigester and Solar PV along the agro value chains. Without GCF support and intervention, it will be impossible to do so and the programme while improving the agriculture value chains will at same time, exacerbates GHGs emissions.

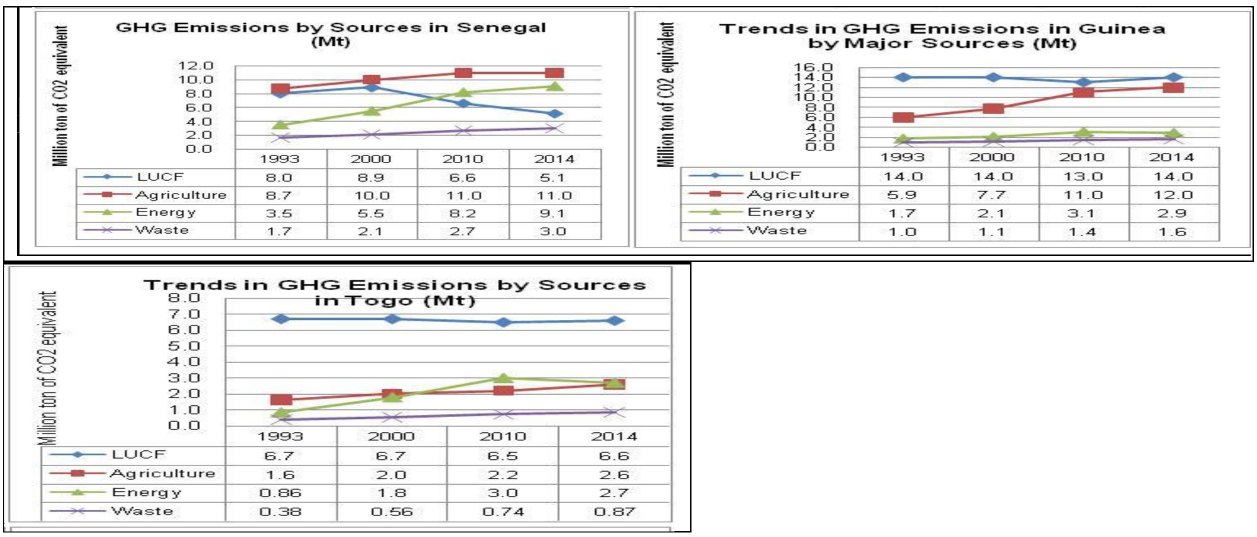
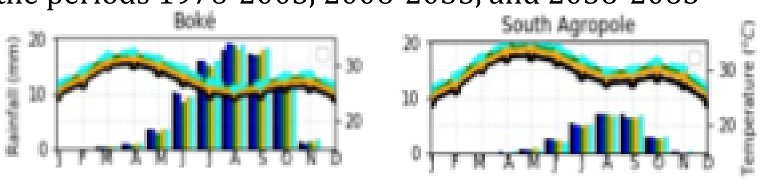


Figure 5. Trends in GHGs Emmissions

Source: WRI CAIT Climate Data Explorer (wri.org)[29]

- Also, in the baseline components presented in sub-section 4.2, there is limited promotion among agricultural value chains actors of the benefits associated with the adopting climate resilient agriculture (CRA) and agro-forestry management practices across the entire value chains. This approach to agriculture has been found to mitigate climate impacts on agriculture productivity and to generate additional benefits, by increasing resilience to floods and droughts (FAO, 2012[30]; USAID, 2017[31]). According to FAO (2013)[32], CRA practices offers ample opportunities for addressing climate change challenges, while simultaneously supporting economic growth and development of the agriculture sector. Most practices are considered climate resilience or smart if they maintain or achieve increases in productivity including at least one of the other objectives of CRA (adaptation and mitigation). Hundreds of technologies and practices around the world fall under the heading of CRA. However, not all CRA practices are suitable and adaptable to every country and region. As discussed in chapter five, climate change is forecasted to impacts the economies of Togo, Senegal and Guinea with growing intensity in the decades to come. For instance, climate projections (Figure 6) for the period (2006 - 2035), clearly shows that in the Kara region of Togo, annual surface air temperature is projected to lie within the range of 25°C–30°C. This also suggests that the yields of maize, millet, rice, cashew, sesame, cassava and sweet potato are likely to decline as a result of heat stress in line with available evidences[33],[34]. Similarly in Senegal, annual surface air temperature is projected to lie within the range of 26°C–33°C in the Agropole region of Casamance. Consistent with literature, the yields of maize, millet, mango, cashew, sesame, cassava and sweet potato are projected to decline as a result of heat stress[35]. Last in the Guinea, annual surface air temperature is projected to lie within the range of 26°C–32°C in the Boke region and 23°C–30°C in Kankan. Consistent with literature, yields of maize, millet, rice, mango cashew, sesame, cassava and sweet potato are likely to decline as a result of heat stress. However, generally, a mean increase in temperature of about 4 - 5% or about 1.5°C - 2.5°C annually is projected in all the regional areas while a decrease in precipitation is projected at the core of the rainy season (June - September), which is typically the growing period for most crops in these countries. Equally, analyses of climate extremes indicates that there will be more long-term seasonal Drought (SD) events in all the regions, shortening of the length of growing period (LGP), more occurences of Consecutive Dry Days (CDD), and an increased in Crop Water Requirement (CWR) for most crops.

Annual Cycle of Surface Air Temperature and Rainfall for the periods 1976-2005, 2006-2035, and 2036-2065



[29] WRI: CAIT Climate Data Explorer (wri.org)
[30] FAO (2012): Climate-Smart Agriculture | Food and Agriculture Organization of the United Nations (fao.org)
[31] USAID (2017): Climate-Smart Agriculture USAID RMP Search — CSA IAWG (rmportal.net)
[32] **FAO. 2013.** Climate-Smart Agriculture Sourcebook. Rome: Food and Agriculture Organization of the United Nations (FAO). Rome. Available at: http://bit.ly/2iJluEQ.
[33] Babacar Faye *et al* 2018. Impacts of 1.5 versus 2.0°C on cereal yields in the West African Sudan Savanna ,*Environ. Res. Lett.* https://doi.org/10.1088/1748-9326/aaab40
[34] Pauw E.D, & S. Ramasamy (2020). Rapid detection of stressed agricultural environments in Africa under climatic change 2000–2050 using agricultural resource indices and a hotspot mapping approach. Weather and Climate Extremes 27 (2020) 100211
[35] World Bank (2011). Senegal Climate Risk and Adaptation Profile.

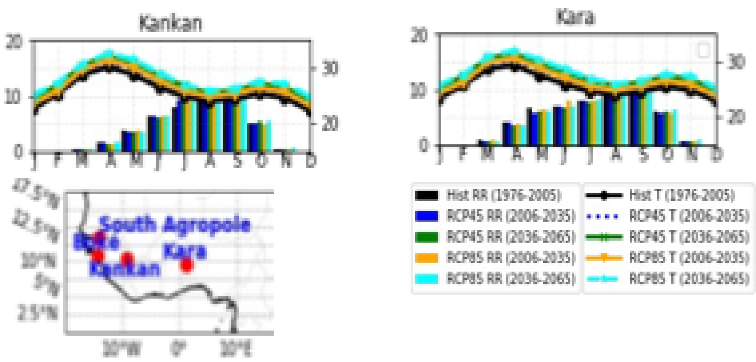


Figure 6. Annual cycle in precipitation (mm/day) and 2-metre temperature (°C) for the SCPZ project areas for the baseline (1976-2005) and future (2006-2035 and 2036-2065) periods

Like most African countries, Togo, Senegal and Guinea are particularly vulnerable to climate change because the economies of these countries rely heavily on climate-sensitive sectors such as agriculture, forestry and hydro-energy. Even without climate change, the agriculture sectors in these countries face serious challenges such as low productivity, due to low input usage (including fertilizers), uncertain and insecure water supply and high costs of doing business. There are also market imperfections in the input markets and lack of reliable services for farmers including land, labour, credit and extension. The market failure in the agricultural sector especially affects resource-poor farmers and makes them more vulnerable to climate-induced shocks from extreme events. This makes it more difficult for them to develop the capacity to cope with climate change.

Climate Resilient Agriculture (CRA) practices can reduce the strength of climate impacts on agriculture productivity and generate additional benefits by increasing resilience to floods and droughts. Certain CRA practices can contribute to improving soil quality and potentially double the yield per hectare (USAID , 2017). For instance, USAID conducted a study in Ghana on private and social benefits of CRA practices as well as their associated costs. The aim of the study was to better understand what motivates farmers to adopt CRA practices. In other words, USAID wanted to better understand the different economic and social benefits from adopting CRA practices and how the combination of these benefits affects the decision of farmers to implement such practices. A Cost-Benefit Analysis (CBA) was used to analyze costs and benefits from implementing CRA practices compared to the non-adoption case (i.e., with and without CRA adoption). Table 12 presents a summary of the associated benefits with selected CRA practices, while Table 13 provides information about the additional costs of CRA practices compared to conventional agriculture on a per hectare basis. As observed in Table 14, an example of such a benefit associated with CRA is the improvement in air quality, by increasing the uptake of CO2 emissions per hectare of agriculture land. The valuation of improved air quality is based on the reduction of CO2 emissions in tons per year, multiplied by a value per ton of CO2 avoided of US$ 7 per ton[36]. While some of the benefits of investing in CRA are immediate and crop-related (e.g., additional revenues from crop rotation), other biophysical benefits, e.g., increased soil fertility, emerge over time. The duration of immediate benefits is relatively short as they are often tied to additional capital investments for land preparation. Biophysical benefits take longer to materialize, but typically outlast the investment period as they are not directly dependent on labour or additional inputs. The cost effectiveness of adopting CRA practices makes investment in these interventions quite challenging.

[36] The value of US$ 7 per ton of CO2 emissions avoided is based on the amount of money that experts were willing to pay to avoid one ton of CO2 emissions.

Table 12. Summary of Associated Benefits with Selected CRA Practices

CRA practice	Soil erosion	On-farm Biodiversity	Carbon Sequestration	Soil Biodiversity	Water Availability	Political and Social Capital *
Minimum tillage	Reduces soil erosion	Increases species of plants per unit area	Improves air quality by sequestering carbon	Increases soil fertility through increased decaying organic matter	Increases water infiltration by slowing flow of water	No significant effect
Improved agronomic practices, *e.g. crop rotation*	Reduces soil erosion	increases on-farm plant diversity (i.e. weeds)	Improves air quality by sequestering carbon	Increases soil fertility through decaying biomass and carbon in the soil	Increases water infiltration by slowing flow of water	Increases social (through labour) and political capital
Integrated nutrient management, *e.g. efficient fertilizer application, split application, timing*	Reduces soil erosion	Increases species of organism per unit area	Improved air quality through reduced ammonia emission from manure storage facilities	Increases soil fertility through decaying biomass and carbon	Enhances infiltration because of improved soil structure	Increases political and social capital (technical expertise and decision making capacity)
Improved genetic resources, *e.g. hybrid seeds to improve yield without changing production practices*	No significant impact	No significant impact	No significant impact	No significant impact	No significant impact	Increases political and social capital
Mixed cropping to make efficient use of inputs	Reduces soil erosion	Increases species of plants per unit area	Enhances carbon sequestration	Increases soil fertility (from crop residues)	Enhances water infiltration	Increases social and political capital
***Increased social and political capital is through interaction with other farmers, extension agents, development partner and government agencies promoting specific CSA practices.**						

Source: Adapted from USAID (2017)[37].

Table 13. Summary of Benefits obtained from CRA Practices (USAID , 2017)

CRA practice	Implementation cost	Maintenance cost	Operation cost
Minimum tillage	$ 691	$ 70	$ 387
Improved agronomic practices, *e.g. crop rotation*	$ 220	$ 200	$ 489
Integrated nutrient management, *e.g. efficient fertilizer application, split application, timing*	$ 63	$ 31	$ 0
Improved genetic resources, *e.g. hybrid seeds to improve yield without changing production practices*	$ 689	$ 63	$ 0
Mixed cropping to make efficient use of inputs	$ 717	$ 72	$ 97

Source: Adapted from USAID (2017)

[37] USAID (2017): PA00TGB9.pdf (usaid.gov).

Table 14. Summary of Benefits obtained from CRA Practices

(USAID , 2017)

List of Positive Externalities for Various CRA Interventions							
	Reduction in Soil Erosion	Increase in Biodiversity	Improvement in Air Quality	Increased Soil Biodiversity	Improvement in Water Availability	Improved Social Capital	Improved Political Capital
Minimum tillage	$ 21.90	$ 10.60	$ 2.50	$ 25.00	$ 37.50	$ 12.00	$ 15.80
Improved agronomic practices, *e.g. crop rotation*	$ 8.70	$ 7.80	$ 2.50	$ 17.80	$ 11.30	$ 13.10	$ 16.30
Integrated nutrient management, *e.g. efficient fertilizer application, split application, timing*	$ 16.30	$ 29.30	$ 27.40	$ 9.80	$ 27.50	$ 19.90	$ 15.50
Improved genetic resources, *e.g. hybrid seeds to improve yield without changing production practices*	$ 4.50	$ 7.50	$ 2.50	$ 5.00	$ 5.00	$ 0.00	$ 0.00
Mixed cropping to make efficient use of inputs	$ 33.80	$ 15.00	$ 10.00	$ 24.00	$ 28.80	$ 14.00	$ 12.00

Source: Adapted from USAID (2017).

Selection of Agriculture Production Systems Key for Food Security in these Countries and Regions

In order to downscale the analysis of CRA options (practices, technologies, and services) to specific agricultural crops systems in the target countries (hereafter, ¨production systems¨), **CIAT and BFS/USAID** selected key production systems, based on their importance to the population’s food security and the national economy. The methodology adopted was an amended version of the production system prioritization methods suggested by researchers at CIAT. All variables used in the analyses are related to ***economic, productive and nutritional quality dimensions as*** follows:

Economic Indicators

- Net Production Value - NPV (US$ Constant 2004-2006): this reflects the importance of the production system in currency value to the economy.
- Production system contribution to national GDP (US$ Constant 2004-2006): this indicator allows for a benchmark with the rest of the sectors of the national economy.

Food Security Indicators

- Food supply (or dietary energy supply) (Kcal/capita/day): indicator of food security (nutrition quality). Calories are a standard measure for ensuring food quantity.
- Protein supply quantity (g/capita/day): indicator of food security (nutrition quality). Protein addresses the quality of the food, as protein affects stunting and is also an indicator of hunger.
- Iron content (mg of iron / 100 gr of product): an indicator of food security (nutritional quality). Iron deficiency is an indicator of hidden hunger, but also a critical reflection of access to quality food. Iron deficiency represents a major global public health challenge in the world.
- Zinc content (mg of zinc / 100 gr of product): indicator of food security (nutrition quality). Zinc deficiency is the number one deficiency in the world and represents a major global public health challenge.

- Vitamin A content (IU Vitamin A / 100 gr of product): indicator of food security (nutrition quality) Deficiency of Vitamin A is an indicator of hidden hunger and represents a major global public health challenge in the world.

Production Indicators

- Harvested area (ha) / Pastureland (ha): indicates the importance of the production system in terms of total harvested area.
- Coefficient of variation in production (standard deviation): simply shows how production has been varying in the past years preferably (5-10). Production systems with higher variation in production systems are considered more vulnerable to climate and non-climate conditions and therefore in greater need to be prioritized.

Based on this, several steps were adopted by CIAT and BFS/USAID to prioritize the agricultural production systems of each country as follows:

1) Compilation of a long list of key agricultural production systems, based on existing literature and knowledge of the country specific context.
2) Undertook an analysis of the selected systems´ contribution to food security and economic productive indicators, to help identify those production systems[38] (eight to ten) that are most relevant to food security and productivity objectives.
3) Normalization of the scores of each production system in each indicator, in order to adjust values measured on different scales to a common 0-1 scale, prior to averaging. This allows for the comparison of indicators´ values within the same production system and across all production systems selected.
4) Calculating a total score for the production system using a weighted average of the values of the economic, productivity, and food security indicators. Each category (economic, productivity, and food security) was given an equal weight (0.33). For example, the total weighted score for a production system = Average [(Economic indicators values x 0.33) + (Productivity indicators values x 0.33) + (Food security indicators values x 0.33)], Where the Economic indicators values = (Value of Economic indicator 1, Value of Economic indicator 2) / 2.
5) Based on the final scores, the list of the production systems was then ranked and reduced to a maximum of 10 for further analysis.
6) Revision and validation of the short list by in-country experts. These experts made suggestions of regrouping systems (if the case) or removing from the list, if they were considered irrelevant for the scope of the study (for instance, not very relevant to small-scale / family farming), or if data availability for further analyses were considered an issue.

In the following figures (Figure 7), the production system ranking in Senegal, West Africa are presented (adopted from the **CIAT and BFS/USAID** 2016 and 2017 reports).

[38]The number of production systems chosen for the analysis was limited to ten maximum, to ensure feasibility of the analysis within the given resources available (data availability, time for the analysis, length of the document).

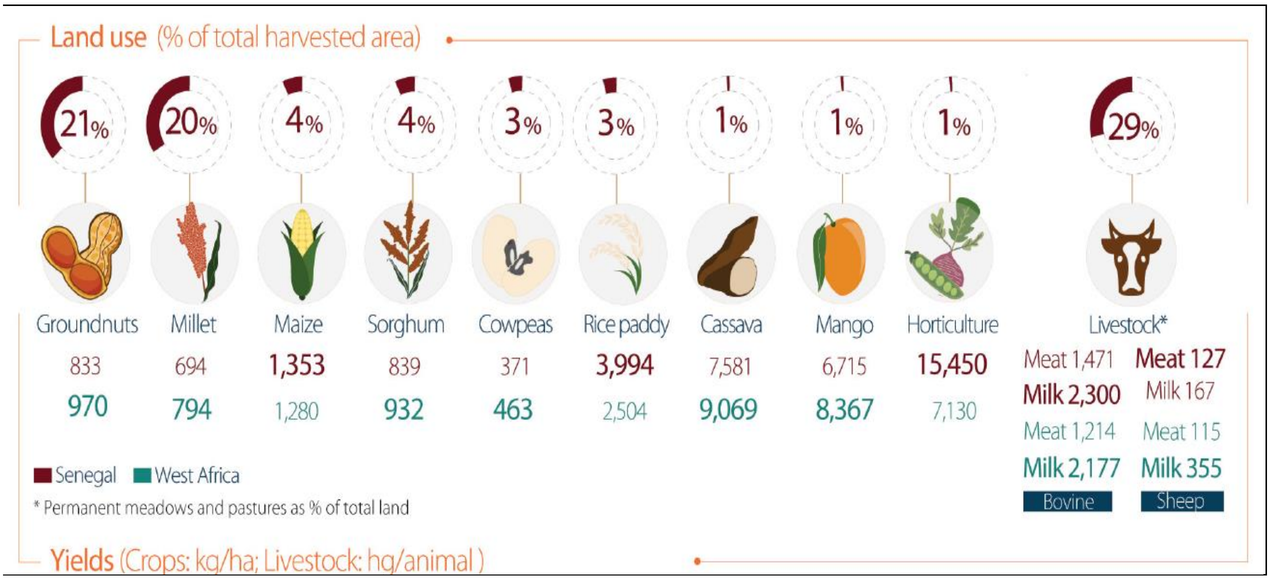


Figure 7. Showing the selection of agriculture production systems key for West African food security. Note that the importance is based on the system's contribution to economic, productivity and nutrition quality indicators as highlighted above.

Source: CIAT; BFS/USAID. 2016.

Methodology for Assessing the Climate Resilience of Ongoing Practices in these Countries

CIAT and BFS/USAID used several processes and methods for collecting data on CRA and AFM practices in the target countries and region such as; types of practices, levels of adoption, climate resilient scores, as described below.

Step 1: First, a desktop review was carried out to help identify and list existing CRA and AFM practices undertaken in each specific country or region. The identified practices were then validated based on the feasibility of implementing them in the important production systems of the country or region. Next, the list of practices was then confirmed with criteria from in-country experts (mainly agronomists with experience in the selected production systems or agricultural regions of interest in the country).

Step 2: Second, after the initial validation of the list of CRA practices identified in the country (and related to the main production systems), experts were then asked to provide, either through semi-structured interviews, surveys or focus group discussions, information on where, how, and to what extent the practice is adopted in the country and the production system it is associated with.

Step 3: Third, experts were then requested to give qualitative evaluations of different components of the **'climate resilient'** concept for each identified practice. To this end, **CIAT &BFS/USAID** created categories of indicators and sub-indicators related to the CRA pillars as follows:

Productivity: yield resilient (yields, post-harvest loss [only for crop systems]) and income resilient (income),

Adaptation: water resilient (water availability, water use efficiency, water quality, ecosystem function, soils water retention capacity), soils resilient (soil disturbance), and info resilient (climate risks management, climate risk prevention, agriculture diversification, local/traditional knowledge use).

Mitigation: energy resilient (energy use from fossil fuels, energy use from renewable sources), carbon resilient (above-ground biomass, below-ground biomass, soil carbon stock, methane emissions [only for livestock systems], manure management), and nitrogen resilient (nutrient use efficiency).

CIAT &BFS/USAID duly acknowledged that there exists several ways to look at when assessing the climate resilience of a production system, and that the list of categories and indicators used in the analyses are not exhaustive. However, those employed should be seen as important entry points for adaptation and mitigation of climate change in the agricultural sector. When combined with the efficient use and management of water, soils, energy, carbon and nitrogen, including efforts to reduce climate risks and to promote local knowledge and social capital when implementing the practice, it will increase the practice's likelihood to contribute to goals related to adaptation, mitigation and improved productivity.

In order to operationalise the analysis of the practice's performance in the six categories of interest, experts were asked specific questions that offer insights into the indicators mentioned above[39]. For each indicator, experts provided values from -10 to 10, which can also be associated with % change (-100 % loss to 100% gain). Table 15 shows how the different indicators suggested were evaluated.

Table 15. Summary of suggested indicators for implementing best practices

Other <-10	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	Other >10

Completely decreases (-100% compared to baseline) — Decreases by half (-50% compared to baseline) — No change (0% compared to baseline) — Increases by half (+50% compared to baseline) — Completely increases (+100% compared to baseline)

[39]Note that these indicators and associated questions should not be taken as absolute metrics for assessment, but they should just guide the qualitative assessment of the practice and be adapted to the context of the analysis.

Pilar	resilientness category	Indicator	Expected change (compared to baseline)	Qualitative scale explained
PRODUCTIVITY	Food Resilient	**Yield**	By implementing the practice, what are the expected changes in PS yields?	
		Post-Harvest Loss	By implementing the practice, what are the expected changes in crop losses experienced after harvesting?	-10=completely decreases (-100% compared to baseline); -5=decreases by half (-50% compared to baseline); 0=no change; 5=increases by half (50% compared to baseline); 10=completely increases (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)
	Info resilient	**Climate Risks Management**	By implementing the practice, what are the expected changes in farmers' capacity to manage climate risks?	-10=completely decreases (-100% compared to baseline); -5=decreases by half (-50% compared to baseline); 0=no change; 5=increases by half (50% compared to baseline); 10=completely increases (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)
		Income	By implementing the practice, what are the expected changes in income?	
ADAPTATION		**Climate Risks Prevention**	By implementing the practice, what are the expected changes in farmers' capacity to limit the exposure of the PS to climate risks?	
		Water Availability	By implementing the practice, what are the expected changes in the quantity of water available for agriculture?	
		Agriculture Diversification	By implementing the practice, what are the expected changes in the level of diversification of farmers' agricultural activities on the farm?	
		Water Use Efficiency	By implementing the practice, what are the expected changes in the quantity of water used per unit of product? (Refers to water used for crop irrigation and/or livestock production).	
		Local/ Traditional Knowledge	By implementing the practice, what are the expected changes in how much farmers use local and traditional knowledge for managing the farm?	
		Water Quality	By implementing the practice, what are the expected changes in water quality?	
		Ecosystem Function	By implementing the practice, what is the expected change in the water cycle equilibrium in the ecosystem? (balance between water inflow and outflow) in the ecosystem)	-10 = completely destabilizes the water balance, 0 = not change, to 10 = completely stabilizes the water balance; OTHER: if the change is off the current scale (>-100% or >+100%)
MITIGATION	Energy Resilient	**Energy Use (Fossil Fuels)**	By implementing the practice, what are the expected changes in the quantity of fossil fuel energy used to manage the PS every season?	-10=completely increases (-100% compared to baseline); -5=increases by half (-50% compared to baseline); 0=no change; 5=decreases by half (50% compared to baseline); 10=completely decreases (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)
		Water Retention Capacity of Soils	By implementing the practice, what are the expected changes in soil's ability to retain water?	-10=completely decreases (-100% compared to baseline); -5=decreases by half (-50% compared to baseline); 0=no change; 5=increases by half (50% compared to baseline); 10=completely increases (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)
		Energy Use (Renewable)	By implementing the practice, what are the expected changes in the quantity of renewable energy used to manage the PS every season?	
	Carbon Resilient	**Biomass (Above-Ground)**	By implementing the practice, what are the expected changes in the availability of the above-ground biomass on the farm every season?	-10=completely decreases (-100% compared to baseline); -5=decreases by half (-50% compared to baseline); 0=no change; 5=increases by half (50% compared to baseline); 10=completely increases (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)
		Soil Disturbance	By implementing the practice, what are the expected changes in soil disturbance?	-10= completely increases levels of soil disturbance (75-100% of the area tilled, deep ploughing [>30 cm]); 0=no change; 10=completely decreases levels of soil disturbance (e.g., no till techniques) (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)
		Biomass (Below-Ground)	By implementing the practice, what are the expected changes in the availability of below-ground biomass on the farm every season?	
		Soil Carbon Stock	By implementing the practice, what are the expected changes in the quantity of organic matter accumulated in soil?	
		Methane Emissions (Only For Livestock Ps)	By implementing the practice, what are the expected changes in the quality of animal diet?	
		Manure Management	By implementing the practice, what are the expected changes in the quantity of manure that is left of pastures/fields? (-10 = much more manure left to 10 = decreased amount of manure)	
	Nitrogen Resilient	**Nutrient Use Efficiency**	By implementing the practice, what are the expected changes in the quantity of fertilizers used per unit of product in a season? (note: the evaluator will mention the type of fertilizer analyzed: organic / inorganic)	-10=completely increases fertilizer use (-100% compared to baseline); - 5=increases by half (-50% compared to baseline); 0=no change; 5=decreases by half (50% compared to baseline); 10=completely

				decreases fertilizer use (+100% compared to baseline); OTHER: if the change is off the current scale (>-100% or >+100%)

Source: Adopted from CIAT and BFS/USAID (2016 & 2017)

Step 5*:* Identification of high-interest practices, based on total climate-resiliency score and best data available[40]. A comprehensive list of all practices analyzed for West Africa are provided below.

Step 6*:* Based on literature review and expert consultations, **CIAT &BFS/USAID** identified possible challenges and barriers to adoption and/or scaling out of the identified CRA practices, related to policies, institutions, finances, etc.

In the following figures, we present the selection of CRA practices with high climate resilient scores according to expert evaluations in Senegal in West Africa conducted by **CIAT &BFS/USAID**. The average climate resilience score is calculated based on the individual scores of each practice on eight climate resilience dimensions. This relates to the CRA pillars: yield (**productivity**); income, water, soil, risks/ information (**adaptation**); energy, carbon and nutrients (**mitigation**). As highlighted in the figures, farmers have begun to adopt new, improved technologies in both crop and livestock production systems. For instance, in crop production, there are efforts to promote organic fertilizer use and precise fertilizer application as opposed to the use of blanket fertilizer recommendations, while use of improved (drought- and heat-tolerant) cereal varieties (teff, maize, sorghum, wheat and barley) and crop rotations are increasingly being practiced. For pulses (faba beans and chickpea), the use of improved varieties, application of biofertilizers and development of cropping calendars informed by meteorological data are among the CRA practices being implemented. For coffee production, irrigation, mulching and agroforestry (tree shade) comprise key climate resilient practices adopted. For agroforestry in coffee production, some key considerations for success include choice of tree, planting density and canopy management.

Similarly, in West Africa, particularly Senegal, farmers are adopting the 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 (Figure 8). Interestingly, 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.

[40] As reported in CIAT; BFS/USAID (2016& 2017), practices were evaluations based on data availability.

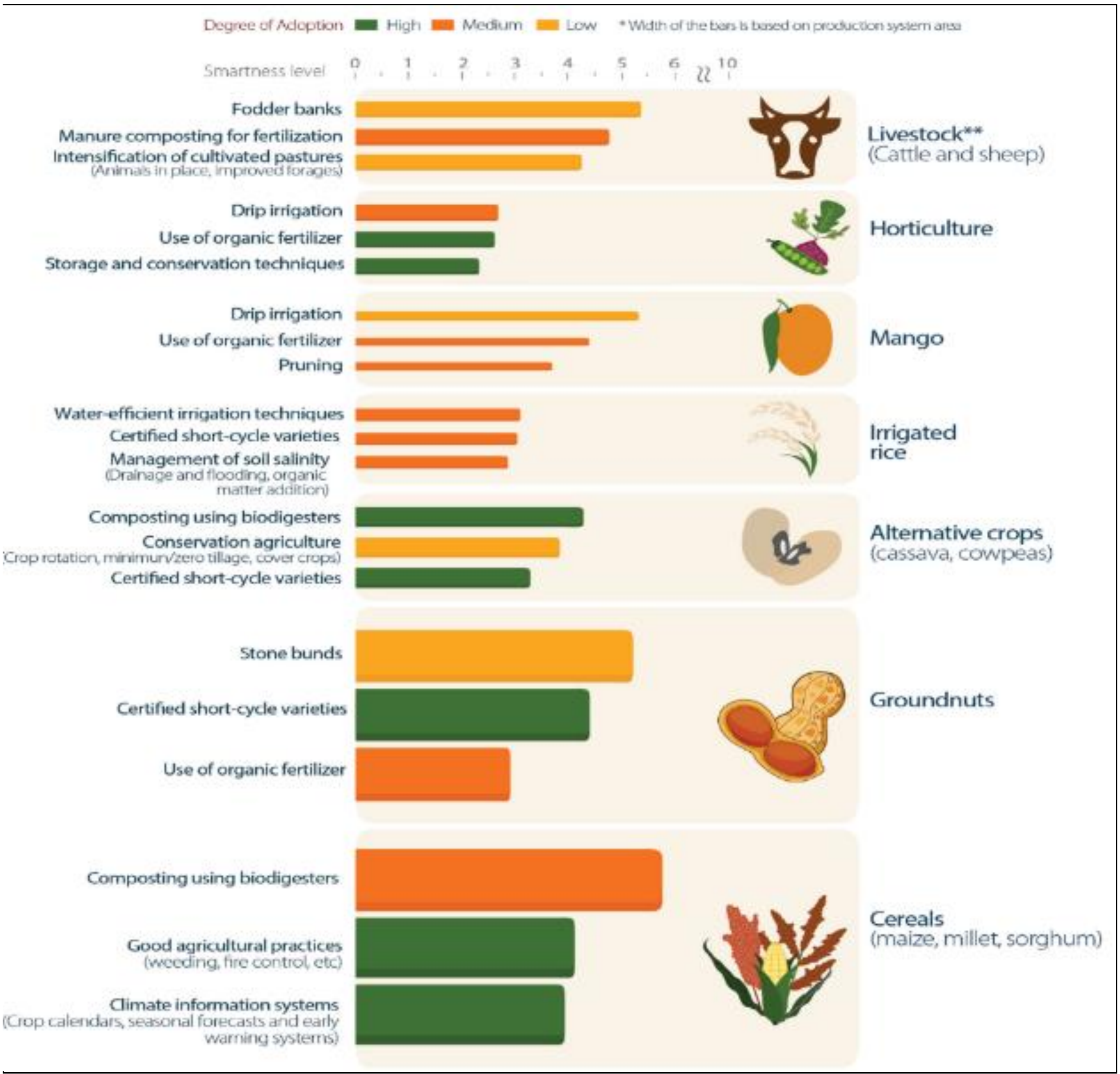


Figure 8. Showing selected CRA practices and technologies for production systems key for food security in Senegal, West Africa

Source*: CIAT ; BFS/USAID. 2016.*

In Table 16 adopted from **CIAT &BFS/USAID, the** climate resilient assessment for top ongoing CRA practices by production systems as implemented in Senegal are presented.

Table 16. Showing detailed resilience assessment for top ongoing CRA practices by production system as implemented in Senegal, West Africa.

Practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. area	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions Averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
Irrigated Rice															
1	**System of Rice Intensification**	**5**	**2%**	**Sylvo-Pastoral Zone**	1, Some 2, 3	2	5.0	5.8	3.4	7.0	3.4	1.8	6.4	-3.5	3.6
1		**4**	**2%**	**River Valley**	1, Some 2, 3	2	3.1	7.3	3.7	6	4	1.5	6.4	-4	3.5
1		**2**	**2%**	**Lower And Middle Casamance**	1,2, Some: 3	2	2.8	4.5	4.2	5.0	5.0	0.0	0.7	ND	3.2
1		**11**	**2%**	***All Regions***	*1,2 Some: 3*	*2*	*3.6*	*5.9*	*3.8*	*6.0*	*4.1*	*1.1*	*4.5*	*-3.8*	*3.1*
2	**Certified salt-tolerant varieties**	**1**	**2%**	**River Valley**	1,2	1	0.0	5.0	2.0	ND	-2.0	ND	ND	ND	1.3
2		**1**	**2%**	**Lower And Middle Casamance**	1,2	1	-1.0	6.0	1.0	ND	-2.0	ND	ND	ND	1.0
2		**2**	**2%**	***All Regions***	*1,2, Some: 3*	*1*	*-0.5*	*5.5*	*1.5*	*ND*	*-2.0*	*ND*	*ND*	*ND*	*1.1*
3	**Community seed banks**	**1**	**2%**	**Lower And Middle Casamance**	2,3	3	2.0	3.0	0.0	0.0	3.3	0.0	2.3	-10.0	0.1
3		**1**	**2%**	**River Valley**	2,3	3	4.0	6.0	0.0	0.0	5.0	0.0	3.3	-10.0	1.0
3		**2**	**2%**	***All Regions***	*2,3*	*3*	*3.0*	*4.5*	*0.0*	*0.0*	*4.2*	*0.0*	*2.8*	*-10.0*	*0.6*
4	**Producer networks**	**1**	**2%**	**Lower And Middle Casamance**	1,2	3	ND	ND	ND	ND	4.3	ND	ND	-10.0	-2.9
4		**1**	**2%**	**River Valley**	1,2	3	ND	ND	ND	ND	5.3	ND	ND	-10.0	-2/6
4		**2**	**2%**	***All Regions***	*1,2*	*3*	*ND*	*ND*	*ND*	*ND*	*4.8*	*ND*	*ND*	*-10.0*	*-2.6*
5	**Certified drought-resistant varieties**	**1**	**2%**	**Sylvo-Pastoral Zone**	2,3	2	1.0	8.0	4.5	7.0	6.8	ND	8.7	-10.0	3.7
5		**1**	**2%**	**River Valley**	2,3	2	1.0	6.0	3.8	5.0	5.8	ND	7.3	-10.0	2.7
5		**2**	**2%**	***All Regions***	*2,3*	*2*	*1.0*	*7.0*	*4.1*	*6.0*	*6.3*	*ND*	*8.0*	*-10.0*	*3.2*
6		**2**	**2%**	**Sylvo-Pastoral Zone**	1,2,3	2	5.5	6.5	6	ND	1	-3	0	7	3.3

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. e	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions Averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
6	**Certified short-cycle varieties**	**2**	**2%**	**River Valley**	1,2,3	2	5.5	7.0	7.0	ND	1.3	-4.0	0.0	7.0	3.4
6		**4**	**2%**	**All Regions**	1,2,3	2	5.5	6.8	6.5	ND	1.2	-3.5	0.0	7.0	3.3
7	**Management of soil salinity (drainage and flooding, organic matter addition)**	**2**	**2%**	**Sylvo-Pastoral Zone**	1,2,3	3	4.0	8.5	7.3	7.0	6.4	ND	6.8	-1.0	5.6
7		**2**	**2%**	**River Valley**	1,2,3	3	3.75	8	7.4	5	5.9	ND	6.5	-1	5.1
7		***4***	***2%***	***All Regions***	*1,2,3*	*3*	*3.9*	*8.3*	*7.3*	*6.0*	*6.1*	*ND*	*6.7*	*-1.0*	*5.3*
8	**Storage and conservation techniques**	***1***	***2%***	**Sylvo-Pastoral Zone**	1,2,3	3	7.0	9.0	8.0	ND	ND	ND	ND	ND	8.0
8		***1***	***2%***	**River Valley**	1,2,3	3	7.0	9.0	8.0	ND	ND	ND	ND	ND	8.0
8		***2***	***2%***	***All Regions***	*1,2,3*	*3*	*7.0*	*9.0*	*8.0*	*ND*	*ND*	*ND*	*ND*	*ND*	*8.0*
Cereals (Maize, Millet, Sorghum)															
1	**Climate information systems (crop calendars, seasonal forecasts and early warning systems)**	**1**	**28%**	**Sylvo-Pastoral Zone**	1,2,3	3	5.0	4.0	2.0	2.0	6.0	3.0	4.5	6.0	4.1
1		**11**	**28%**	**Groundnut Basin**	1,2,3	2	4.2	3.3	2.0	5.0	5.1	4.5	3.5	2.6	3.8
1		**12**	**28%**	**All Regions**	1,2,3	3	4.6	3.7	2.0	3.5	5.6	3.8	4.0	4.3	3.9
2	**Agroforestry**	**1**	**28%**	**Sylvo-Pastoral Zone**	1	1	2.0	3.0	3.8	4.0	3.5	2.0	2.0	3.0	2.6
2		**3**	**28%**	**Groundnut Basin**	2, Some: 1	1	0.0	4.7	4.1	3.3	5.2	0.2	5.8	3.3	3.3
2		***4***	***28%***	***All Regions***	*1,2*	*1*	*1.0*	*3.8*	*4.0*	*0.3*	*4.3*	*-0.9*	*3.9*	*3.2*	*2.9*
3		**1**	**28%**	**Sylvo-Pastoral Zone**	1	1	3.0	6.0	2.8	0.0	4.5	3.0	2.5	3.0	3.1

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. e	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions Averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
3	**Certified short-cycle varieties**	**9**	**28%**	**Groundnut Basin**	1,2,3	2	6.3	6.0	2.4	0.0	3.7	3.0	2.3	0.8	3.1
3		**10**	**28%**	**All Regions**	1, Some: 2.3	2	4.7	6.0	2.6	0.0	4.1	3.0	2.4	1.9	3.1
4	**Good agricultural practices (weeding, fire control)**	**2**	**28%**	**Groundnut Basin**	1.2	3	7.0	6.5	3.8	2.5	5.4	4.0	7.3	4.0	5.1
5	**Producer networks**	**4**	**28%**	**Groundnut Basin**	1,2 Some: 3	2	4.5	3.0	4.0	3.0	4.5	3.3	3.2	2.5	3.5
6	**Assisted natural regeneration**	**8**	**28%**	**Groundnut Basin**	1 Some: 2	2	3.7	3.3	3.1	3.8	4.0	3.8	3.4	3.3	3.5
7	**Composting using biodigesters**	**4**	**28%**	**Groundnut Basin**	1 Some: 2, 3	2	7.0	7.5	2.0	6.5	3.9	7.3	5.8	6.5	5.8
						Mango									
1	**Drip irrigation**	**1**	**1%**	**Groundnut Basin**	2,3	1	7.0	8.0	7.6	2.0	6.3	2.5	5.0	6.0	5.5
1		**1**	**1%**	**Niayes**	2,3	1	5.0	7.0	7.6	2.0	5.0	2.5	5.0	ND	4.9
1		***2***	***1%***	***All Regions***	*2,3*	*1*	*6.0*	*7.5*	*7.6*	*2.0*	*5.6*	*2.5*	*5.0*	*6.0*	*5.3*
2	**Pruning**	**1**	**1%**	***Groundnut Basin***	2,3	2	7.5	7.0	3.0	3.0	2.3	3.0	3.3	3.0	4.0
2		**1**	**1%**	**Niayes**	1,2	2	7.0	7.0	3.0	3.0	2.3	3.0	3.3	3.0	3.9
2		***2***	***1%***	***All Regions***	*2, Some: 1,3*	*2*	*7.3*	*7.0*	*3.0*	*3.0*	*2.3*	*3.0*	*3.3*	*3.0*	*4.0*
3	**Mulching**	**1**	**1%**	***Groundnut Basin***	1,2	2	2.0	3.0	2.2	1.0	1.8	2.0	2.0	ND	2.4
3		**2**	**1%**	**Niayes**	1,2	3	4.0	3.0	4.3	1.0	2.0	2.0	2.8	ND	2.4
3		***3***	***1%***	***All Regions***	*1,2*	*3*	*3.0*	*3.0*	*3.3*	*1.0*	*1.9*	*2.0*	*2.4*	*ND*	*2.4*
4	**Grafting**	**1**	**1%**	***Groundnut Basin***	1,2	3	2.5	5.0	-0.8	0.0	-0.3	-1.0	0.8	2.0	1.1
4		**1**	**1%**	**Niayes**	1,2	3	2.5	5.0	-0.8	0.0	-0.3	-1.0	0.8	3.0	1.1
4		***2***	***1%***	***All Regions***	*1,2*	*3*	*2.5*	*5.0*	*-0.8*	*0.0*	*-0.3*	*-1.0*	*0.8*	*2.5*	*1.1*

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. area	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
5	**Composting**	*6*	*1%*	***Niayes***	*2, Some: 1,3*	*1*	*4*	*6*	*3.8*	*4.0*	*3*	*1.5*	*1.25*	*1.5*	*3.2*
6	**Intercropping with cassava**	*1*	*1%*	***Niayes***	*1,2*	*3*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
7	**Use of organic fertilizer**	*5*	*1%*	***Niayes***	*1,2,3*	*2.2*	*7*	*7.5*	*5*	*ND*	*3*	*ND*	*5*	*-1*	*4.4*
Groundnuts															
1	**Use of organic fertilizer**	***2***	**21%**	**Sylvo-Pastoral Zone**	2,3, Some: 1	2	3.0	5.0	2.4	3.5	3.4	1.5	2.0	2.0	2.8
1		***2***	**21%**	**Groundnut Basin**	1, 2, Some: 3	2	4	6.5	1.6	4.5	3.9	1	2.6	ND	3.4
		4	***21%***	***All Regions***	*1, 2, Some: 3*	*2*	*3.5*	*5.8*	*2.0*	*4.0*	*3.6*	*1.3*	*2.3*	*2.0*	*3.1*
2	**Intercropping with cowpeas**	**1**	**21%**	**Sylvo-Pastoral Zone**	1	2	0.5	2.0	2.0	0.0	2.8	2.0	2.0	2.0	1.7
2		**1**	**21%**	***Groundnut Basin***	1	2	0.5	1.0	1.2	0.0	1.8	2.0	1.5	ND	1.1
		2	***21%***	***All Regions***	*1*	*2*	*0.5*	*1.5*	*1.6*	*0.0*	*2.3*	*2.0*	*1.8*	*2.0*	*1.5*
3	**Producer networks**	***2***	***21%***	**Sylvo-Pastoral Zone**	1, 2, Some: 3	2	3.0	3.0	0.0	2.0	3.2	2.5	1.8	6.0	2.7
3		***2***	***21%***	***Groundnut Basin***	1, 2, Some: 3	2	4	3	0	2	3.7	2.5	2.3	ND	2.5
		4	***21%***	***All Regions***	*1, 2, Some: 3*	*2*	*3.5*	*3.0*	*0.0*	*2.0*	*3.5*	*2.5*	*2.0*	*6.0*	*2.8*
4	**Living fence with food-bearing tree (hibiscous, moringa)**	**1**	**21%**	**Sylvo-Pastoral Zone**	1,2	3	0.0	1.0	0.0	0.0	1.3	0.0	1.5	ND	0.5
4		**1**	**21%**	**Groundnut Basin**	1,2	3	0.0	1.0	0.0	0.0	1.3	0.0	1.5	ND	0.5
		2	***21%***	***All Regions***	*1,2*	*3*	*0.0*	*1.0*	*0.0*	*0.0*	*1.3*	*0.0*	*1.5*	*ND*	*0.5*
5	**Stone bunds**	**1**	**21%**	**Sylvo-Pastoral Zone**	1,2	1	3.5	4.0	5.2	2.0	5.5	4.5	5.8	7.0	4.7
5		**1**	**21%**	**Groundnut Basin**	1,2	1	4.0	5.0	6.2	5.0	6.8	4.5	6.8	ND	5.5
		2	***21%***	***All Regions***	*1,2*	*1*	*3.8*	*4.5*	*5.7*	*3.5*	*6.1*	*4.5*	*6.3*	*7.0*	*5.2*
6		**2**	**21%**	**Sylvo-Pastoral Zone**	1 Some: 2, 3	2	6.0	6.0	3.0	2.0	4.8	2.0	4.4	4.0	4.0

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. area	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
6	**Certified short-cycle varieties**	**8**	**21%**	**Groundnut Basin**	2, Some: 3	3	3.4	6.4	0.4	0.4	5.4	0.7	1.5	1.0	2.4
		10	**21%**	***All Regions***	1,2, Some: 3	3	4.7	6.2	1.7	1.2	5.1	1.3	3.0	2.5	3.2
7	**Crop rotation**	**2**	**21%**	***Groundnut Basin***	2	3	1.8	5.0	0.0	6.0	0.5	0.0	0.5	0.0	1.7
8	**Agroforestry**	**2**	**21%**	***Groundnut Basin*** a a	1	1	1.5	5.0	2.1	7.0	3.1	0.0	4.5	0.0	2.9
9	**Assisted natural regeneration**	**4**	**21%**	***Groundnut Basin***	1, Some: 2	1	0.3	3.5	1.2	10.0	2.3	0.0	0.1	1.0	2.3
10	**Climate information systems (crop calendars, seasonal forecasts and early warning systems)**	**2**	**21%**	***Groundnut Basin***	1,2	2	2.3	4.0	1.5	6.5	2.3	0.0	4.5	0.0	2.6
Livestock (cattle and sheep)															
1	**Intensification of cultivated pastures (animals in place, improved forages)**	**11**		***Sylvo-Pastoral zone***	2, Some: 1, 3	1.25	7.4	8.0	3.8	3.0	4.7	ND	5.6	-3.0	4.2
2	**Increase number of small ruminants/chicken in**	**11**		***Sylvo-Pastoral zone***	1,2, Some: 3	3	7.0	8.0	-0.8	ND	4.6	ND	3.2	1.8	4.0

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. area	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
	livestock management														
3	**Fodder banks**	**5**		***Sylvo-Pastoral zone***	3	1	9.0	9.0	6.4	4.0	4.6	2.0	6.4	1.3	5.3
4	**Manure composting for fertilization**	**11**		***Sylvo-Pastoral zone***	1 Some: 2	2	7.0	5.0	2.7	4.0	5.8	6.0	2.4	4.8	4.7
Alternative Crops (Cassava, Cowpeas)															
1	**Intercropping (cowpeas/groundnuts; cassava/maize; cowpeas/ millet)**	**3**	**4%**	**Sylvo-Pastoral Zone**	1, Some: 2	2	0.7	1.0	2.5	0.0	4.0	1.0	1.6	0.5	1.4
1		**3**	**4%**	**Groundnut Basin**	1, Some: 2	2	1.2	1	2.3	0	4.2	1	1.9	0	1.4
1		**6**	**4%**	**All Regions**	1, Some: 2	2	0.9	1.0	2.4	0.0	4.1	1.0	1.7	0.3	1.4
2	**Composting using biodigesters**	**1**	**4%**	**Sylvo-Pastoral Zone**	1,2,3	3	6.0	6.0	1.0	ND	2.3	ND	3.0	ND	3.7
2		**1**	**4%**	**Groundnut Basin**	1,2,3	3	6.0	6.0	1.5	ND	2.3	ND	3.5	7.0	4.4
2		**2**	**4%**	***All Regions***	1,2,3	3	6.0	6.0	1.3	ND	2.3	ND	3.3	7.0	4.3
3	**Certified short-cycle varieties**	**2**	**4%**	**Sylvo-Pastoral Zone**	1,2,3	2.5	4	6	ND	0	6	ND	2.3	1	3.2
3		**2**	**4%**	**Groundnut Basin**	1,2,3	3	4.0	7.0	ND	0.0	6.5	ND	2.3	1.0	3.5
3		**4**	**4%**	***All Regions***	1,2,3	3	4.0	6.5	ND	0.0	6.3	ND	2.3	1.0	3.3
4	**Use of organic fertilizer**	**1**	**4%**	**Sylvo-Pastoral Zone**	1,2,3	2	3.0	7.0	1.5	6.0	2.3	ND	5.0	6.0	2.7
4		**1**	**4%**	**Groundnut Basin**	1,2,3	2	3.0	7.0	2.0	6.0	2.3	ND	5.0	7.0	2.9
4		**2**	**4%**	***All Regions***	1,2,3	2	3.0	7.0	1.8	6.0	2.3	ND	5.0	6.5	2.8

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. area	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions Averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
5	**Conservation agriculture (Crop rotation, minimun/zero tillage, cover crops)**	**2**	**4%**	***Sylvo-Pastoral zone***	**2,3**	**1**	**3.5**	**4.5**	**3.0**	**6.0**	**4.4**	**1.5**	**3.4**	**5.0**	**3.9**
				Horticulture											
1	**Use of organic fertilizer**	**1**	**N/D**	**River Valley**	1	3	2.5	5.0	1.8	0.0	3.8	0.0	2.5	0.0	1.9
1	**Use of organic fertilizer**	**5**	**N/D**	***All Regions***	1, Some: 2, 3	3	4.8	5.9	1.7	0.0	2.5	0.8	3.4	1.7	2.6
2	**Wind breaks using living fences**	**1**	**N/D**	**River Valley**	1,2,3	2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.1
2		**2**	**N/D**	**Niayes**	1,2,3	2.3	4.5	6	3	0	1.75	-1	2.25	0	2.1
2		**3**	**N/D**	***All Regions***	1,2,3	2	2.3	3.0	1.5	0.0	0.9	-0.5	1.4	0.0	1.1
3	**Composting**	**1**	**N/D**	**River Valley**	1,2	2	5.0	3.0	0.0	0.0	0.5	0.0	0.5	0.0	1.1
3		**5**	**N/D**	**Niayes**	1,2 Some: 3	1	5.4	7.0	1.0	0.0	1.0	-2.0	1.0	10.0	2.9
3		**6**	**N/D**	***All Regions***	1,2 Some: 3	2	5.2	5.0	0.5	0.0	0.8	-1.0	0.8	5.0	2.0
4	**Storage and conservation techniques**	**1**	**N/D**	**River Valley**	1,2,3	3	2.0	5.0	0.0	0.0	4.3	0.0	0.0	3.0	1.8
4		**7**		**Niayes**	2, 3 Some: 1	2	4.9	5.9	0.0	0.0	7.5	0.7	0.0	3.0	2.7
4		**8**	**N/D**	***All Regions***	1,2,3	3	3.4	5.4	0.0	0.0	5.9	0.4	0.0	3.0	2.3
5	**Drip irrigation**	**1**	**N/D**	**River Valley**	1,2,3	2	1.5	3.0	0.4	5.0	2.0	2.5	2.0	0.0	2.1

practice #	Practice name	# of evaluations	% of harvested area / % land use area of total ag. area	Agroecozone	Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale	Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%	Dimensions Averages								Climate Resilience
							Yield	Income	Water	Soil	Info	Energy	Carbon	Nutrient	
5		**8**	**N/D**	**Niayes**	2, 3 Some: 1	2.125	6.2	6	4.4	0.7	2.3	2.5	3	1.4	3.3
5		**9**	**N/D**	***All Regions***	1,2,3	2	3.9	4.5	2.4	2.9	2.2	2.5	2.5	0.7	2.7
practice #	**Practice name**	**# of evaluations**	**% of harvested area / % land use area of total ag. area**	**Agroecozone**	**Farmer predominance 1: Small scale; 2: Medium Scale; 3: Large scale**	**Practice adoption (of country's ag. area) 1: <30% 2: 30-60% 3: >60%**	**Dimensions Averages**								**Climate Resilience**
							Yield	**Income**	**Water**	**Soil**	**Info**	**Energy**	**Carbon**	**Nutrient**	
5	**Conservation agriculture (Crop rotation, minimum/zero tillage, cover crops)**	**2**	**4%**	***Sylvo-Pastoral zone***	2,3	1	3.5	4.5	3.0	6.0	4.4	1.5	3.4	5.0	3.9

Why are the Identified CRA and AFM Interventions Important for the Programme

As discussed previously, in the Kara region of Togo, annual surface air temperature is projected to lie within the range of 25°C–30°C. This also suggests that the yields of maize, millet, rice, cashew, sesame, cassava and sweet potato are likely to decline as a result of heat stress in line with available evidences[41],[42]. Similarly in Senegal, annual surface air temperature is projected to lie within the range of 26°C–33°C in the Agropole region of Casamance. Consistent with literature, the yields of maize, millet, mango, cashew, sesame, cassava and sweet potato are projected to decline as a result of heat stress[43]. Last in the Guinea, annual surface air temperature is projected to lie within the range of 26°C–32°C in the Boke region and 23°C–30°C in Kankan. Consistent with literature, yields of maize, millet, rice, mango cashew, sesame, cassava and sweet potato are likely to decline as a result of heat stress. However, generally, a mean increase in temperature of about 4 - 5% or about 1.5°C - 2.5°C annually is projected in all the regional areas while a decrease in precipitation is projected at the core of the rainy season (June - September), which is typically the growing period for most crops in these countries. Equally, analyses of climate extremes indicates that there will be more long-term seasonal Drought (SD) events in the regions, shortening of the length of growing period (LGP), more occurrences of Consecutive Dry Days (CDD), and increased in Crop Water Requirements (CWR).

As highlighted above, the selected CRA interventions provide ample opportunities for addressing these climate change challenges, while simultaneously supporting economic growth and development of the agriculture sector in these target countries. As illustrated above, these CRA practices will lead to increases in productivity as well as achieving other objectives of adaptation and mitigation.

- According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014)[44], climate change (CC) will amplify existing stress on agricultural systems and water resources in Africa. In fact, the report stresses that between 75 million and 250 million people in Africa will be exposed to increased water stress due to CC. Consequently, it is projected that agricultural production, including access to food, in many African nations particularly sub-Saharan Africa (SSA), will be severely compromised by climate variability and change. According to the Montpellier panel of 2013, without positive productivity changes, food production systems in many parts of Africa, for example, will only be able to meet 13% of the needs in 2050; and, under moderate CC without adaptation, total agricultural production in several of these countries will even decline by at least 1.5% by 2050. This situation is abysmal in countries like Senegal, where the frequency of annual droughts and extremely hot temperatures during the seasons have increased considerably as discussed in chapter 5. This has had profound adverse effects on the major economic growth driver, agriculture. The search for solutions has led to overwhelming agreement that the most effective strategies capable of addressing the devastating consequences of CC on socio-ecological systems in African countries, are embedded in simultaneously: (i) tackling the issue of soil infertility and land degradation; (ii) scaling up recommended agricultural technologies or practices to increase agricultural productivity; (iii) improving the livelihoods

[41] Babacar Faye *et al* 2018. Impacts of 1.5 versus 2.0°C on cereal yields in the West African Sudan Savanna ,*Environ. Res. Lett.* https://doi.org/10.1088/1748-9326/aaab40
[42] Pauw E.D, & S. Ramasamy (2020). Rapid detection of stressed agricultural environments in Africa under climatic change 2000–2050 using agricultural resource indices and a hotspot mapping approach. Weather and Climate Extremes 27 (2020) 100211
[43] World Bank (2011). Senegal Climate Risk and Adaptation Profile.
[44] IPCC (2014): https://www.ipcc.ch/assessment-report/ar5/.

of smallholders and enhancing food security; (iv) mainstreaming solutions to CC and variability into local, regional and transnational development plans; and, (v) developing the capacity of smallholders, stakeholders and policy makers.

It is in that context that an array of small-scale agricultural water management (AWM) intervention solutions are currently being promoted in many parts of Africa, to improve agricultural productivity in different ways[45]. For instance, smallholder drip irrigation has been extensively promoted in the Sahelian countries to improve agricultural productivity and generate livelihood benefits through water-saving[46] (Figure 9). Despite the great potential of these small-scale AWM interventions to improve productivity, food security, livelihoods and environmental health, these solutions have not received much publicity in the SCPZs programme context. Failure to do so will mean that many of the smallholder farmers in these countries will still practice the traditional, less-water efficient, bucket-based irrigation, which constantly leads to water shortages, especially in the dry season. Dry-season farming is increasingly becoming important in some parts of these countries. In fact, many smallholders are now engaged in market gardening of vegetables in the dry season as a way of generating an additional household income stream outside the rainy season. However, access to sufficient water and soil infertility remain major challenges to sustainable production in these countries.

GCF support is highly needed to bridge this gap in the programme. Without GCF support, dry-season farming of vegetables including market gardening especially among women to generating additional household income streams outside the rainy season may be difficult within the SCPZs programme context (Figure 10).

[45] Houessionon et al. (2017). 'Economic Valuation of Ecosystem Services from Small-Scale Agricultural Management Intervention Options in Burkina Faso: A Discrete Choice Experiment Approach'. ***Sustainability***, 2017, *9(9), 1672.* https://doi.org/10.3390/su9091672.

[46] Balana et al. (2017). Can Drip Irrigation Help Farmers to Adapt to Climate Change and Increase their Incomes? ***WLE Briefing Series*** *No. 15:1-5.*https://wle.cgiar.org/can-drip-irrigation-help-farmers-adapt-climate-change-and-increase-their-incomes.

Figure 9. Crops Irrigated with Drip Irrigation during Dry Season in the Sahel

Figure 10. Drip Irrigation Powered by Solar Pumps used for Market Gardening.

- Lastly, it is really ironical that with the substantial volume of waste to be generated through agricultural activities in the IAIPs, the baseline interventions fail to integrate clean mechanisms into the programme that can help transformed this large volume of waste into clean and affordable energy (biogas technology). Besides, all three countries produced large quantities of livestock such as such as cattle, sheep, poultry and goats etc., with huge potentials for ruminant waste products as shown in Table 17. These waste products (liquid and solid waste), food and agro wastes that are like to pose sanitation and waste management challenges in these countries are actually sustainable "resources" for biogas technology. Biogas technology presents great opportunities for decentralized (off-grid) and diversified (multiple uses such as for stoves, refrigerators and generators) energy use. It is also the only renewable energy technology that is able to address multiple challenges such as waste management, access to energy, and improving agricultural productivity. Other products of anaerobic digestion include effluent, sludge or bio slurry. Compared to composting, anaerobic process reduces nitrogen loss from 50-80% to just 5-12%. It also increases ammonia content by 120% and quick-acting phosphorus by 150% and increases agricultural yield by 11% per year[47]. Other benefits of biogas technology include improved sanitation, sustainable land use, improved environmental health, climate change mitigation by reducing atmospheric emission

[47]McGarry, Michael G. and Jill Stainforth. 1978. Compost, Fertilizer, and Biogas Production from Human and Farm Wastes in the People's Republic of China. Ottawa: International Development Research Centre.
Gregory R. 2010. China Biogas. http://www.ecotippingpoints.org/our-stories/indepth/china-biogas.html. Accessed December 2016

of methane, costs savings and optimizing water use through recycling and reuse and providing green jobs (for example for masons, carpenters, electricians).

This is one of the reasons why additional support is requested from the GCF focusing on anaerobic digestion of waste (biogas technology) to provide renewable energy for diversified use by the agricultural value chain actors in these countries. In Togo for example, the energy sector is characterized by the dominance of biomass (71% of final energy consumption) and heavy dependence on energy imports (100% of petroleum product needs and 79% of electricity needs covered by imports). Moreover, the country is not much involved in the development of renewable energy sources (solar, wind, mini and micro hydropower). It also has a low electricity access rate (28%) and very low electricity consumption (118 kWh/inhabitant. /year) compared to the average for sub-Saharan Africa (535 kWh/inhabitant. /year). Currently, electricity is generated primarily from five thermal power plants which jointly represent an installed capacity of 128 MW and the Nangbeto hydroelectricity power plant with a capacity of 30 MW. With support for the GCF, Togo can benefit from additional cheap and clean energy to bridge its current renewable energy gap.

Table 17. Production of Livestock Manure in kg in the three Pilot Countries (2017)

Domain	Country	Source	Value (kg)
Livestock Manure	Guinea	Cattle, dairy	43,362,000.00
Livestock Manure	Guinea	Cattle, non-dairy	254,136,312.08
Livestock Manure	Guinea	Chickens, broilers	8,889,701.07
Livestock Manure	Guinea	Chickens, layers	3,738,855.60
Livestock Manure	Guinea	Goats	43,804,380.00
Livestock Manure	Guinea	Sheep	30,156,789.99
Livestock Manure	Guinea	Swine, breeding	74,776.16
Livestock Manure	Guinea	Swine, market	1,921,083.65
Total			***386,083,898.55***
Livestock Manure	Senegal	Cattle, dairy	38,972,259.98
Livestock Manure	Senegal	Cattle, non-dairy	116,433,527.09
Livestock Manure	Senegal	Chickens, broilers	18,772,412.55
Livestock Manure	Senegal	Chickens, layers	4,309,920.00
Livestock Manure	Senegal	Goats	85,854,289.57
Livestock Manure	Senegal	Sheep	72,177,795.96
Livestock Manure	Senegal	Swine, breeding	234,255.18
Livestock Manure	Senegal	Swine, market	6,018,244.45
Total			***342,772,704.78***
Livestock Manure	Togo	Cattle, dairy	3,988,641.53
Livestock Manure	Togo	Cattle, non-dairy	14,957,389.79
Livestock Manure	Togo	Chickens, broilers	10,047,234.49
Livestock Manure	Togo	Chickens, layers	1,346,850.00
Livestock Manure	Togo	Goats	42,675,487.12
Livestock Manure	Togo	Sheep	27,910,556.53
Livestock Manure	Togo	Swine, breeding	275,496.45
Livestock Manure	Togo	Swine, market	7,077,770.35
Total			***108,279,426.26***

Source: FAO Statistics (2017)[48]

[48] FAO (2017): www.fao.org/faostat/en/#data/QC.

5. CLIMATE RATIONALE FOR ADDITIONAL PROGRAMME INTERVENTIONS

5.1. Vulnerability to Climate Change

Togo, Senegal and Guinea, which are situated in the Horn of Africa and the Sahel, are among the major climate 'hotspots' in the continent. These countries are already suffering the effects of climate change as a result of historical warming and increased precipitation intensity trends. Future climate scenarios also indicate general warming and reduced precipitation trends with increased extremes[49],[50]. The vulnerabilities of these countries to climate extremes are high due to the strong dependence of the economies on rain-fed agriculture, largely dominated by smallholder farmers (about 80%) for daily subsistence. Reliance on rain-fed farming and pastoralism for income and subsistence mean that livelihoods and food security in these countries are strongly affected by climate variability and change. According to WFP report, during the lean season (June to August), more than 21 million people across West Africa including Togo, Senegal and Guinea, will struggle to feed themselves as a result of recurrent food crises attributed to extreme weather events (prolonged droughts and floods). For example, the 2012 food crisis in Senegal caused by prolonged drought events left over 800,000 households' food insecure. Similarly, in Togo, reduced grain quality and yields of maize, sorghum, millet and rice among peasant farmers have been reported, especially in the northern part of the country as a result of heat stress, water stress, flooding, erosion, and water logging.[51] With a combined population of over 135 million people (about 11.1% of the continent's total population), and projected to double by 2050[52], these countries are committed to achieving the goals of the Paris Climate Agreement, as expressed in their NDCs (conditional and unconditional), by strengthening the mitigation and adaptation capacity of the agricultural sector (Table 18).

Table 18. Countries NDCs in the agricultural sector, land use and forestry and energy by 2030

Country	Commitment	Sectors for mitigation and enhanced removals	Budget
Togo ***LUCF - highest emitting sector in 2014 based on WRI CAIT data (6.6 MtCO2e)***	Unconditional – Reduce GHG emissions by 20.51% by 2030, i.e., 6,236.02 Gg CO2-eq, compared to 2030 BAU emissions Conditional – Reduce GHG emissions by 30.06% by 2030, i.e. 9,305.59 Gg CO2-eq, compared to 2030 BAU emissions	Energy, Agriculture and LULUCF **Agriculture** Identification and promotion of varieties of rain-fed rice, and support and guidance in the better use of organic matter in the paddy fields Reduction of GHG emissions (optimal waste management from livestock and harvest remnants, promotion of low emission land use planning practices, etc.). **Energy** Promotion of energy-efficient stoves (which can yield 50-60% savings in wood and charcoal).	**~USD$5.4 billion** (mitigation and adaptation measures are USD$2.7 and USD$2.6 billion, respectively)

[50]USAID 2018. Fact Sheet: Climate Change Risk Profile, West Africa. USAID, December 2017.
[51]USAID 2018. Fact Sheet: Climate Change Risk Profile, West Africa. USAID, December 2017.
[52]The Montpellier Panel (2013).

		Introduction of solar equipment at the household level	
Senegal: ***Agriculture - highest emitting sector in 2014 based on WRI CAIT data (11.0* MtCO2e)**	Unconditional – Reduce GHG emissions by 5% (i.e. 30,987 GgCO2eq) and 7% (i.e., 35,106 GgCO2eq) by 2025 and 2030, respectively, compared to the BAU emissions in those years. Conditional – Reduce GHG emissions by 23% (i.e., ~24,883 GgCO2eq), and 29% (i.e., ~26,611 GgCO2eq) in 2025, and 2030, compared to the BAU emissions in those years.	Agriculture, Forestry and Energy **Agriculture** Implementation of projects and programs to reduce GHG emissions **Forestry** Emission reduction related to the consumption of firewood and charcoal (unconditional and conditional actions) Emission reduction from deforestation and Forest degradation (unconditional and conditional actions) **Energy** Provision of 160 MW of Solar PV 392 villages provided with Solar or hybrid mini-grid Installation of 27,000 biodigester at the household level.	**USD$13 billion** (USD$8.7 billion dedicated to mitigation with USD$3.4 and $5.3 billion unconditional and conditional, respectively, and USD$4.3 billion for adaptation, including USD$1.4 and $2.9 billion unconditional and conditional, respectively)
Guinea: ***LUCF - highest emitting sector in 2014 based on WRI CAIT data (14.0* MtCO2e)**	Excluding LULUCF Unconditional - 2,056 ktCO2eq/year, i.e. a 9.7% reduction in emissions by 2030 Conditional – Excluding storage capacity from LUCF, reduce 3,929 ktCO2 eq/year, or 17.0% GHG emissions by 2030 compared to the BAU scenario On LULUCF Unconditional - 23% reduction in emissions by 2030 Conditional – Excluding reforestation actions, reduce 49% GHG emissions by 2030 compared to the BAU scenario	Energy, Land-Use Change and Forestry (LUCF) and Agriculture Produce 30% of its energy (excluding wood-energy) from renewable energy sources (cumulative GHG reduction of 34 MtCO2e by 2030) Support the dissemination of technologies and practices that are energy- efficient or use alternatives to wood-energy and charcoal (cumulative GHG reduction of 23 MtCO2e by 2030)	**USD$13.8 billion**

Source: Adopted from USAID 2019.

These countries have a long history of confronting economic, social and environmental crises as well as climate-related challenges. Key human-influenced drivers of climate change include rising temperatures caused by increasing global GHG emissions and changes in land use, namely deforestation (clearing land for agriculture, extended periods of shifting cultivation, mono-cropping, over exploitation of the already vulnerable land and forests and cutting trees for firewood and as an alternative source of income), and overgrazing of pastureland. These combine to contribute to alterations in rainfall patterns and increase the frequency of extreme weather events (floods including riverine floods, wind and dust storms, prolonged dry spells or droughts), resulting in loss of assets (infrastructure, productive land livestock, etc), crop losses, lower productivity levels and even famine and desertification. All these climatic and non-climatic factors contribute to growing food insecurity and poverty experienced in the countries.

5.2. Methodology

This section summarizes the key elements of the methodology used for climate analysis. Firstly, the historical climate of the regions of interest is presented. Thereafter, the future climate under different emission scenarios is analyzed. Also, the section describes the Regional Climate Models (RCMs) used for the downscaled simulations including the data used for evaluating the baseline simulations. The baseline climate is taken as the 30-year period from 1976 to 2005 and compared with different climate periods in the current (i.e., 2006 – 2035 and 2011-2040) and future (i.e., 2036-2065, 2041-2070, and 2071-2100). The model evaluation is performed based on annual cycle, climatological mean and trends in annual values of precipitation, minimum and maximum temperatures.

Climate Change Scenario

Basically, two representative concentration pathways (RCPs) were used-RCP4.5 (low-medium emission) and RCP8.5 (high emission). Under RCP 4.5, emissions peak around 2040 before declining and this requires that carbon dioxide (CO2) emissions start declining by approximately 2045 to reach roughly half of the levels of 2050 by 2100. It also requires that methane emissions (CH4) stop increasing by 2050 and decline somewhat to about 75% of the CH4 levels of 2040, and that sulphur dioxide (SO2) emissions decline to approximately 20% of those of 1980–1990[53]. In the RCP4.5 scenario, radiative forcing is expected to stabilize at 4.5 W m^{-2} in the year 2100 without ever exceeding that value[54]. RCP8.5 is generally considered as the basis for worst-case (business-as-usual) climate change scenarios, and was based on what proved to be overestimation of projected coal outputs. In RCP 8.5 emissions continue to rise throughout the 21st century thereby stabilizing the radiative forcing at 8.5 Wm^{-2}. The use of the RCPs scenario provides a common platform for the RCMs used, to explore the climate system response to stabilizing the anthropogenic components of radiative forcing. By extending the simulations until 2065, the range in radiative forcing across RCPs is small compared to their dispersion in 2100[55].

Station data

Daily station precipitation, minimum and maximum temperature data from 1981-2010 were analyzed for selected stations within the SCPZs (Table 19). These datasets are extracted from the archives of the National Meteorological Services of the corresponding host countries. The datasets were used to evaluate the performance of the RCMs in terms of their representation of annual trends and variability. Furthermore, the daily series were used to generate project-scale climate indices relevant to agriculture as defined by WMO Expert Team Sector-Specific Climate Indices (ET-SCI)[56]. Analysis of trends in the indices in order to investigate the direction, magnitude and deviation of the index from the climatological mean is also presented.

Table 19. Selected meteorological stations within the SCPZ of the three host countries

[53]https://ar5-syr.ipcc.ch/topic_futurechanges.php

[54]Moss RH, Edmonds JA, Hibbard KA, Manning MR, Rose SK, van Vuuren DP, et al. The next generation of scenarios for climate change research and assessment. Nature. 2010; 463: 747±756. https://doi.org/10.1038/nature08823 PMID: 20148028

[55]IPCC. 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. In Stocker T. F., Qin D.,Plattner G.-K., Tignor M., Allen S. K., Boschung J., . . . Midgley P. M. (Eds.) (p. 1535). United Kingdom and New York, NY, USA.: Cambridge University Press.

[56] https://climpact-sci.org/indices/

Country	Region	Station	Latitude	Longitude
Guinea	Boke	Boke	10.93532	-14.28633
	Kankan	Kankan	10.38886	-9.29399
Togo	Kara	Kara	9.62788	1.20357
		Niamtougou	9.8	1.083333
Senegal	Southern Agropole	Zinguinchor	12.5	-16.272
		Kolda	12.888	-14.972
		Velingara	13.15	-14.1

Gridded observation

Station-based gridded rainfall and surface temperature from the Climate Research Unit (CRU)[57] were used for evaluating the downscaled simulations. Specifically, the CRU Time-Series (TS) version 4.02 - CRU TS4.02[58] was used, supplemented with Stations Data from the University of California in Santa Barbara Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)[59]. The CRU station-based gridded dataset is produced by angular-distance weighting interpolation of station observations onto a 0.5° grid[60]. It is derived by the interpolation of monthly climate anomalies from extensive networks of weather station observations. The dataset is available from 1901 to near present on a monthly time scale by the inclusion of additional station observations[61]. CRU temperature is widely used and has also been applied for correcting reanalysis data in order to apply them to impact modeling[62],[63]. Although CRU is a purely station-based dataset, the reliability of CRU data varies spatially due to station sparsity, especially in the data spare continent like Africa. However, this dataset fulfills most of the IPCC climatological baseline criteria reported in IPCC Technical guidelines for assessing climate change impacts and adaptations (IPCC AR6, 2021[64]):

- It is representative of the present-day or recent average climate in the study regions;
- It is of sufficient duration to encompass a wide range of climatic variations in the regions;
- It sufficiently covers a period for which data on all climatological variables are abundant in the regions, and readily available;
- It is of sufficient quality for use in assessing climate impacts in the regions; and,
- The dataset is consistent with the current WMO recommended period (30 years) adopted in impact assessment.

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[57]http://badc.nerc.ac.uk/data/cru/.

[58]Harris, I.C.; Osborne, T.; Jones, P.; Lister, D. Version 4 of the CRU TS monthly high-resolution gridded multivariate climate dataset. Sci. Data 2020, 7, 2052–4463

[59]Funk C, Peterson P, Landsfeld M, Pedreros D, Verdin J, Shukla S, et al. The climate hazards infrared precipitation with stations a new environmental record for monitoring extremes. Scientific Data, 2015;2: 150066. https://doi.org/10.1038/sdata.2015.66 PMID: 26646728

[60]Harris, I.; Jones, P.D.; Osborn, T.J.; Lister, D.H. Updated high-resolution grids of monthly climatic observations—The CRU TS3.10 Dataset. Int. J. Climatol. 2014, 34, 623–642.

[61] Ibid 11.

[62]Weedon, G.P.; Balsamo, G.; Bellouin, N.; Gomes, S.; Best, M.J.; Viterbo, P. The WFDEI meteorological forcing data set: WATCH Forcing Data methodology applied to ERA-interim reanalysis data. Water Resour. Res.2014, 50, 7505–7514.

[63] Mitchell, T. D., & P. D. Jones, 2005: An improved method of constructing a database of monthly climate observations and associated high-resolution grids. Int. J. Climatol. , 25, 693–712

[64] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_TS.pdf

The gridded data analyzed were derived from the area average that represents the region of interest as shown in Figure 11 below.

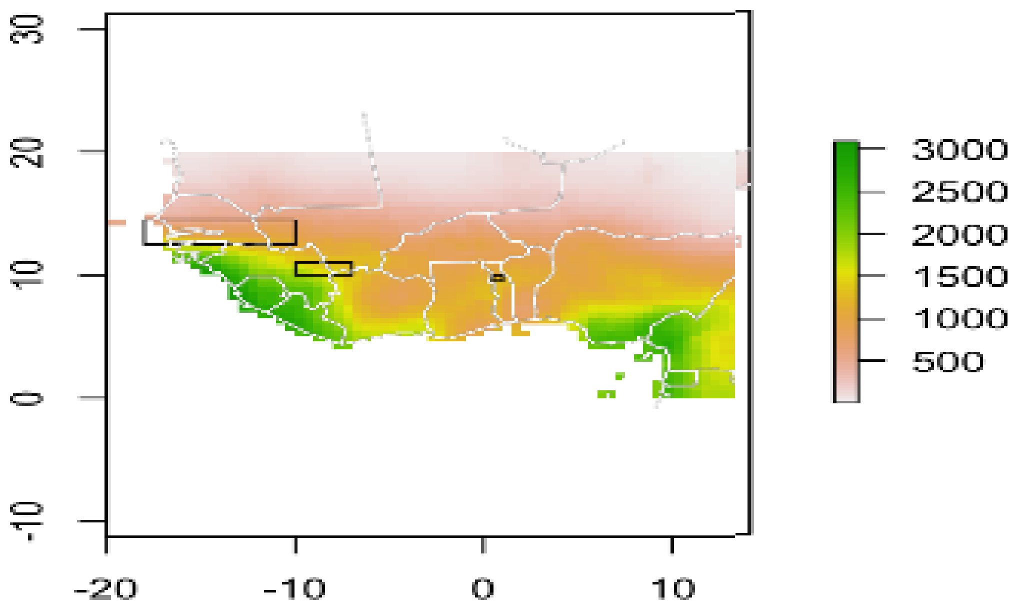


Figure 11. Map showing the outline of the area blocks (black boxes) where data was extracted from and the average annual total rainfall amount derived from CRU for the period 1976–2005

Another useful precipitation data source is the daily rainfall dataset from CHIRPS[65]. It uses TIR imagery and gauge data in addition to a monthly precipitation climatology, CHPClim, and atmospheric model rainfall fields from the NOAA Climate Forecast System, version 2 (CFSv2). CHIRPS is gridded precipitation data created from a blend of high-resolution satellite imagery (at 0.05^{o}) and station-based data to produce a 0.25^{o} horizontal resolution data. The CRU gridded datasets were also compared with the resolution of ERA5 reanalysis daily maximum and minimum temperature fields. ERA-5 is the fifth generation of the European Centre for Medium Range Weather Forecasts (ECMWF) reanalysis produced by combining the Integrated Forecast System with data assimilation[66]. ERA5 reanalysis is produced at a spatial resolution of 0.25^{o} grid and at hourly time intervals.

The Regional Climate Models

The long-term climate simulations carried out in the analyses are produced by three regional climate models (RCMs) participating in the Coordinated Regional Climate Downscaling Experiment (CORDEX) framework[67]. The RCMs include: (i) the Swedish Meteorological and Hydrological Institute, Rossby Centre (SMHI-RCA v4), (ii) the Climate Limited-area Modelling Community (CCLM v4.8.17) and (iii) the Helmholtz-Zentrum Geesthacht, Climate Service Center, Max Planck Institute for Meteorology (REMO2009). Common to these regional climate models is the global circulation model (i.e., the Maxx Planck's Earth Systems Model low

[65]Funk, C. et al. (2015) 'The climate hazards infrared precipitation with stations--a new environmental record for monitoring extremes', Scientific data, 2(1), p. 150066.
[66]Hersbach, H. et al. (2020) 'The ERA5 Global Reanalysis: achieving a detailed record of the climate and weather for the past 70 years'. doi: 10.5194/egusphere-egu2020-10375.
[67]https://cordex.org/data-access/esgf/

resolution runs) that was used as initial and boundary conditions to force the historical simulations and future projections. These RCMs have been extensively used for weather forecasts, seasonal forecasts, and climate change studies over Africa[68,69, 70, 71,72, 73,74]. The CORDEX RCMs downscale many global climate models (GCMs) from the Coupled Model Intercomparison Project, Phase 5 (Taylor et al., 2012[75]; Sylla *et al.*, 2016[76]). The RCMs are run over the whole of Africa at 44 km resolution. To date, the CORDEX-Africa data constitute the most comprehensive RCMs projections available for the continent.

Owing to the fact that observational data are sparsely distributed over much of the target areas, and even when they exist, most of these datasets are inconsistent (e.g., missing or erroneous data) in many parts of African countries (IPCC 1994[77]; Kalognomou *et al.*, 2013[78]; Sylla *et al.*, 2013[79]; Shongwe *et al.*, 2015[80]; Girvetz et al. 2019[81]), independent observations of the same variable and the model ensemble were used in line with IPCC recommendations as follows:

> *'Although crucial, the evaluation of climate models based on past climate observations has some important limitations. By necessity, it is limited to those variables and phenomena for which observations exist. In many cases, the lack or insufficient quality of long-term observations be it a specific variable, an important process, or a particular region, remains an impediment. In addition, owing to observational uncertainties and the presence of internal variability, the observational record against which models are assessed is 'imperfect'. These limitations can be reduced, but not*

[68]Fotso-Nguemo, T.C., Vondou, D.A., Pokam, W.M., Djomou, Z.Y., Diallo, I., Haensler, A., Tchotchou, L.A.D., Kamsu-Tamo, P.H., Gaye, A.T. and Tchawoua, C., 2017. On the added value of the regional climate model REMO in the assessment of climate change signal over Central Africa. Climate Dynamics, 49(11), pp.3813-3838.

[69]Akinsanola, A.A., Ogunjobi, K.O., Gbode, I.E. and Ajayi, V.O., 2015. Assessing the capabilities of three regional climate models over CORDEX Africa in simulating West African summer monsoon precipitation. Advances in Meteorology, 2015.

[70]Sawadogo et al. (2020). Current and future potential of solar and wind energy over Africa using the RegCM4 CORDEX-CORE ensemble. *Climate Dynamics*, 1-26.

[71]Dosio et al. (2020). A tale of two futures: contrasting scenarios of future precipitation for West Africa from an ensemble of regional climate models. *Environmental Research Letters*, 15 (6), 064007.

[72]Kebe et al. (2020). Late 21st Century Projected Changes in the Relationship between Precipitation, African Easterly Jet, and African Easterly Waves. *Atmosphere.11 (4), 353.*

[73]Mbaye et al. (2019). Impacts of 1.5 and 2.0 ◦C Global Warming on Water Balance Components over Senegal in West Africa. *Atmosphere* **2019**, *10*(11), 712; https://doi.org/10.3390/atmos10110712.

[74]Gibba et al. (2019). State-of-the-art climate modeling of extreme precipitation over Africa: analysis of CORDEX added-value over CMIP5. *Theoretical and Applied Climatology*, 137 (1), 1041-1057.

[75]Taylor, K.E., Stouffer, R.J. and Meehl, G.A. (2012), "An overview of CMIP5 and the experiment design", Bulletin of the American Meteorological Society, Vol. 93 No. 4, pp. 485-498.

[76]Sylla, M.B., Elguindi, N., Giorgi, F. and Wisser, D. (2016), "Projected robust shift of climate zones over West Africa in response to anthropogenic climate change for the late 21st century", Climatic Change, Vol. 134 Nos 1/2, pp. 241-253.

[77] IPCC (1994). IPCC Technical guidelines for assessing climate change impacts and adaptations. University College London and Center for Global Environmental Research.

[78]Kalognomou E-A, Lennard C, Shongwe M, Pinto I, Favre A, Kent M, Hewitson B, Dosio A, Nikulin G, Panitz H-J, Bⁿchner M. 2013. A diagnostic evaluation of precipitation in CORDEX models over southern Africa. *Journal of Climate* **26**: 9477–9506.

[79]Sylla MB, Giorgi F, Coppola E, Mariotti L. 2013. Uncertainties in daily rainfall over Africa: assessment of gridded observation products and evaluation of a regional climate model simulation. *International Journal of Climatology* **33**: 1805–1817.

[80]Shongwe et al. 2015. An evaluation of CORDEX regional climate models in simulating precipitation over Southern Africa. *Atmos. Sci. Let.* **16**: 199–207 (2015).

[81]Girvetz E. et al. (2019) Future Climate Projections in Africa: Where Are We Headed?. In: Rosenstock T., Nowak A., Girvetz E. (eds) The Climate-Smart Agriculture Papers. Springer, Cham. https://doi.org/10.1007/978-3-319-92798-5_2.

entirely eliminated, through the use of multiple independent observations of the same variable as well as the use of model ensembles' (IPCC, 2013)[82].

Prior to carrying out the analysis covering the historical period, spatial correlation was carried out between the CRU observations and simulated precipitation and mean 2-metre temperature patterns derived from the 3 RCMs and their ensemble mean (Table 20). The spatial correlation between the simulated precipitation pattern by the ENS model, the RCMs and CRU. DJF is the season when the 3 RCMs and the ENS-model precipitation exhibits the highest correlations. Results indicate that the ENS provides added value to the simulations over the three RCMs. In all seasons, the spatial pattern of temperature is better reproduced by the ENS model when compared to the individual model runs. For the highly variable precipitation, the pattern correlation is low and comparable between the CCLM model and ENS. Although the pattern correlation between ENS model simulations and CRU observations are lower for precipitation than for temperature, these correlations are still much higher than with the individual model simulations, except for DJF, MAM, and JJA when the CCLM correlates better with CRU observations.

Table 20. Pattern correlations between the CCLM, SMHI, REMO simulations and observations, and between ENS simulations and observations, for DJF, MAM, JJA, and SON trimesters over the West African Domain.

		2-m Temperature			
RCMs/season	DJF	MAM	JJA	SON	Annual
CCLM	0.88	0.82	0.82	0.85	0.84
SMHI	0.87	0.82	0.83	0.85	0.84
REMO	0.81	0.81	0.82	0.9	0.84
ENS	0.9	0.88	0.88	0.93	0.90
		Precipitation			
CCLM	0.39	0.32	0.38	0.22	0.33
SMHI	0.38	0.3	0.34	0.23	0.31
REMO	0.38	0.31	0.33	0.22	0.31
ENS	0.38	0.31	0.35	0.23	0.32

DJF = December -January - February; **MAM** = March - April - May; **JJA** = June - July - August;
SON = September -October - November.

5.3. Baseline

Seasonal Mean: Figure 12 shows the seasonal climatological precipitation patterns for the period 1976 - 2005. The first column shows the CRU observation whereas the second column presents the RCMs ensemble means (RCMs-ENS). In the last column, the bias between the CRU observation and the RCMs-ENS is presented. The major feature of the observations is a wide band of high rainfall, which spans along the Sudanian AEZ from the southern parts of Senegal, Guinea, and Togo in JJA and the difference between CRU and model is about 20 mm/month. The ENS model is able to simulate most of the precipitation characteristics, particularly during June, July and August (JJA). The intense precipitation region over Senegal,

[82]IPCC (2013). Evaluation of Climate Models. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Togo, and Guinea, which mainly occurs during (JJA) and early September, is well represented by the ENS model. In terms of precipitation amount, simulated precipitation is overestimated with respect to observations in JJA and SON seasons and underestimate in DJF and MAM by ± 20 mm. The position and latitudinal displacement of the precipitation band northwards from July to September, associated with both Pacific El Niño/La Niña sea surface temperature (SST) anomalies and the Atlantic dipole[83] is well reproduced by the ENS model as in previous studies[84].

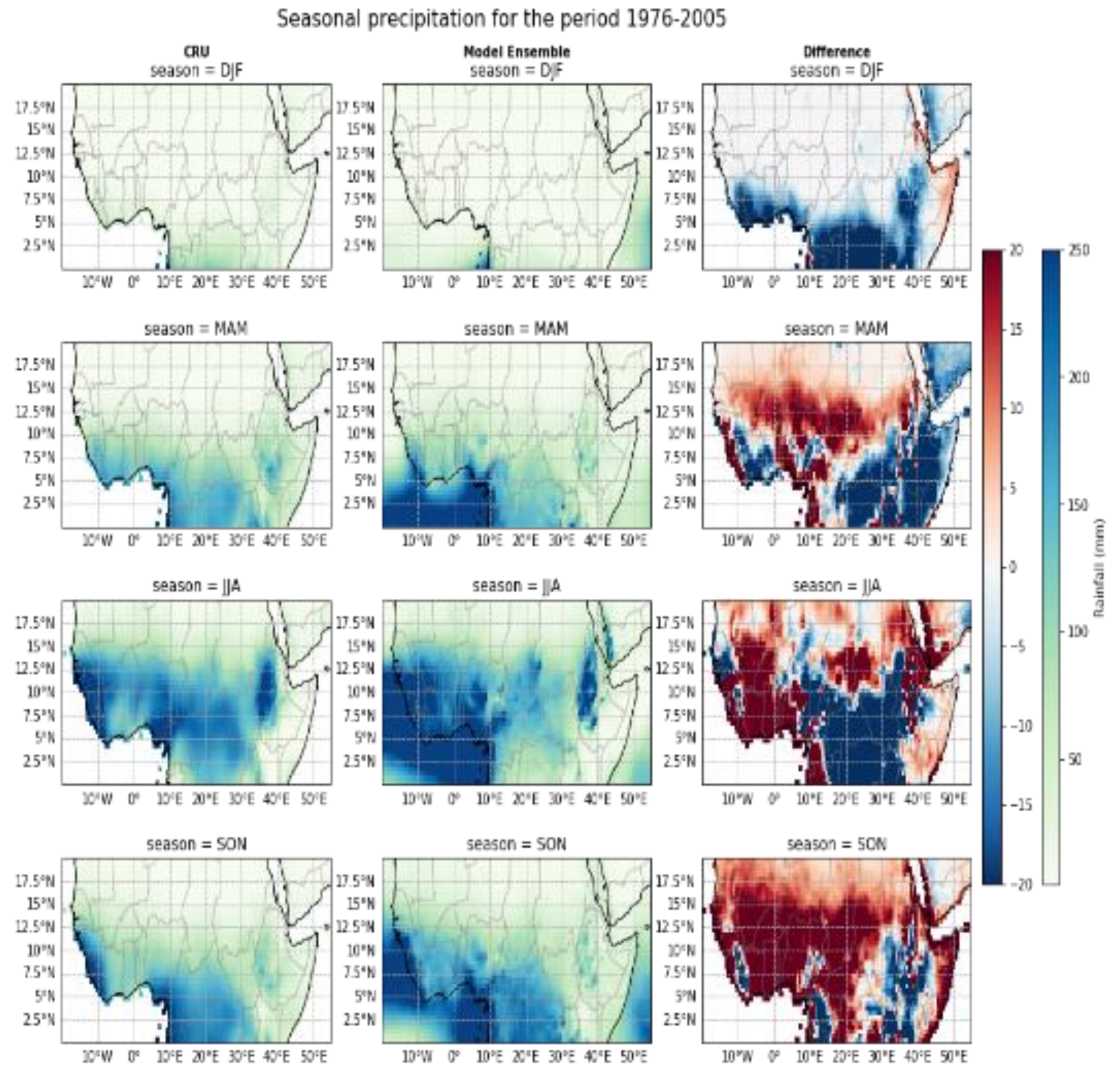


Figure 12. Mean precipitation (mm/day), CRU (first column), ENS simulations (second column) and differences between CRU and ENS (third column). The average is taken for the period 1976–2005 for the seasons DJF, MAM, JJA, and SON (from bottom to top).

[83] Bette L. Otto-Bliesner, 1999, "El Niño/La Niña and Sahel precipitation during the Middle Holocene", Geophysical Research letters, , vol. 26, issue 1, January. Available from https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/1998GL900236.

[84] Dosio et al. (2020). A tale of two futures: contrasting scenarios of future precipitation for West Africa from an ensemble of regional climate models. *Environmental Research Letters*, 15 (6), 064007.

The spatial distribution of precipitation in the host countries show distinct patterns with average annual rainfall ranging from about 600 mm/year to above 2500 mm/year (Figure 13). Both observations and model show the south to north decrease in rainfall signal in Guinea, the driest northern region in Senegal, and wettest western Plateaux sector and drying conditions further north of the Kara region in Togo. On the average, Senegal receives the lowest amount of annual total rainfall. Although the RCM response to topographic features such as the Plateaux in Togo and Ocean effects in Guinea is strong, the mean pattern of the observed rainfall in conserved highlight the usefulness of the RCMs for investigating the possible climate situation in the future.

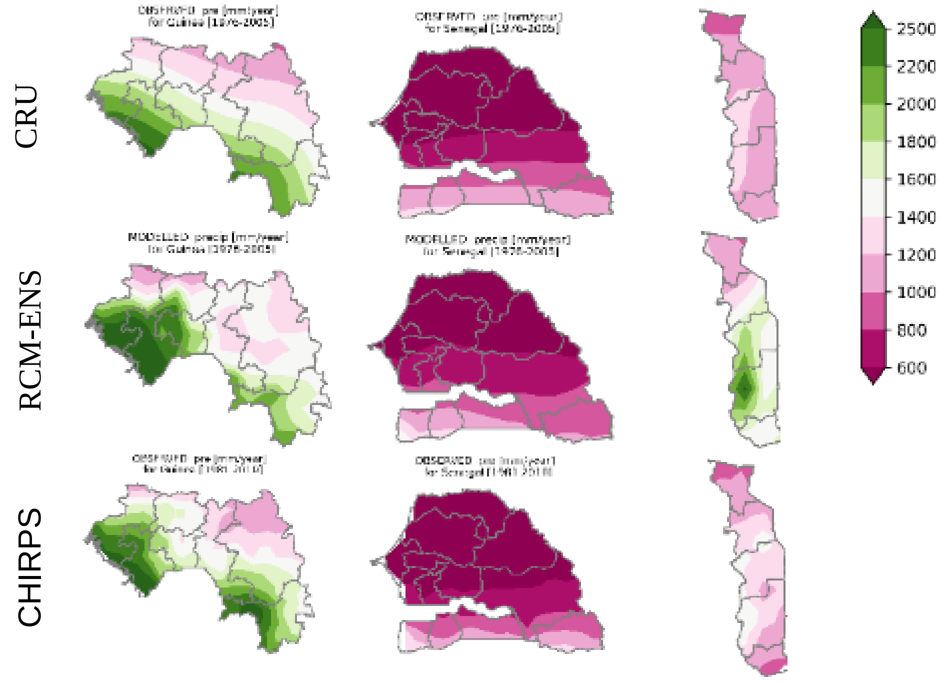


Figure 13. Spatial pattern of mean annual total precipitation (mm/year) from CRU[85] (Top row) and RCM-ENS[86] (middle row) for the period 1976–2005 and CHIRPS[87] (bottom row) for the period 1981-2010.

At project scale the RCM ensemble mean also compares well with most of the stations although with some systematic biases (Figure 14). For instance, trends in observed precipitation increased during the 1981-2010 period in Niamtougou, Togo. In Kankan, the observed and modelled trends in precipitation diverge slightly, where the observed trends show increase.

85 Harris, I. et al. (2020) 'Version 4 of the CRU TS monthly high-resolution gridded multivariate climate dataset', Scientific data, 7(1), p. 109.

86 The three regional climate models (RCMs) participate in the Coordinated Regional Climate Downscaling Experiment (CORDEX, Giorgi et al., 2009) framework and were retrieved from the ESGF portal. These RCMs consist of the Swedish Meteorological and Hydrological Institute, Rossby Centre (SMHI, Samuelsson et al., 2015), the Climate Limited-area Modelling Community (CCLM, Rockel, Will and Hense, 2008) and the Helmholtz-Zentrum Geesthacht, Climate Service Center, Max Planck Institute for Meteorology (REMO, Jacob et al., 2001). The RCMs were driven with initial and boundary conditions from the Max Planck's Earth Systems Model (Giorgetta et al., 2013) low resolution runs.

87 Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Husak, G., Rowland, J., Harrison, L., Hoell, A., & Michaelsen, J. (2015). The climate hazards infrared precipitation with stations--a new environmental record for monitoring extremes. Scientific Data, 2(1), 150066.

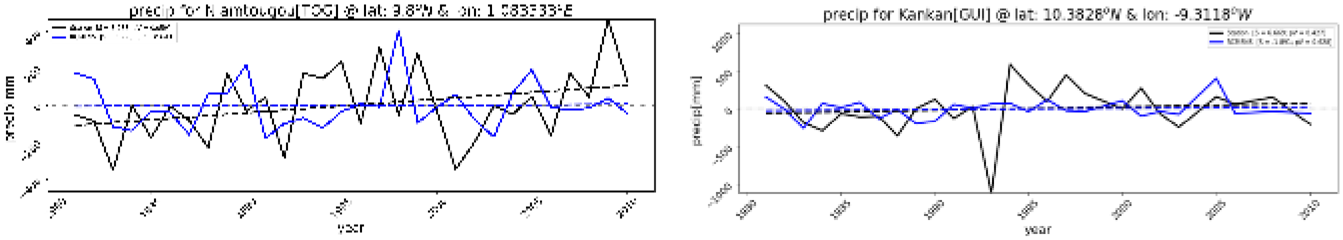


Figure 14. Trends in observed[88] (black line) and modelled (blue line) annual total precipitation for selected SCPZ stations the period 1981-2010.

The regional scale mean 2-metre temperature from the CRU observation and ENS-model simulations are shown in Figure 15, while the correlation pattern between the simulated and the observed 2-metre mean temperature is presented in Table 20. As shown in Table 20, in all the seasons, the spatial pattern of temperature is better reproduced by the RCM-ENS model. The pattern correlation between the ENS model temperature simulations and CRU observations range from 0.88 to 0.93, whereas the correlation for other RCMs is less than 0.9. The spatial distribution of mean 2-metre temperature from the CRU observation and ENS-model simulations is presented in Figure 15, the first column shows the CRU observation while the second column presents the RCMs-ENS. In the last column, the bias between the CRU observation and the RCMs-ENS is presented. The ENS model represents well the spatial patterns of 2-metre temperature for all seasons. The temperature gradient, the regional characteristics, and the seasonal variations are well reproduced by the ENS model. The ENS simulations captures well the areas of cold temperatures, such as in the coastal area of Guinea, and the areas of warmer temperatures such as in northern Senegal and northern Guinea. It equally captures the season when temperatures are extremely hot (MAM) and the colder season (SON). However, in terms of mean 2-metre temperature amount, the ENS model tends to overestimate temperatures almost everywhere in the coastal domain. The cold bias of temperature may be contributing to the overestimate of precipitation in the coastal areas as the convection trigger criterion in the ENS model depends on the near-surface air temperatures.

[88] The observed data are computed from daily rainfall data retrieved from the archives of the respective meteorological services for selected stations within the SCPZs

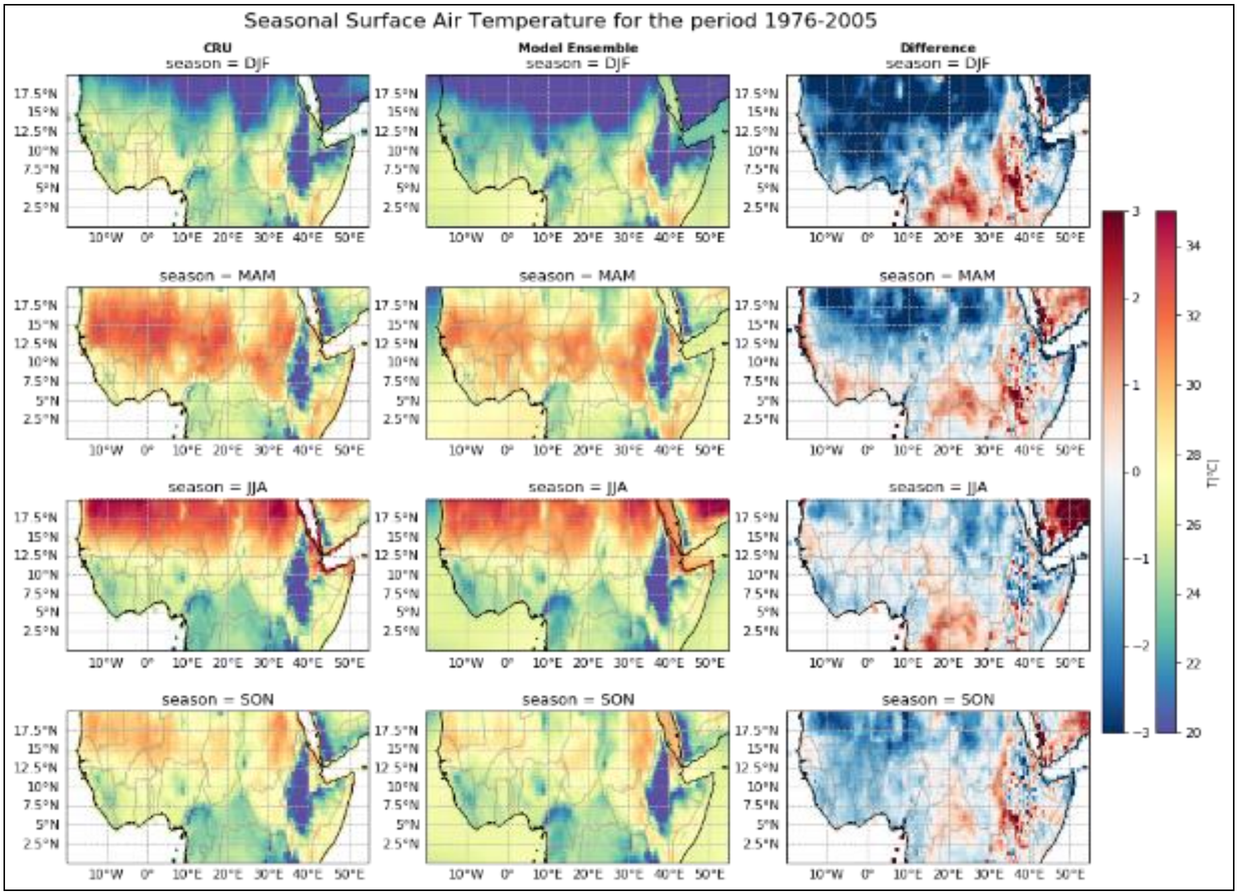


Figure 15. Mean 2-metre temperature (°C) from CRU (first column), ENS simulations (second column) and differences between CRU and ENS (third column). The plotted values are averaged for the period 1976–2005 for the seasons DJF, MAM, JJA, and SON (from bottom to top)

Both observed and modelled 2-metre temperature agree well in terms of spatial patterns for all seasons in the two AEZs. The temperature gradient, the regional characteristics, and the seasonal variations are well reproduced by the ENS model. The ENS simulations captures well the areas of cold temperatures, such as in the coastal area of Guinea, and the areas of warmer temperatures such as in northern Senegal and northern Guinea. However, the ENS model tends to overestimate temperatures almost everywhere in the coastal domain. The warm bias of temperature may be contributing to the overestimation of precipitation in the coastal areas as warming results in enhanced evaporation that will favour convection trigger criterion in the ENS model depends on the near-surface air temperatures. The national scale spatial pattern of annual mean surface temperature is conserved in the RCM both for minimum and maximum temperature (Figure 16). Temperatures are largely influenced over complex terrains like the Plateaux in Togo and nearness to water bodies like the coastlines of Guinea and Senegal. The average minimum and maximum temperature ranges from 14°C in the highlands of Guinea to about 38°C in the northern region of Senegal.

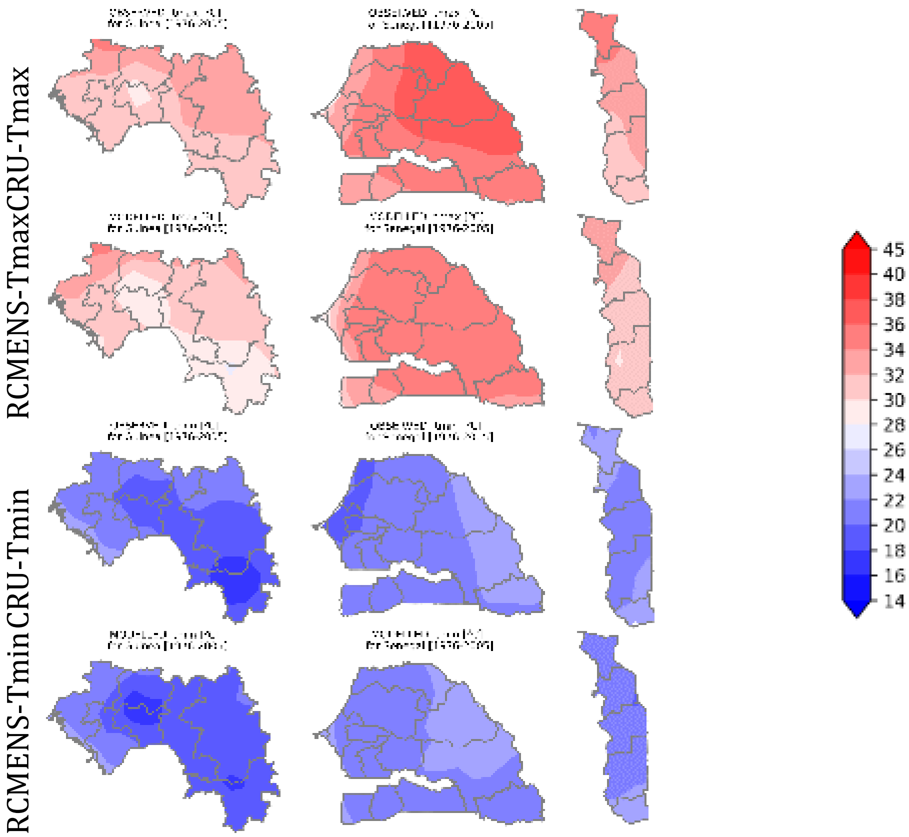
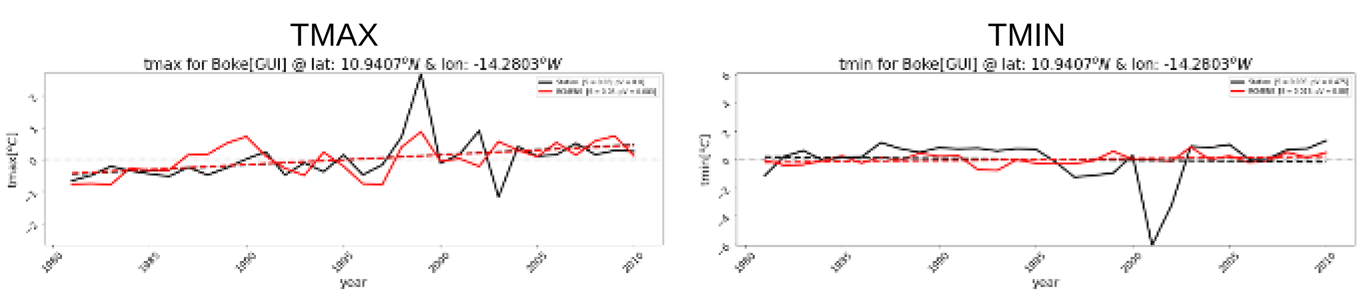


Figure 16. Spatial pattern of annual mean surface maximum and minimum temperature(°C) from CRU and RCM-ENS for the period 1976–2005

Local trends in temperature show a general increase for minimum and maximum temperature in both station observed and model simulated data (Figure 17). The warming is statistically significant, especially with maximum temperature where the mean annual deviation from the climatological mean is about 1 to 2°C. The observed warming partly contributes to soil degradation which could result in low crop yields in the SCPZs. Consequently, decline in agricultural productivity discourages the farmers and may lead to change in livelihood especially in the rural settings of the host SCPZs.



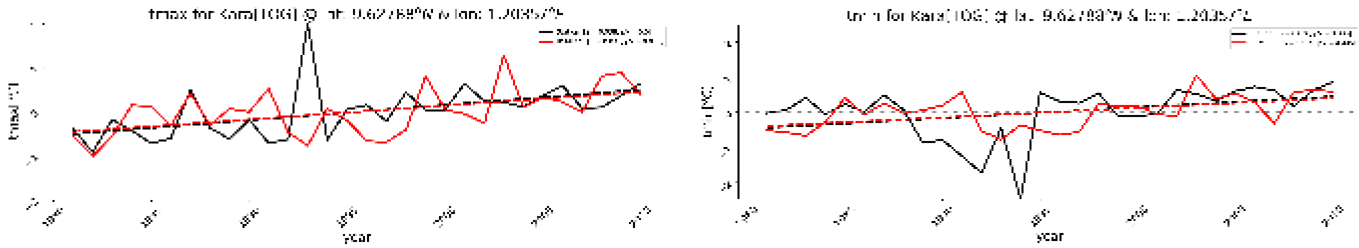
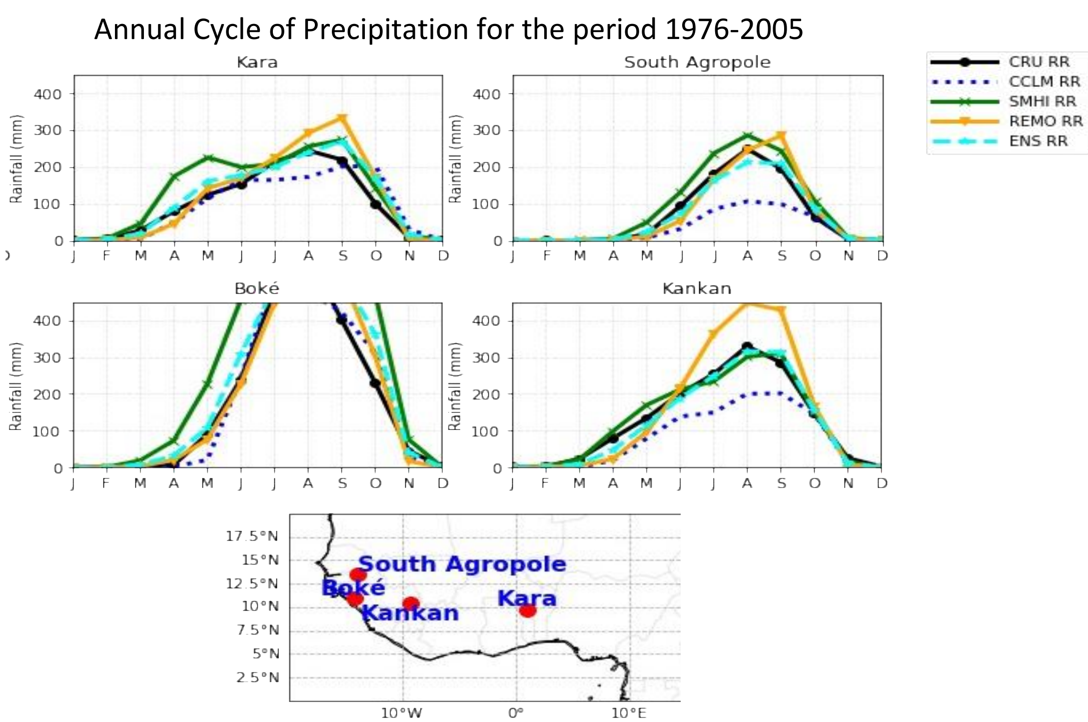


Figure 17. Trends in observed[89] (black line) and modelled (blue line) minimum and maximum surface temperature (°C) for selected SCPZ stations the period 1981–2010.

***Annual cycle*:** Figure 18 shows the annual cycle of the observed and simulated precipitation for the project-specific regions including the Kara region of Togo; the Casamance Natural region of Senegal; and the Boké and Kankan regions of Guinea. The annual cycle is shown for the CRU observational datasets, and the three RCMs simulations and ENS simulations. The RCMs and ENS-model simulations approach the CRU observations for all the project-specific regions. The annual cycle of precipitation of the project-specific regions shows a single precipitation peak for most of the regions. The onset of the rainy season, which usually occurs in May or June, is well captured by the ENS model simulations. In addition, the amount of rainfall is also well simulated by 3 RCMs simulations. This variability is better reproduced by the ENS model. The ENS, in general, captures a better intensity of the peaks of rainfall in most of the points in the region.



89 The observed data are computed from daily minimum and maximum temperature data retrieved from the archives of the respective meteorological services for selected stations within the SCPZs

Figure 18. Mean annual cycle of precipitation (mm/day), averaged over the baseline 30-year period for SCPZ Project Areas. Observations from CRU are plotted (black line), as well as model simulations (CCLM, SMHI, REMO and ENS. The curves refer to the model grid-point that contains the SCPZ project regions in Togo, Guinea and Senegal

In Figure 19, the mean annual cycle of 2-metre temperature for the project-specific areas are presented. The observed and modelled simulations show similar trends in the mean annual cycle of 2-metre temperatures in all the regions. The shape of the annual cycle of the RCMs and the ENS model simulations follows closely the CRU temperature cycle. The ENS simulations reproduces the temperature better when compared with the regional model simulations, although some underestimate and overestimation also occur in some sites.

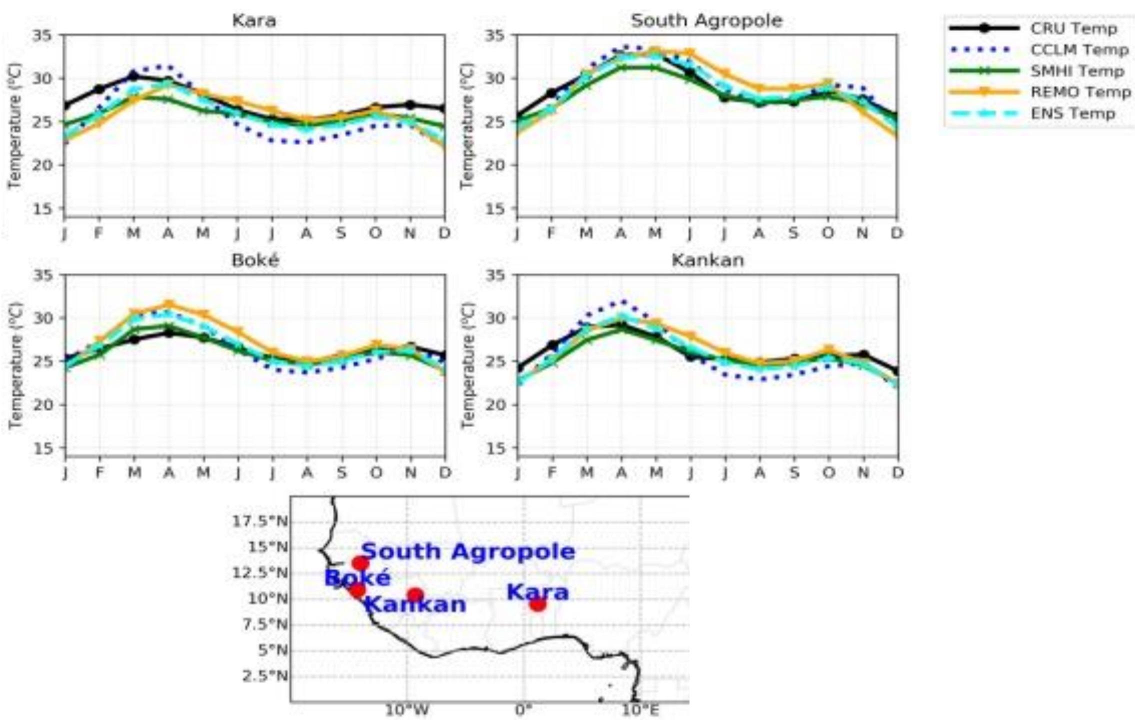


Figure 19. Mean annual cycle of 2-metre temperature (^oC) averaged over the baseline 30-year period for SCPZ Project-specific Regions. Observations from CRU are plotted (black line), as well as model simulations (CCLM, SMHI, REMO and ENS). The curves refer to the model grid-point that contains the SCPZ project regions in Togo, Guinea and Senegal.

Seasonal Drought (SD): With evident of historical warming as evident from the analysis of annual cycle of mean 2-metre temperature at the project specific levels, droughts occurrence is a suitable feature to investigate. This is because drought monitoring is very important for irrigational planning in agriculture as well as a guide for early warning and assessment. The WMO recommends the use of the **Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI),** as a starting point for meteorological drought monitoring. The SPEI takes temperature into account, but the SPI does not. The ability to calculated the SPI and SPEI at various timescales allows for multiple applications in drought monitoring and assessment. Depending on the drought impact in question, SPI values for 3 months or less might be useful for basic drought monitoring, values for 6 months or less for monitoring agricultural impacts and values for 12 months or longer for hydrological impacts.[90]

Computation of SPI and SPEI

SPI is calculated based on the original procedure developed by McKee et al. (1993)[91], which uses only monthly (weekly) precipitation as the input data. Precipitation is transformed into normalised numerical values and the SPI is given as the number of standard deviations by which the observed precipitation deviates from the long-term mean for a normally distributed random variable. The index is calculated as follows:

$$SPI = \frac{x_i - \bar{x}}{\sigma} \tag{1}$$

where x_i is the precipitation of the selected period during the year i, $\bar{x}$ is the long-term mean precipitation and σ is standard deviation for the selected period.

The calculation of the SPEI is based on the SPI calculation procedure. SPEI utilizes "climatic water balance", which is the difference between precipitation and reference evapotranspiration (Di = Pi – ET0i), as the input data. The climatic water balances (Di) is calculated at various time scales (i.e., over one month, two months, three months, 6 months or 12 months, etc.), and the resulting values are fitted into a log-logistic probability distribution to transform the original values to standardized units that are comparable in space and time and at different SPEI time scales. Parameters of the Log-logistic distribution can be obtained following different procedures such as, the L-moment procedure that is very robust and easy to apply. Alternatively, the probability weighted moments (PWMs) method can be applied based on the plotting-position approach (Hosking, 1990; Vicente-Serrano et al. 2010)[92],[93]. In the analysis, the latter approach was used by means of the unbiased estimator proposed by Hosking (1986)[94].

However, it is important to note that in the original formulation of the SPEI, the Thornthwaite (Th) equation was used for estimation of ET0 (Thornthwaite, 1948)[95], which only requires mean daily temperature and latitude of the site. However, it has shown that the Th equation underestimated ET0 in arid and semi-arid regions (Jensen et al., 1990)[96], and overestimated ET0 in humid equatorial and tropical regions (van der Schrier et al., 2011)[97]. Moreover, this equation

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[90]World Meteorological Organization (WMO) and Global Water Partnership (GWP), 2016: *Handbook ofDrought Indicators and Indices* (M. Svoboda and B.A. Fuchs). Integrated Drought ManagementProgramme (IDMP), Integrated Drought Management Tools and Guidelines Series 2. Geneva.

[91] McKee, T. B. N., J. Doesken, and J. Kleist, 1993: The relationship of drought frequency and duration to time scales. Proc. Eight Conf. on Applied Climatology. Anaheim, CA, Amer. Meteor. Soc. 179–184.

[92] Vicente-Serrano S.M., Santiago Beguería, Juan I. López-Moreno, (2010): A Multi92scalar drought index sensitive to global warming: The Standardized Precipitation Evapotranspiration Index – SPEI. Journal of Climate 23: 1696-1718

[93] Hosking, J.R.M., (1990): L-Moments: Analysis and estimation of distributions using linear combinations of order statistics. Journal of Royal Statistical Society B, 52: 105-124.

[94] Hosking, J.R.M., (1986): The theory of probability weighted moments. Res. Rep. RC 12210 IBM Research Division, Yorktown Heights NY 10598.

[95] Thornthwaite, C.W., 1948: An approach toward a rational classification of climate. Geographical Review, 38, 55-94

[96] Jensen, M. E., Burman, R. D., and Allen, R. G. (ed). 1990. Evapotranspiration and Irrigation Water Requirements. ASCE Manuals and Reports on Engineering Practices No. 70., Am. Soc. Civil Engrs., New York, NY, 360 p.

[97] van der Schrier, G., P. D. Jones, and K. R. Briffa (2011), The sensitivity of the PDSI to the Thornthwaite and Penman-Monteith parameterizations for potential evapotranspiration, J. Geophys. Res., 116, D03106, doi:10.1029/2010JD015001

leads to an overestimation of ET0 with increasing air temperature and it does not accurately estimate the evolution of ET0 over the last decades (Donohue et al., 2010)[98]. When data is available such as solar radiation, temperature, wind speed, and relative humidity, the Penman-Monteith (PM) equation is widely used for the calculation of ET0. Unfortunately, many meteorological stations in Africa do not routinely measure these variables, and so are long-term records of these variables are not always available. For this reason, the Hargreaves (Hg) equation (Hargreaves and Samani, 1985)[99] is recommended for use (Su and Li, 2012[100], Li et al. 2012[101]; Abiodun et al. 2012[102]; Droogers and Allen, 2002)[103]. It only requires maximum and minimum temperatures. As noted by Beguería et al. (n.d)[104], the Hg equation does not have the limitations of the Th equation, and at monthly and annual timescales ET0 estimates from the Hg and PM equations are very similar, with differences of less than 2 mm per day (Droogers and Allen, 2002)[105].

Furthermore, many scientists have argued that considering ETa (actual evapotranspiration) is better than ET0 when a drought index is defined since ETa and not ET0 would determine the surface water balance and the drought conditions (e.g., Dai, 2011; Joetzjer et al., 2012)[106]. Proponents of this idea (i.e., the use of Precipitation–ETa) explain that, compared to ET0, ETa would always be a better estimation of the amount of water really transferred to the atmosphere. Thus, ETa would allow for a better estimation of the soil water balance than ET0. Whether the SPEI aim would be simulating the true water balance of the soils, as other indices such as the PDSI do, then using ETa instead of ET0 would be a better option for the SPEI. But that is actually not the case: the idea behind the SPEI is to compare the highest possible evapotranspiration (what we call the evaporative demand by the atmosphere) with the current water availability. Thus, precipitation (accumulated over a period of time) in the SPEI stands for the water availability, while ET0 stands for the atmospheric water demand. ETa would be a poor estimator of this demand, since it depends in turn on the current water availability. On the other hand, the very definition of ET0 indicates that it refers to the maximum amount of water that would be transferred to the atmosphere by the soils and vegetation if there were no water supply deficit. Using ET0 as an estimator of the true evaporative demand seems, thus, a more convenient choice (Beguería et al. (n.d)[107]. The CRU observation was used for computing the historical SPEI (1976 – 2005), while the model ENS (due to high degree of correlation with CRU) was used for SPEI projections for (2006 – 2035) and (2036 – 2065). However, for ease of presentation, the projections have been presented from 2006 – 2065.

In Figure 20, the SPI and SPEI calculated at 3-, 6- and 12-months intervals for Kara region in Togo (1976 - 2005) is presented. Both graphs exhibit very similar shape, however, the duration and intensity differ. As observed, the 6 months and 12 months intervals, indicate that the drought

[98] Donohue, R, McVicar, T and Roderick, M (2010): Assessing the ability of potential evaporation formulations to capture the dynamics in evaporative demand within a changing climate, Journal of Hydrology, 386: 186-197.

[99] Hargreaves GL, Samani ZA. 1985. Reference crop evapotranspiration from temperature. Applied Engineering in Agriculture 1: 96–99.

[100] Su, H., Li, G. (2012): Low-frequency drought variability based on SPEI in association with climate indices in Beijing. Shengtai Xuebao/ Acta Ecologica Sinica 32 (17) , pp. 5467-5475.

[101] Li, W., Hou, M., Chen, H., Chen, X. (2012): Study on drought trend in south China based on standardized precipitation evapotranspiration index. Journal of Natural Disasters 21: 84-90.

[102] Abiodun, B.J., Ayobami T. Salami, Olaniran J. Matthew, Sola Odedokun (2012): Potential impacts of afforestation on climate change and extreme events in Nigeria. Climate Dynamics, DOI 10.1007/s00382-012-1523-9.

[103] Droogers P, Allen RG. 2002. Estimating reference evapotranspiration under inaccurate data conditions. Irrigation and Drainage Systems 16: 33–45.

[104] Beguería et al. (n.d). Standardized Precipitation Evapotranspiration Index (SPEI) revisited: parameter fitting, evapotranspiration models, tools, datasets and drought monitoring.

[105] Ibid.

[106] Joetzjer, E., H. Douville, C. Delire, P. Ciais, B. Decharme, and S. Tyteca (2012): Evaluation of drought indices at interannual to climate change timescales: a case study over the Amazon and Mississippi river basins. Hydrol. Earth Syst. Sci. Discuss., 9, 13231–13249

[107]

frequency and intensity in Kara region were more pronounced in the early parts of the 80's and 90's than the 21st century. However, more severe drought events with values ≥ -1 where mostly recorded in the later parts of the 21st century, notably years 2000 and 2003.

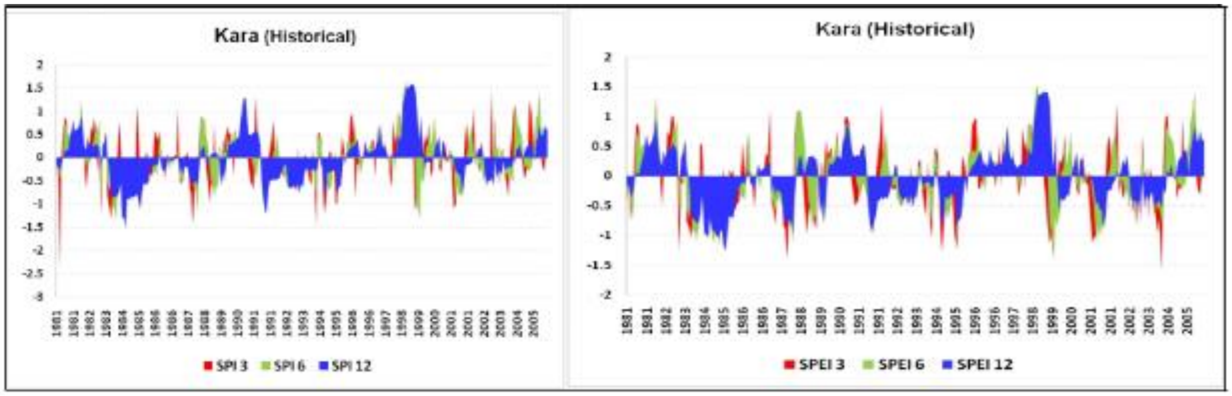


Figure 20. The SPI and SPEI time series (for 3, 6 and 12months), Kara Region, Togo

The historical SPI and SPEI calculated at 3-, 6- and 12-months' time intervals for the South Agropole of the Casamance Natural region of Senegal and the Boké and Kankan regions of Guinea (1976 - 2005), is shown in Figure 21. The SPEI captures more drought frequency with longer duration for Senegal than the SPI at 6- and 12-month intervals. Conversely, in the Boké and Kankan regions of Guinea, both graphs exhibit very similar shape, but with different duration and intensity. While SPEI measure of drought for 12 months' time scale, showed larger duration and intensity from 1987 to 2000, it was smaller and milder with the SPI during this period. The general takeaway from the SPI and SPEI analysis so far presented above is that, drought is a recurrent extreme climate events in the targeted areas. And also, that, the agricultural and water sectors are the two areas with the greatest drought impacts.

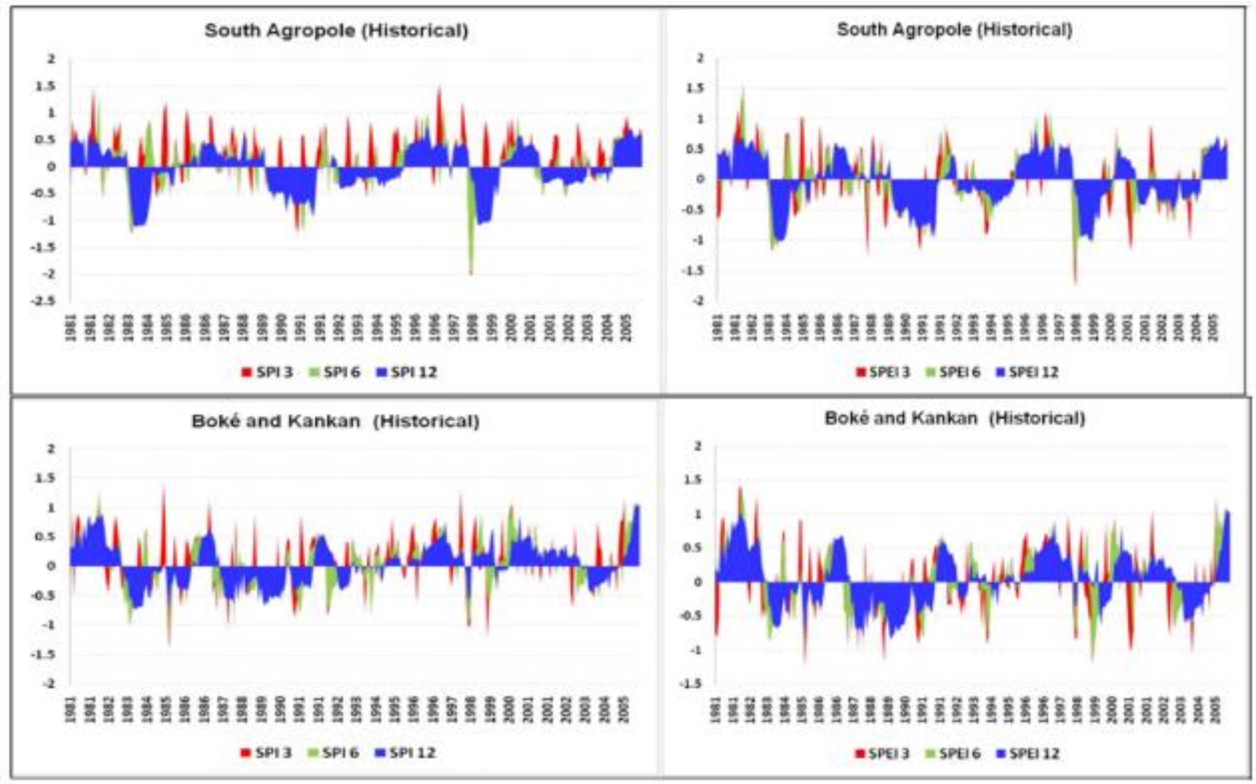


Figure 21. SPI and SPEI time series (for 3, 6 and 12 months), SCPZ areas in Senegal and Guinea

5.4. Climate Projections

To further understand the potential physical risk associated with future climate, projections from downscaled global climate model projections are used to provide a more refined regional and country specific information especially for extremes that are particularly relevant for agriculture. The assessment of future climate change is based on the projections produced from ensemble mean (ENS) of three RCMs under the representative concentration pathways (RCP4.5 and RCP8.5) emission scenario. It is quite worthy of note that this ENS presents only one of several possible future outcomes that will manifest as a result of GHG emissions trajectory and other socioeconomic situations.

Change in mean climate. Figure 22 and Figure 23 shows projected change in annual total precipitation rate averaged for the climate periods 2011-2040 (current-near future), 2041-2070 (mid-future) and 2071-2100 (far future) under RCP4.5 and RCP8.5 emission scenarios. Statistically significant drying and wet conditions reaching 300 mm/year are expected in the three countries. For instance, the drying conditions in the central region of Boké in Guinea will further intensify significantly in the mid future but less in the far future. In Kankan, a pattern of high and low precipitation is expected in the southern and northern parts, respectively, of the region. A general dryness is expected to dominate most parts of Senegal and Togo, especially in the Casamance and Kara regions of the corresponding countries. The projected dryness in the north-western parts of Guinea is expected to intensify significantly under RCP8.5 emission scenario. Also, a general significant dryness of about 100 mm is expected in the Senegal and Togo particularly by the end of the 21st Century.

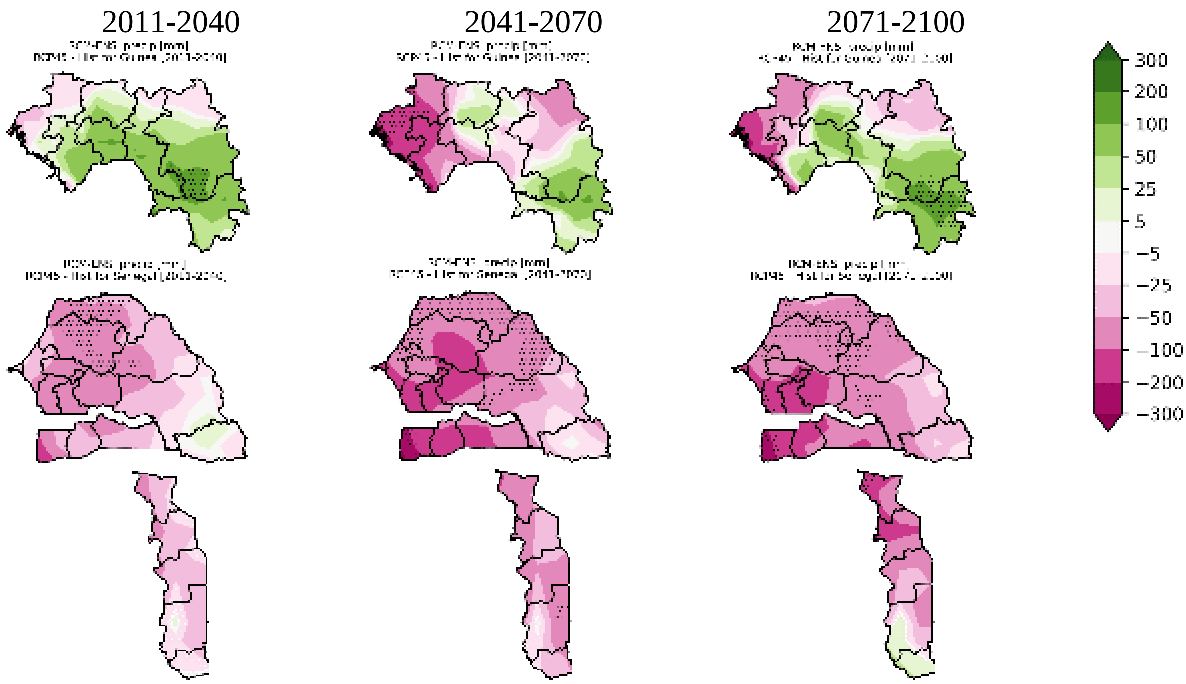
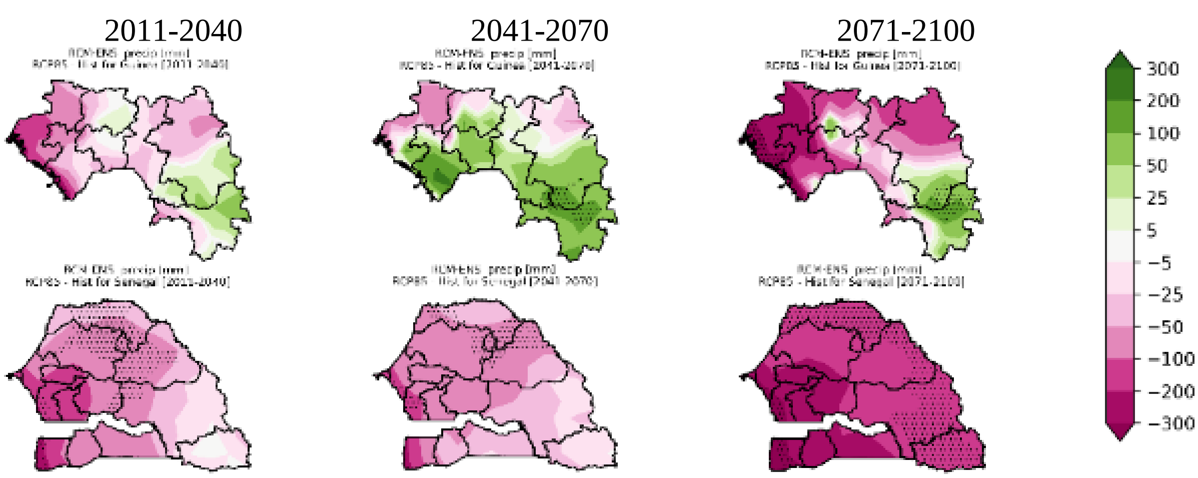


Figure 22. Projected change in mean annual total precipitation (mm) relative to the baseline (1976-2005) for the periods 2011-2040 (current-near future), 2041–2070 (mid-future) and 2071–2100 (far future) under the RCP4.5 emission scenario
(Dotted areas indicate regions where the change is statistically[108] significant at 0.05 significance level.)



[108] The current and future climate conditions are compared using a two-sided student t-test considering unequal variance at 0.05 significance level to determine if the mean values are significantly different between the two climates.

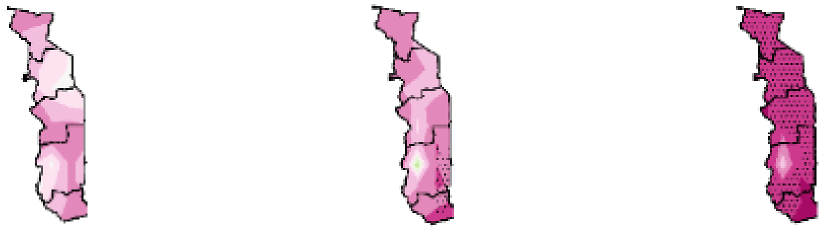


Figure 23. Projected change in mean annual total precipitation (mm) relative to the baseline (1976-2005) for the periods 2011-2040 (current-near future), 2041-2070 (mid-future) and 2071-2100 (far future) under the RCP8.5 emission scenario

(Dotted areas indicate regions where the change is statistically[109] significant at 0.05 significance level.)

Climate model projects a general increase in surface temperature for all three climate periods: current-near; mid-; and far future under RCP4.5 and RCP8.5 emission scenario (Figure 24 and Figure 25). The projected warming is estimated at about 0.8ºC, 1.2ºC and 2.0ºC for current-near, mid- and far future, respectively. Precisely, significant warming of about 1.2ºC is expected to increase further in the mid- and far future. Warming in Boké and Kankan in Guinea is about 0.8ºC in the current-near future climate. A change in temperature of about 2ºC is expected in the mid- and far future with high level of significance in the southern and northern areas of Boké and Kankan, respectively. Due to the effect of the Atlantic Ocean, there is a west to east increase gradient of temperature change in Senegal. Temperature change from the central to the eastern part of the country is statistically significant and could reach a value of 2.4ºC. Although not statistically significant, temperatures in the Casamance region could attain values of 2ºC in the future. For Kara region in Togo, larger temperature difference (greater than 2.4ºC) is expected in the extreme north. The prejected intense warming is a potential threat to food security as it could present far reaching implications for crops growth and productivity including livestock farming. This is particular worrisome for these countries where the ability to prepare and plan for eminent disasters are still very low as measured by their climate vulnerability readiness index (Table 21).

[109] The current and future climate conditions are compared using a two sided student t-test considering unequal variance at 0.05 significance level to determine if the mean values are significantly different between the two climates.

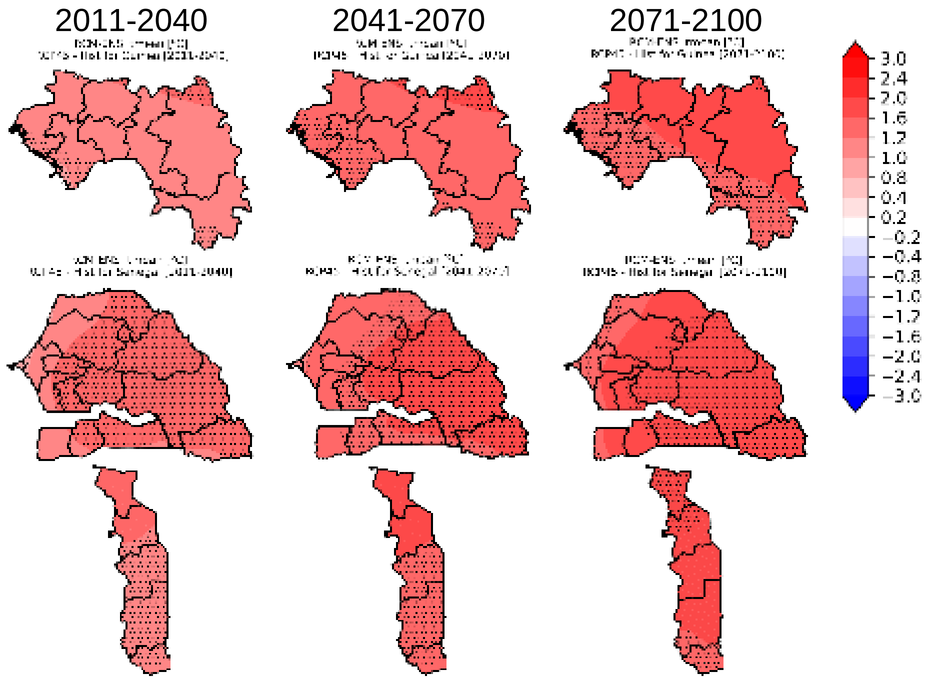


Figure 24. Projected change in mean surface temperature (°C) relative to the baseline (1976-2005) for the periods 2011-2040 (current-near future), 2041-2070 (mid-future) and 2071-2100 (far future) under the RCP4.5 emission scenario.

(Dotted areas indicate regions where the change is statistically[110] significant at 0.05 significance level.)

[110] The current and future climate conditions are compared using a two sided student t-test considering unequal variance at 0.05 significance level to determine if the mean values are significantly different between the two climates.

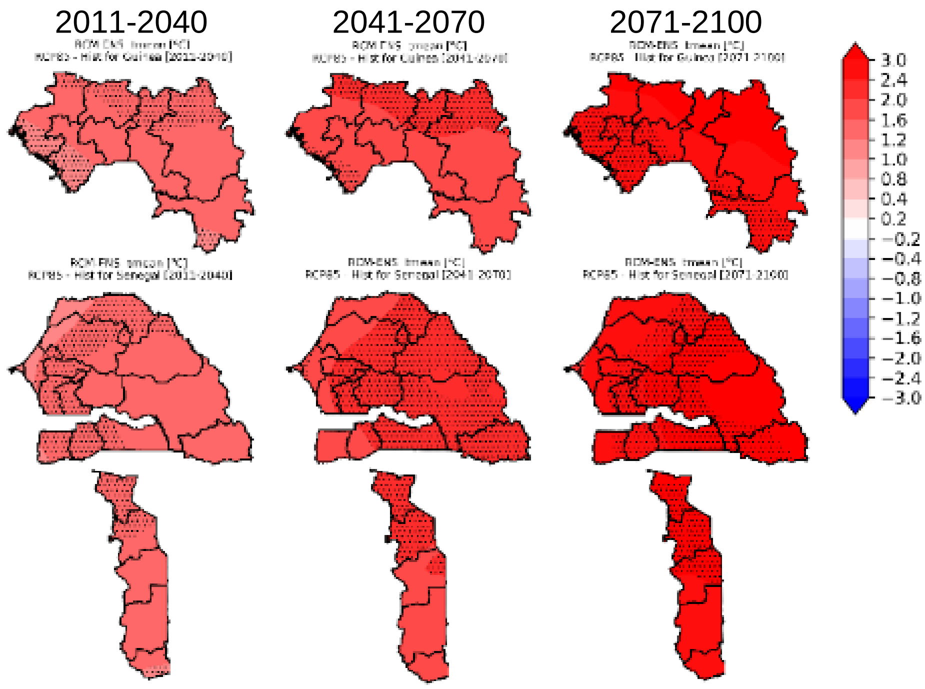


Figure 25. Projected change in mean surface temperature (^{o}C) relative to the baseline (1976-2005) for the periods 2011-2040 (current-near future), 2041-2070 (mid-future) and 2071-2100 (far future) under the RCP8.5 emission scenario

(Dotted areas indicate regions where the change is statistically[111] significant at 0.05 significance level.)

Under RCP8.5, the projected warming is expected to intensify further across the three climate epochs (Figure 25). Statistically significant warming of greater than 3^{o}C is likely in the mid to far future.

Table 21. Vulnerability and readiness scores for each country

Countries	Adaptive Capacity Scoring	Readiness Ranking Scoring
Togo	0.521 (Low)	0.301 (Low)
Senegal	0.533 (Lower Middle)	0,535 (Lower Middle)
Guinea	0.528 (Low)	0.301 (Low)

Source: ND-GAIN index ranking, 2020.

[111] The current and future climate conditions are compared using a two sided student t-test considering unequal variance at 0.05 significance level to determine if the mean values are significantly different between the two climates.

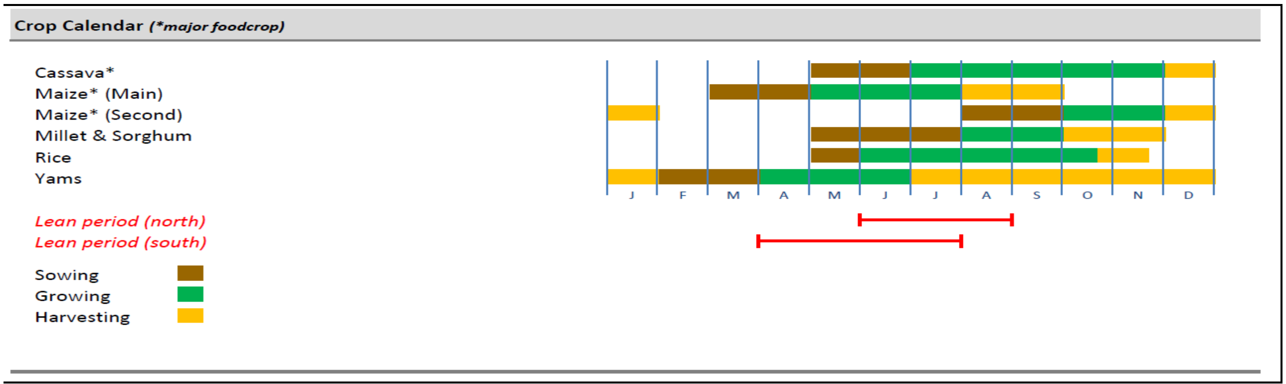


Figure 26. Major Crops Calendar for Togo
Source: Adopted from FAO (2020).

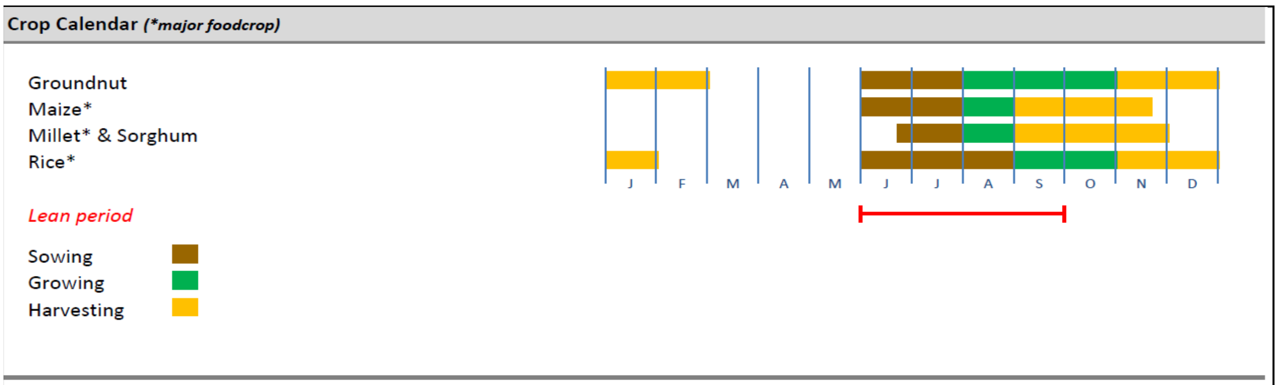
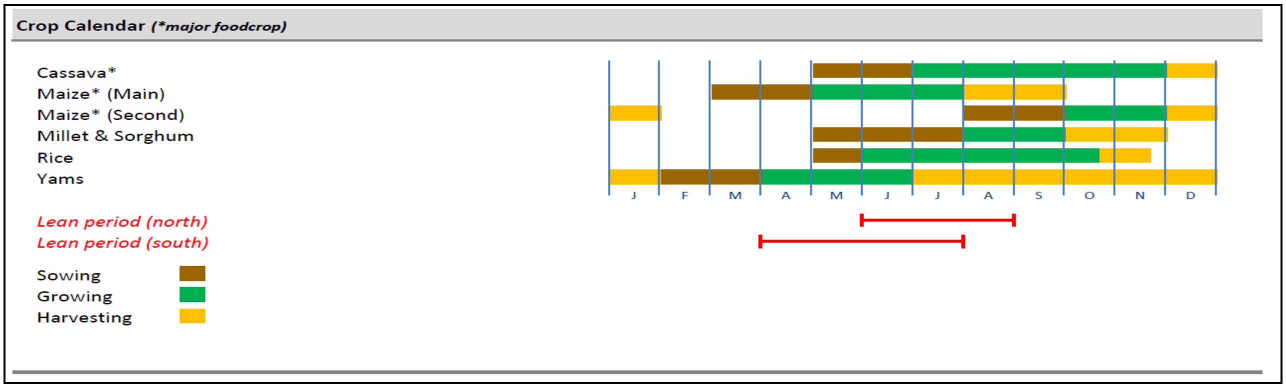


Figure 27. Major Crops Calendar for Senegal
Source: Adopted from FAO (2020)[112].

The implications of 1.5°C - 2.0°C global warming scenarios for agriculture and water resources have been duly recognized in the continent. For example, Faye et al. (2018),[113] assessed impacts of 1.5°C versus 2.0°C on yields of maize, pearl millet and sorghum in the West African Sudan Savanna using two crop models that were calibrated with common varieties from experiments in the region while management reflected a range of typical sowing windows (

[112] FAO (2020): www.fao.org/agriculture/seed/cropcalendar/welcome.do.
[113] Faye *et al* 2018. Impacts of 1.5 versus 2.0°C on cereal yields in the West African Sudan Savanna ,*Environ. Res. Lett.* https://doi.org/10.1088/1748-9326/aaab40



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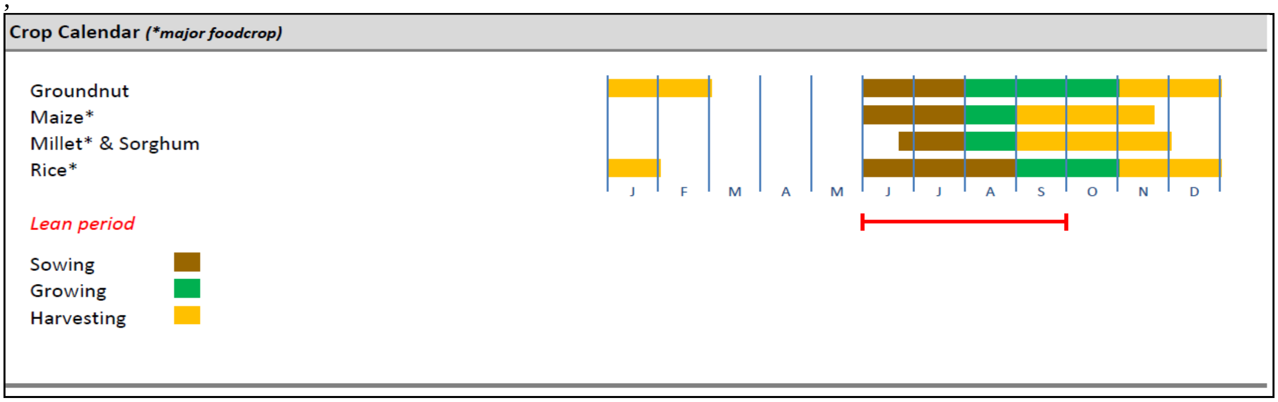


). As sustainable intensification is promoted in the region for improving food security, simulations were conducted for both current fertilizers use and for an intensification case (fertility not limiting). With current fertilizer use, results indicated 2% of unit higher losses for maize and sorghum with 2.0°C compared to 1.5°C warming, with no change in millet yields for either scenario (Figure 28). In the intensification case, yield losses due to climate change were larger than with current fertilizer levels. However, despite the larger losses, yields were always 2-3 times higher with intensification, irrespective of the warming scenario. Though yield variability increased with intensification, there was no interaction with a warming scenario.

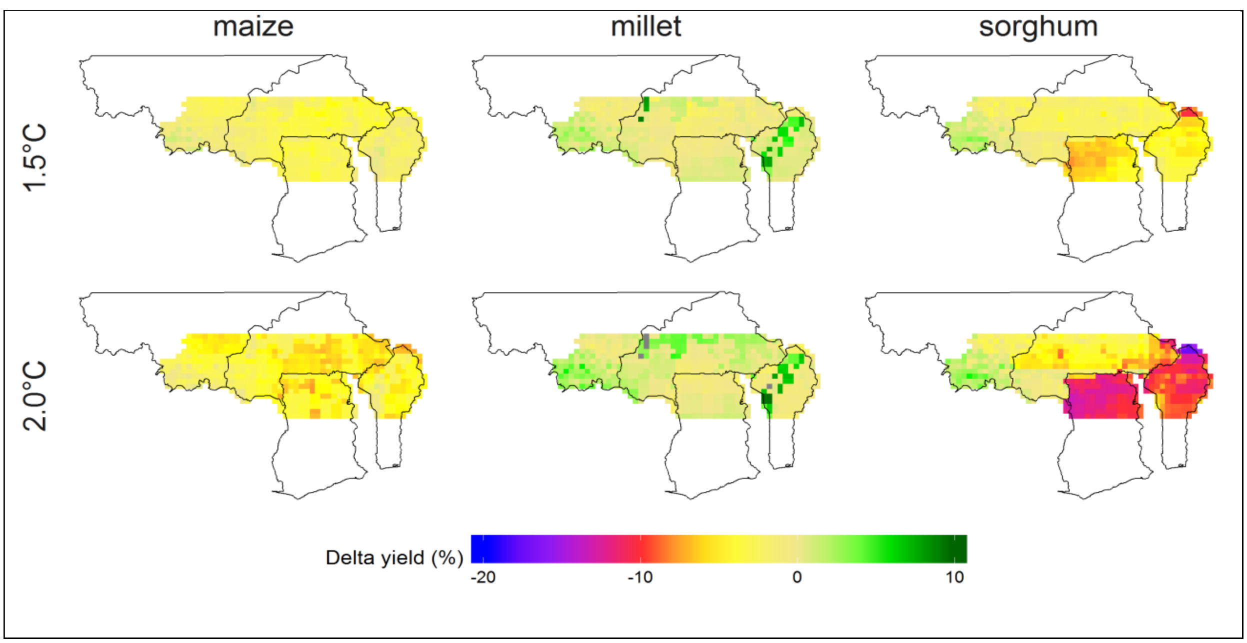


Figure 28. Simulated impact of 1.5°C and 2.0°C warming on maize, millet and sorghum yields for the West African Sudan Savanna region relative to the baseline period (2006 –2015)

Source: *Adopted from Faye et al. (2018).*

Similarly; in Senegal, Mbaye et al. (2015)[114], assessed the changes in precipitation (P) and in evapotranspiration (ET) are under 1.5^{0}C and 2.0^{0}C global warming levels (GWLs). The authors used a set of twenty RCMs simulations within the CORDEX following the RCP4.5 emission scenario Annual and seasonal changes were computed between climate simulations under 1.5^{0}C and 2.0^{0}C warming, with respect to 0.5ºC warming, compared to pre-industrial levels. The results show that annual precipitation is likely to decrease under both magnitudes of warming; this decrease is also found during the main rainy season (July, August, September) only and is more pronounced under 2 ◦C warming. All reference evapotranspiration calculations, from Penman, Hamon, and Hargreaves formulations, show an increase in the future under the two GWLs, except annual Penman evapotranspiration under 1.5ºC warming scenario. Furthermore, seasonal and annual water balances (P-ET) generally exhibit a water deficit. This water deficit (up to 180 mm) is more substantial with Penman and Hamon under 2ºC. In addition, analyses of changes in extreme precipitation reveal an increase in dry spells and a decrease in the number of wet days. However, Senegal may face a slight increase in very wet days (95th percentile), extremely wet days (99th), and rainfall intensity in the coming decades. Therefore, in the future, Senegal may experience a decline in precipitation, an increase of evapotranspiration, and a slight increase in heavy rainfall. Klutse et al. (2018),[115] also examines the potential impact of 1.5 °C and 2 °C global warming on consecutive dry and wet days over West Africa, using climate projections from a multi-model ensemble of 25 RCM simulations under the RCP8.5 scenario. The authors define CDD as the maximum number of consecutive days with rainfall amount less than 1 mm and CWD as the maximum number of consecutive days with rainfall amount more than 1 mm. The models agree on a noticeable response to both 1.5ºC and 2ºC warming for each index, and enhanced warming results in a reduction in mean rainfall across the region. Specifically, more than 80% of ensemble members agree that CDD will increase over the Guinea Coast, in tandem with a projected decrease in CWD at both 1.5ºC and 2ºC global warming levels. These projected changes may influence already fragile ecosystems and agriculture in the region, both of which are strongly affected by mean rainfall and the length of wet and dry periods.

Drought projections: In Figure 29, the SPI and SPEI calculated at 3-, 6- and 12- months scale for Kara, Casamance, and the Boké and Kankan regions are presented. As expected, the results are not quite different from the baseline results obtained. The frequency and duration of droughts vary between the 6- and 12- months scale, and between the SPI and the SPEI. Notably, the SPEI predicts more frequent and longer drought periods for all the regions than the SPI. However, contrary to the baseline, the calculated 6- and 12- months drought duration, increases for all the regions. This is consistent with the rising trends in temperature and declining precipitation as projected in Figure 22, Figure 23, Figure 24 and Figure 25. The growing frequency and duration suggest that investing in agriculture must be accompanied by plans to support efficient use of water in the regions. This offers greater opportunity for more investment in drip irrigation technologies. It equally calls for need to promote the use of drought-tolerant varieties for seasonal crops in addition to adopting climate-smart agricultural practices for precision farming to ensure food security.

[114] Mbaye et al. (2015). Impacts of 1.5 and 2.0 ◦C Global Warming on Water Balance Components over Senegal in West AfricaImpacts of 1.5 and 2.0 ◦C Global Warming on Water Balance Components over Senegal in West Africa

[115] Ibid 105.

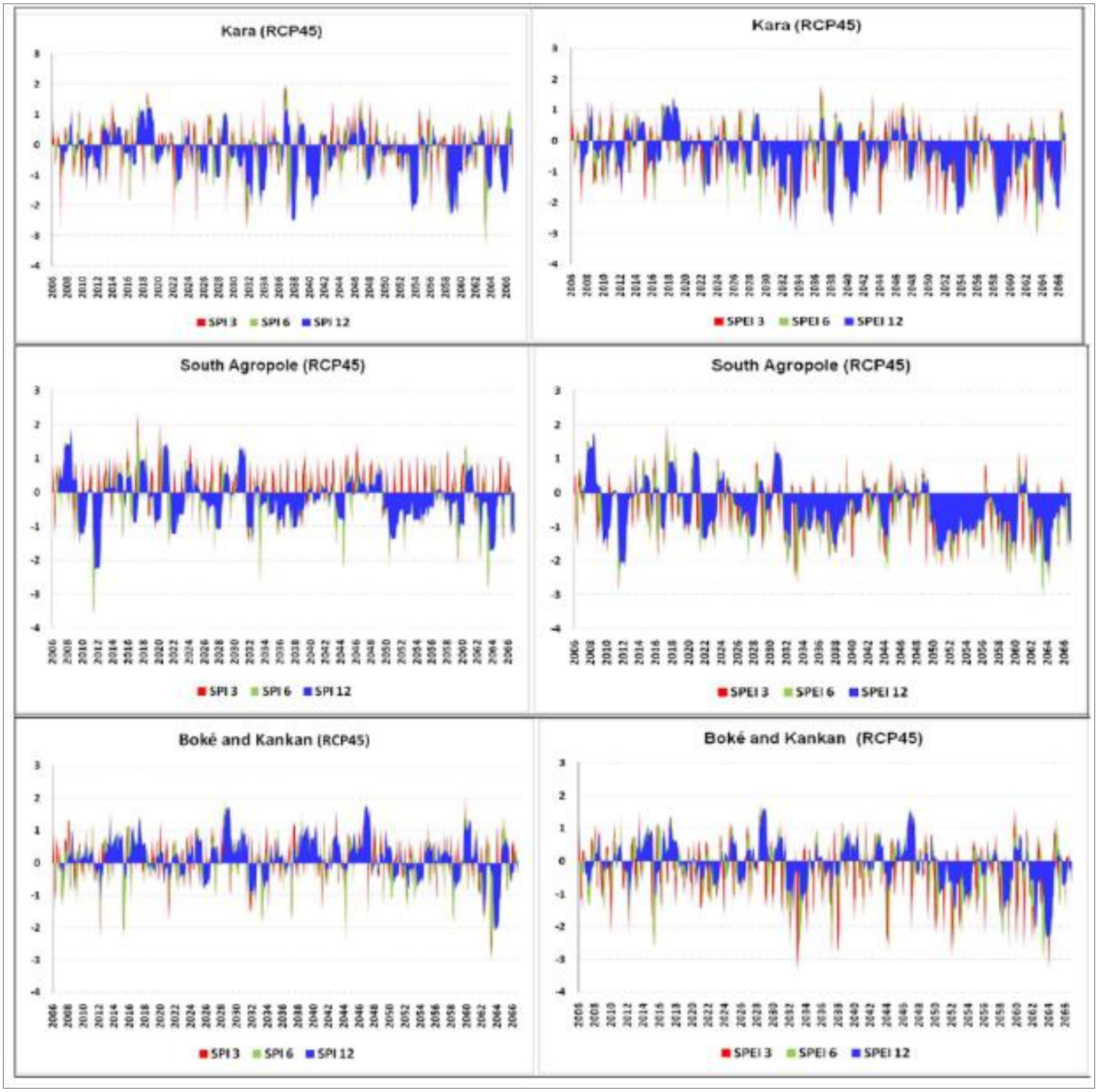


Figure 29. The SPI and SPEI time series (for 3, 6 and 12months) Togo, Senegal and Guinea

Climate Change and Crop Water Requirement (CWR): In this sub-section, we analysis the impacts of climate change on crops water needs in the three pilot countries. The essence is to accentuate the effects of climate change and its variability on crops and whether introducing irrigation in the programme is actually a viable adaptation option. In order to carry out this analysis, we begin by looking at the length of the growing season (LGS) for major cash crops produced in these countries. This information is summarised in Table 22.

Table 22. Indicative Values of the total Growing Period of Major Crops Grown in SCPZs Pilot Countries

Crop	Total growing period (days)	Crop	Total growing period (days)
Banana	300-365	Millet	105-140
Barley/Oats/Wheat	120-150	Onion green	70-95
Bean green	75-90	Onion dry	150-210
Bean dry	95-110	Peanut/Groundnut	130-140
Cabbage	120-140	Cowpea	90-100
Carrot	100-150	Pepper	120-210
Citrus	240-365	Potato	105-145
Cucumber	105-130	Rice	90-150
Eggplant	130-140	Sorghum	120-130
Grain/small	150-165.	Soybean	135-150
Lettuce	75-140	Spinach	60-100
Maize sweet	80-110	Tomato	135-180
Maize grain	125-180		
Melon	120-160		

Source: FAO Irrigation Water Management Training Manual No. 3[116]

The length of the growing season (LGS) generally portrays a nation's potential for cropping and in general, regions with high soil-moisture content can support long duration crops especially during severe water deficits than regions with low soil-moisture content. There are, for example, many rice varieties, some with a short growing cycle (e.g., 90 days) and others with a long growing cycle (e.g., 150 days). This has a strong influence on the seasonal rice water needs: a rice crop which is in the field for 150 days will need in total much more water than a rice crop which is only in the field for 90 days. The same could be said about millet varieties, some with a short growing cycle (e.g., 105 days) and others with a long growing cycle (e.g., 140 days). A millet crop which is in the field for 140 days will need in total much more water than a millet crop which is only in the field for 105 days.

Given the length of the growing season for most crops, the calculation of crop water requirements is relatively simple and straight forward. The basic formula for the calculation is as follows:

ETcrop = kc x ETo
where:

ETcrop = the water requirement of a given crop in mm per unit of time. For example, this could be in mm/day, mm/month or mm/season.
kc = the "crop factor"
ETo = the "**reference crop evapotranspiration**" in mm per unit of time and equally expressed in mm/day, mm/month or mm/season.

ETo is sometimes referred to as potential evapotranspiration (PET). It simply measures the average daily water need of the standard grass during irrigation under different climatic zones. Put differently, it is defined as the rate of evapotranspiration from a large area covered by green grass which grows actively, completely shades the ground and which is not short of water[117]. In

[116] FAO Irrigation Water Management Training Manual No. 3: www.fao.org/3/S2022E/s2022e00.htm.
[117]http://www.fao.org/3/u3160e/u3160e04.htm

general, hot, dry, windy and sunny areas have higher ETo values in areas that are cool, humid and cloudy with little or no wind. It is important to note that in the absence of field or measured data for **ETo**, the following approximate values presented in the Table 23 below by FAO, may be used as the basis for calculating the crop water requirements in different climatic zones (http://www.fao.org/3/s2022e/s2022e02.htm). These values give the average daily water needs of the reference grass crop, which should be used for the computation for the ETo in different climatic conditions.

Table 23. Indicative Values of ETo (mm/day) for Reference Grass Crop[118]

Climatic zone	Mean Daily Temperature		
	Low	Medium	High
	(Less than 15°C)	(15-25°C)	(More than 25°C)
Desert/Arid	4-6	7-8	9-10
Semi Arid	4-5	6-7	8-9
Sub-humid	3-4	5-6	7-8
Humid	1-2	3-4	5-6

Source: FAO Irrigation Water Management Training Manual No. 3

Given the standardized reference crop evapotranspiration ETo presented in the table above, computation of the crop water requirement ETcrop is relatively straight forward. It is simply computed by multiplying the crop factor, kc, by the reference crop evapotranspiration, ETo. However, note that the crop factor (or "crop coefficient") varies according to the growth stage of a given crop. Generally, there are four growth stages to distinguish as follows:

a) the initial stage: when the crop uses little water;
b) the crop development stage, when the water consumption increases;
c) the mid-season stage, when water consumption reaches a peak; and,
d) the late-season stage, when the maturing crop once again requires less water.

In the following Table 24, we present computed crop factors (kc) for the most widely grown crops in Desert/Arid regions, Semi-arid regions, Sub-humid and Humid regions under water conservation techniques.

Table 24. Indicative Values of the Crop Factor (kc) for various Crops and Growth Stages

[118]Based on the The Blaney-Criddle Method. For more details, see, for example, http://www.fao.org/3/u3160e/u3160e04.htm.

Crop	Initial Stage	Crop Develop Stage	Mid-season Stage	Late Season Stage	Seasonal Average
Barley/Oats/Wheat	0.35	0.75	1.15	0.45	0.68
Bean, green	0.35	0.70	1.10	0.90	0.76
Bean, dry	0.35	0.70	1.10	0.30	0.61
Cabbage/Carrot	0.45	0.75	1.05	0.90	0.79
Cucumber/Squash	0.45	0.70	0.90	0.75	0.70
Eggplant/Tomato	0.45	0.75	1.15	0.80	0.79
Grain/small	0.35	0.75	1.10	0.65	0.71
Lentil/Pulses	0.45	0.75	1.10	0.50	0.70
Lettuce/Spinach	0.45	0.60	1.00	0.90	0.74
Maize, sweet	0.40	0.80	1.15	1.00	0.84
Maize, grain	0.40	0.80	1.15	0.70	0.76
Melon	0.45	0.75	1.00	0.75	0.74
Millet	0.35	0.70	1.10	0.65	0.70
Onion, green	0.50	0.70	1.00	1.00	0.80
Onion, dry	0.50	0.75	1.05	0.85	0.79
Peanut/Groundnut	0.45	0.75	1.05	0.70	0.74
Pea, fresh	0.45	0.80	1.15	1.05	0.86
Pepper, fresh	0.35	0.70	1.05	0.90	0.75
Potato	0.45	0.75	1.15	0.85	0.80
Rice	0.45	0.80	0.90	0.90	0.71
Sorghum	0.35	0.75	1.10	0.65	0.71
Soybean	0.35	0.75	1.10	0.60	0.70

Since the values for ETo are normally measured or calculated on a daily basis (mm/day), an average value for the total growing season has to been determined and then multiplied with the average seasonal crop factor kc (last column of 3). In order to compute the average ETo for the total growing season for each country (regions), we used CRU data for the historical period (1976 -2005) and the ENS model for the future time period. The regions were classified as follows: : i) Kara region in Togo - Hot and Humid zone; ii) South Agropole in Senegal (Casamance Region) - Hot and Humid zone; and iii) Boké and Kankan regions in Guinea - Hot and Humid zones (Table 25).

Table 25. Indicative Values of Historic and Future ETo (mm/day) for Reference Grass Crop in Pilot Countries

Country	Climate zone	Mean Daily Temperature (Baseline 1976-2005)		Future Climate (2016-2045)
		Medium	High	Ensembles
Togo			(26°C)	(28°C)
	Humid		5,1	5,3
Senegal			(27°C)	(28°C)
	Humid		5,2	5,3
Guinea			(26°C)	(26°C)
	Humid		5,1	5,1

With indicative values of Historic and Future ETo computed for these countries, the calculations of each crop water requirement is straight forward as follows:

- the length of total growing season: 120 days (short growing cycles)
- ETo: average of 6.5 mm/day over the total growing season.

Crop water Requirement (Historic):

ETcrop = kc x ETo
ETcrop = 0.68 x 6.5 = 4.42 mm per day
ETcrop = 4.42 x 120 days = approx. 530 mm per total growing season.

Crop water Requirement (Future):

ETcrop = 0.68 x 6.6 = 4.49 mm per day
ETcrop = 4.49 x 120 days = approx. 538 mm per total growing season.

The same computations can be done for Millet in Senegal under Humid and Semi-arid conditions.

- the length of total growing season: 105 days (short cycle variety)
- ETo: average of 8.2 mm/day over the total growing season.

Crop water Requirement (Historic):

ETcrop = 0.70 x 8.2 = 5.74 mm per day
ETcrop = 5.74 x 105 days = approx. 602.7 mm per total growing season.

Crop water Requirement (Future):

ETcrop = 0.70 x 8.3 = 5.81 mm per day
ETcrop = 5.81 x 105 days = approx. 610.1 mm per total growing season.

Under Humid conditions.

- the length of total growing season: 105 days (short cycle variety)
- ETo: average of 5.2 mm/day over the total growing season in humid conditions

Crop water Requirement (Historic):

ETcrop = 0.70 x 5.2 = 3.64 mm per day
ETcrop = 3.64 x 105 days = approx. 382.2 mm per total growing season.

Crop water Requirement (Future):

ETcrop = 0.70 x 5.3 = 3.71 mm per day
ETcrop = 3.71 x 105 days = approx. 389.6 mm per total growing season.

Two categories of crops were used in the computations, that is, long cycle growing crops with longer growing days denoted by (LGC), and more drought tolerant crops with shorter growing days, denoted by (SGC). For each crop, the approximate crop water need (CWN) in mm per total season was estimated for the historic period (1976 - 2005), and the future (2006 - 2045) with the ENS model from the 3 RCMs (CCLM, SHMI and REMO), using the RCP 4.5 scenario. Figure 30, Figure 31 and Figure 32 show the approximate crop water need for each crop in mm per total growing season for the future period minus the baseline period for LGC and SGC crops in the three SCPZ’s host countries.

The major feature of the observations is a wide disparity in the approximate crop water requirement between the LGC crops and the SGC crops under the present and future scenarios. This disparity is present for all the countries and regions, but being more intense for Senegal and Togo than the other countries. Another interesting feature of the observations is that, as these countries continue to experience global warming in the mist of declining precipitation, LGC crops will even need more water than the SGC crops: suggesting that the deployment of crops with LGC in these countries would not be profitable in terms of water needs in the future. This again calls for careful and meticulous planning in the introduction of seed varieties in the programme, including the adoption of more efficient water management and conservation techniques such as drip irrigation. It also calls for the adoption of good climate resilient agricultural (CRA) management practices such as mixed agro-forestry management, improved nutrient recycling, and improved genetic resources among many other techniques. These CRA management practices have been shown to not only improve the yields of crops and soil health, but also responsible for reducing greenhouse gases (GHGs). In all three countries, agriculture and forestry are the main culprits of GHG emissions.

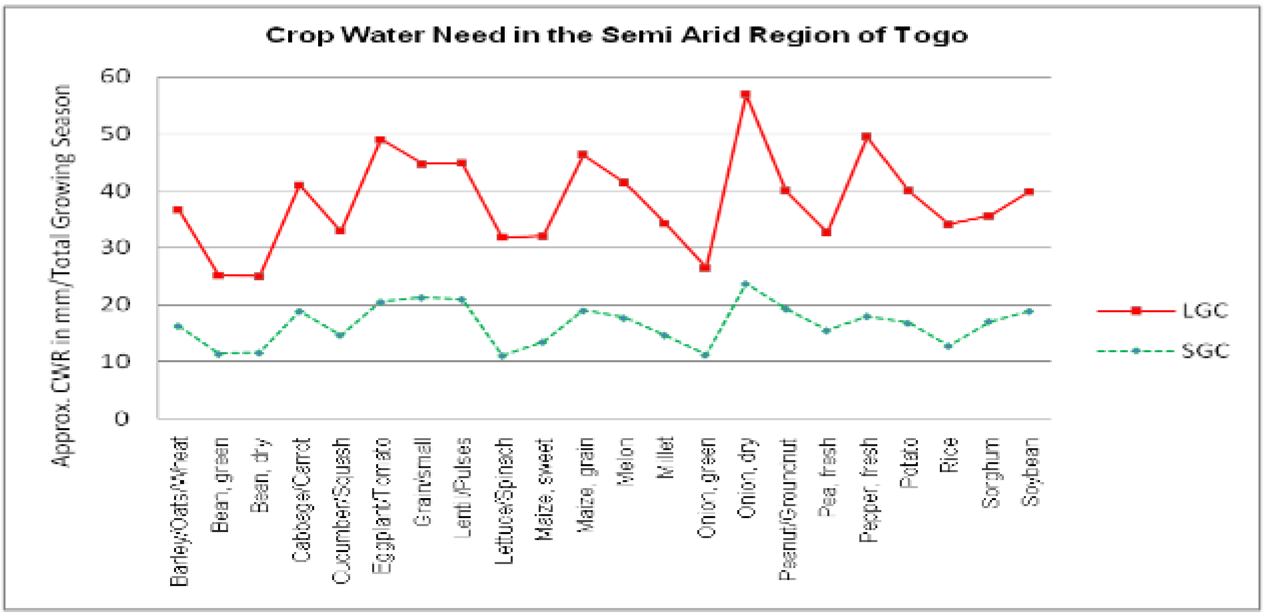


Figure 30. Difference in crop water need for LGC and SGC in the Semi-Arid Region of Togo

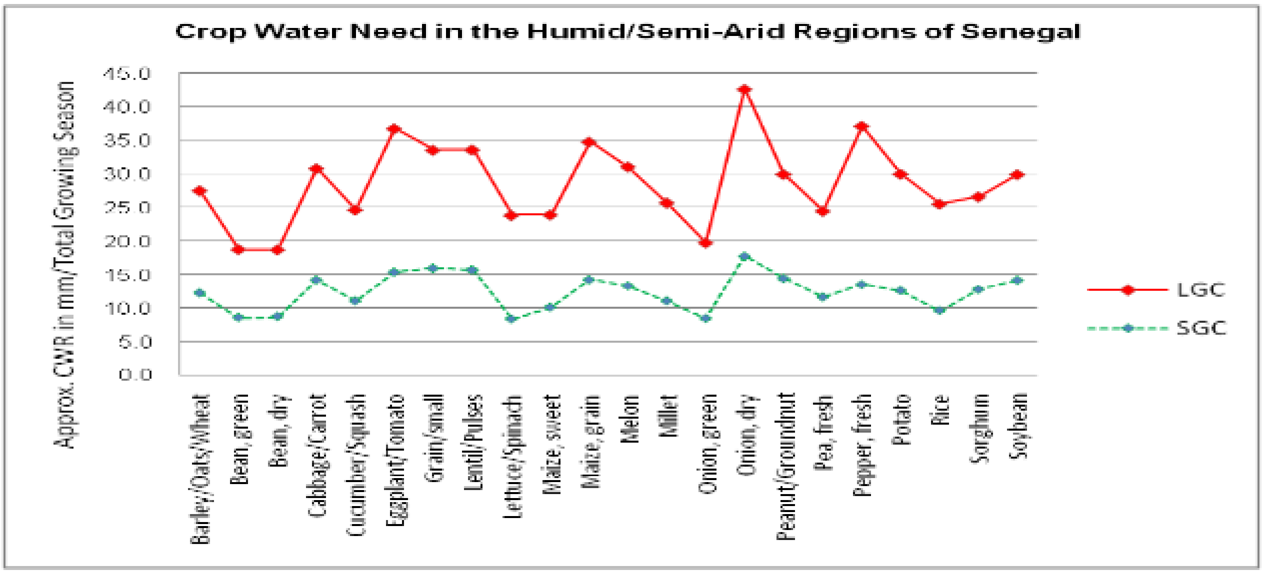


Figure 31. Difference in crop water need for LGC and SGC in the Humid/Semi-Arid Regions in Senegal

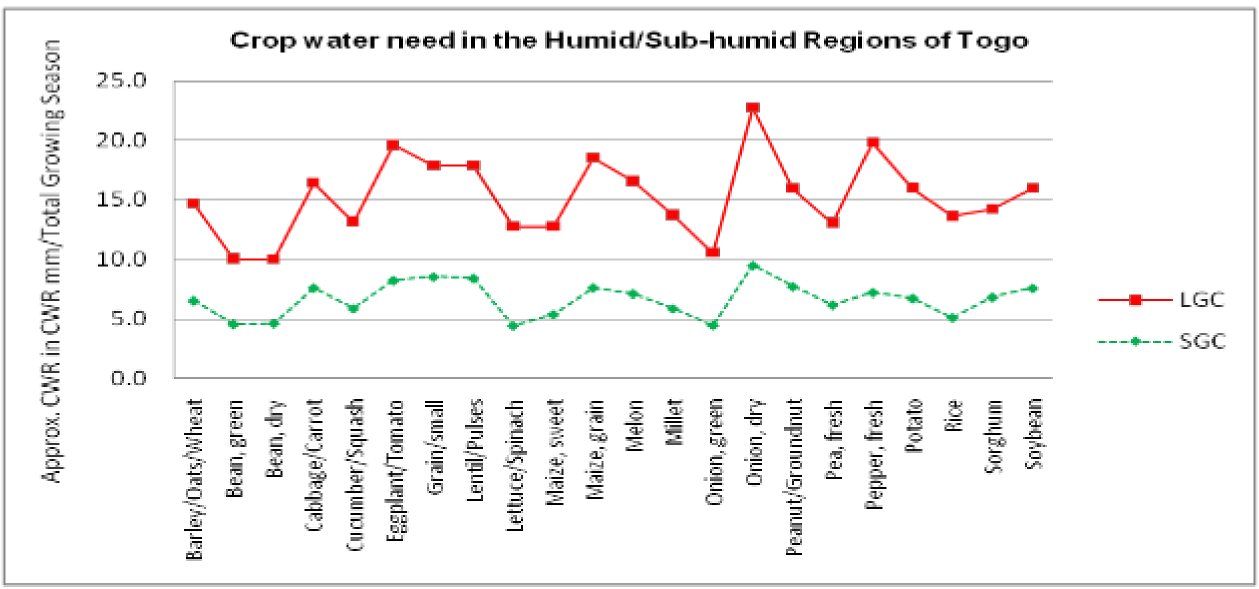


Figure 32. Difference in crop water need for LGC and SGC in the Humid/Sub-humid Regions in Guinea

While the figures above show the difference between the approximate crop water need for each crop (in mm per total growing season) for the future period minus the baseline period, the following Table 26 to Table 29 show the seasonal crop water need and rainfall availability in the past, present and future in these regions for the two types of crops considered (LGC and SGC).

(1) Togo

Table 26. Approximate Range of Values of Seasonal Crop Water Requirements in the Humid Zone of Togo

						Short Cycle (mm/total growing period)		Long Cycle (mm/total growing period)	
	kc Factor	LGS (Short)	LGS (Long)	ETo (Historic)	ETo (Future)	Historic (1976- 2005)	Future (2016-2045)	Historic (1976 -2005)	Future (2016-2045)
Barley/Oats/Wheat	0.68	120	150	5.1	5.3	416.2	432.5	520.2	540.6
Bean, green	0.76	75	90	5.1	5.3	290.7	302.1	348.8	362.5
Bean, dry	0.61	95	110	5.1	5.3	295.5	307.1	342.2	355.6
Cabbage/Carrot	0.79	120	140	5.1	5.3	483.5	502.4	564.1	586.2
Cucumber/Squash	0.7	105	130	5.1	5.3	374.9	389.6	464.1	482.3
Eggplant/Tomato	0.79	130	180	5.1	5.3	523.8	544.3	725.2	753.7
Grain/small	0.71	150	165	5.1	5.3	543.2	564.5	597.5	620.9
Lentil/Pulses	0.7	150	170	5.1	5.3	535.5	556.5	606.9	630.7
Lettuce/Spinach	0.74	75	140	5.1	5.3	283.1	294.2	528.4	549.1
Maize, sweet	0.84	80	110	5.1	5.3	342.7	356.2	471.2	489.7
Maize, grain	0.76	125	180	5.1	5.3	484.5	503.5	697.7	725.0
Melon	0.74	120	160	5.1	5.3	452.9	470.6	603.8	627.5
Millet	0.7	105	140	5.1	5.3	374.9	389.6	499.8	519.4
Onion, green	0.8	70	95	5.1	5.3	285.6	296.8	387.6	402.8
Onion, dry	0.79	150	210	5.1	5.3	604.4	628.1	846.1	879.3
Peanut/Groundnut	0.74	130	140	5.1	5.3	490.6	509.9	528.4	549.1
Pea, fresh	0.86	90	100	5.1	5.3	394.7	410.2	438.6	455.8
Pepper, fresh	0.75	120	210	5.1	5.3	459.0	477.0	803.3	834.8
Potato	0.8	105	145	5.1	5.3	428.4	445.2	591.6	614.8
Rice	0.71	90	150	5.1	5.3	325.9	338.7	543.2	564.5
Sorghum	0.71	120	130	5.1	5.3	434.5	451.6	470.7	489.2
Soybean	0.7	135	150	5.1	5.3	482.0	500.9	535.5	556.5

(2) Senegal

Table 27. Approximate Range of Values of Seasonal Crop Water Requirements in the Humid Region of Casamance, Senegal

						Short Cycle (mm/total growing period)		Long Cycle (mm/total growing period)	
	kc Factor	LGS (Short)	LGS (Long)	ETo (Historic)	ETo (Future)	Historic (1976-005)	Future (2016-2045)	Historic (1976-2005)	Future (2016-2045)
Barley/Oats/Wheat	0.68	120	150	5.2	5.3	424.3	432.5	530.4	540.6
Bean, green	0.76	75	90	5.2	5.3	296.4	302.1	355.7	362.5
Bean, dry	0.61	95	110	5.2	5.3	301.3	307.1	348.9	355.6
Cabbage/Carrot	0.79	120	140	5.2	5.3	493.0	502.4	575.1	586.2
Cucumber/Squash	0.70	105	130	5.2	5.3	382.2	389.6	473.2	482.3
Eggplant/Tomato	0.79	130	180	5.2	5.3	534.0	544.3	739.4	753.7
Grain/small	0.71	150	165	5.2	5.3	553.8	564.5	609.2	620.9
Lentil/Pulses	0.70	150	170	5.2	5.3	546.0	556.5	618.8	630.7
Lettuce/Spinach	0.74	75	140	5.2	5.3	288.6	294.2	538.7	549.1
Maize, sweet	0.84	80	110	5.2	5.3	349.4	356.2	480.5	489.7
Maize, grain	0.76	125	180	5.2	5.3	494.0	503.5	711.4	725.0
Melon	0.74	120	160	5.2	5.3	461.8	470.6	615.7	627.5
Millet	0.70	105	140	5.2	5.3	382.2	389.6	509.6	519.4
Onion, green	0.80	70	95	5.2	5.3	291.2	296.8	395.2	402.8
Onion, dry	0.79	150	210	5.2	5.3	616.2	628.1	862.7	879.3
Peanut/Groundnut	0.74	130	140	5.2	5.3	500.2	509.9	538.7	549.1
Pea, fresh	0.86	90	100	5.2	5.3	402.5	410.2	447.2	455.8
Pepper, fresh	0.75	120	210	5.2	5.3	468.0	477.0	819.0	834.8
Potato	0.80	105	145	5.2	5.3	436.8	445.2	603.2	614.8
Rice	0.71	90	150	5.2	5.3	332.3	338.7	553.8	564.5
Sorghum	0.71	120	130	5.2	5.3	443.0	451.6	480.0	489.2
Soybean	0.70	135	150	5.2	5.3	491.4	500.9	546.0	556.5

Table 28. Approximate Range of Values of Seasonal Crop Water Requirements in the Semi-arid Region of Casamance, Senegal

						Short Cycle (mm/total growing period)		Long Cycle (mm/total growing period)	
	kc Factor	LGS (Short)	LGS (Long)	ETo (Historic)	ETo (Future)	Historic (1976-2005)	Future (2016-2045)	Historic (1976-2005)	Future (2016-2045)
Barley/Oats/Wheat	0.68	120	150	8.2	8.3	669.1	677.3	836.4	846.6
Bean, green	0.76	75	90	8.2	8.3	467.4	473.1	560.9	567.7
Bean, dry	0.61	95	110	8.2	8.3	475.2	481.0	550.2	556.9
Cabbage/Carrot	0.79	120	140	8.2	8.3	777.4	786.8	906.9	918.0
Cucumber/Squash	0.70	105	130	8.2	8.3	602.7	610.1	746.2	755.3
Eggplant/Tomato	0.79	130	180	8.2	8.3	842.1	852.4	1166.0	1180.3
Grain/small	0.71	150	165	8.2	8.3	873.3	884.0	960.6	972.3
Lentil/Pulses	0.70	150	170	8.2	8.3	861.0	871.5	975.8	987.7
Lettuce/Spinach	0.74	75	140	8.2	8.3	455.1	460.7	849.5	859.9
Maize, sweet	0.84	80	110	8.2	8.3	551.0	557.8	757.7	766.9
Maize, grain	0.76	125	180	8.2	8.3	779.0	788.5	1121.8	1135.4
Melon	0.74	120	160	8.2	8.3	728.2	737.0	970.9	982.7
Millet	0.70	105	140	8.2	8.3	602.7	610.1	803.6	813.4
Onion, green	0.80	70	95	8.2	8.3	459.2	464.8	623.2	630.8
Onion, dry	0.79	150	210	8.2	8.3	971.7	983.6	1360.4	1377.0
Peanut/Groundnut	0.74	130	140	8.2	8.3	788.8	798.5	849.5	859.9
Pea, fresh	0.86	90	100	8.2	8.3	634.7	642.4	705.2	713.8
Pepper, fresh	0.75	120	210	8.2	8.3	738.0	747.0	1291.5	1307.3
Potato	0.80	105	145	8.2	8.3	688.8	697.2	951.2	962.8
Rice	0.71	90	150	8.2	8.3	524.0	530.4	873.3	884.0
Sorghum	0.71	120	130	8.2	8.3	698.6	707.2	756.9	766.1
Soybean	0.70	135	150	8.2	8.3	774.9	784.4	861.0	871.5

(3) Guinea

Table 29. Approximate Range of Values of Seasonal Crop Water Requirements in the Semi-arid Region of Guinea

						Short Cycle (mm/total growing period)		Long Cycle (mm/total growing period)	
	Kc Factor	LGS (Short)	LGS (Long)	ETo (Historic)	ETo (Future)	Historic (1976- 2005)	Future (2016-2045)	Historic (1976-2005)	Future (2016-2045)
Barley/Oats/Wheat	0.68	120	150	5.1	5.1	416.2	416.2	520.2	520.2
Bean, green	0.76	75	90	5.1	5.1	290.7	290.7	348.8	348.8
Bean, dry	0.61	95	110	5.1	5.1	295.5	295.5	342.2	342.2
Cabbage/Carrot	0.79	120	140	5.1	5.1	483.5	483.5	564.1	564.1
Cucumber/Squash	0.70	105	130	5.1	5.1	374.9	374.9	464.1	464.1
Eggplant/Tomato	0.79	130	180	5.1	5.1	523.8	523.8	725.2	725.2
Grain/small	0.71	150	165	5.1	5.1	543.2	543.2	597.5	597.5
Lentil/Pulses	0.70	150	170	5.1	5.1	535.5	535.5	606.9	606.9
Lettuce/Spinach	0.74	75	140	5.1	5.1	283.1	283.1	528.4	528.4
Maize, sweet	0.84	80	110	5.1	5.1	342.7	342.7	471.2	471.2
Maize, grain	0.76	125	180	5.1	5.1	484.5	484.5	697.7	697.7
Melon	0.74	120	160	5.1	5.1	452.9	452.9	603.8	603.8
Millet	0.70	105	140	5.1	5.1	374.9	374.9	499.8	499.8
Onion, green	0.80	70	95	5.1	5.1	285.6	285.6	387.6	387.6
Onion, dry	0.79	150	210	5.1	5.1	604.4	604.4	846.1	846.1
Peanut/Groundnut	0.74	130	140	5.1	5.1	490.6	490.6	528.4	528.4
Pea, fresh	0.86	90	100	5.1	5.1	394.7	394.7	438.6	438.6
Pepper, fresh	0.75	120	210	5.1	5.1	459.0	459.0	803.3	803.3
Potato	0.80	105	145	5.1	5.1	428.4	428.4	591.6	591.6
Rice	0.71	90	150	5.1	5.1	325.9	325.9	543.2	543.2
Sorghum	0.71	120	130	5.1	5.1	434.5	434.5	470.7	470.7
Soybean	0.70	135	150	5.1	5.1	482.0	482.0	535.5	535.5

In the following Table 30, we present differences between crop water requirements in the baseline (short and long cycle seasons) and the future. As clearly observed, in all three countries, the differences are quite substantial. Reinforcing the importance of irrigation to supplement the crop water needs under declining rainfalls.

Table 30. Difference between Crop Water Requirements in the Baseline and Future

	SC	LC	SC	LC	SC	LC	SC	LC
	Togo		Senegal				Guinea	
	Dif. (3)	Dif. (4)	Dif. (5)	Dif. (6)	Dif. (7)	Dif. (8)	Dif. (9)	Dif. (10)
Barley/Oats/Wheat	16.3	20.4	8.2	10.2	8.2	10.2	8.2	10.2
Bean, green	11.4	13.7	5.7	6.8	5.7	6.8	5.7	6.8
Bean, dry	11.6	13.4	5.8	6.7	5.8	6.7	5.8	6.7
Cabbage/Carrot	19.0	22.1	9.5	11.1	9.5	11.1	9.5	11.1
Cucumber/Squash	14.7	18.2	7.3	9.1	7.4	9.1	7.3	9.1
Eggplant/Tomato	20.5	28.4	10.3	14.2	10.3	14.2	10.3	14.2
Grain/small	21.3	23.4	10.7	11.7	10.7	11.7	10.7	11.7
Lentil/Pulses	21.0	23.8	10.5	11.9	10.5	11.9	10.5	11.9
Lettuce/Spinach	11.1	20.7	5.6	10.4	5.6	10.4	5.6	10.4
Maize, sweet	13.4	18.5	6.7	9.2	6.7	9.2	6.7	9.2
Maize, grain	19.0	27.4	9.5	13.7	9.5	13.7	9.5	13.7
Melon	17.8	23.7	8.9	11.8	8.9	11.8	8.9	11.8
Millet	14.7	19.6	7.3	9.8	7.4	9.8	7.3	9.8
Onion, green	11.2	15.2	5.6	7.6	5.6	7.6	5.6	7.6
Onion, dry	23.7	33.2	11.9	16.6	11.9	16.6	11.8	16.6
Peanut/Groundnut	19.2	20.7	9.6	10.4	9.6	10.4	9.6	10.4
Pea, fresh	15.5	17.2	7.7	8.6	7.7	8.6	7.7	8.6
Pepper, fresh	18.0	31.5	9.0	15.7	9.0	15.8	9.0	15.7
Potato	16.8	23.2	8.4	11.6	8.4	11.6	8.4	11.6
Rice	12.8	21.3	6.4	10.7	6.4	10.7	6.4	10.7
Sorghum	17.0	18.5	8.5	9.2	8.5	9.2	8.5	9.2
Soybean	18.9	21.0	9.4	10.5	9.5	10.5	9.4	10.5

SC = Short Cycle; **LC**------**Dif. 10** = Difference between future and historic crop water requirements.

Table 31 shows the projected change in crop suitability for selected crop types for present-day (PD, 2011-2040) and mid-century (MC, 2041-2070) climates relative to the baseline (1981-

2010). The crop suitability was derived from the Eco-crop model implemented in R. This model uses the FAO Eco-crop (FAO, 2000) database alongside climatic variables such as temperature and precipitation as inputs to determine the crop suitability index. It is developed based on established ranges of optimal temperature, precipitation, and climatic limits where production of that crop would be impossible. The analysis employed modelled temperature and precipitation for historical and scenario MIP, that is, shared socioeconomic pathways (SSP); SSP2-4.5 and SSP5-8.5 (O'Neill et al., 2016) simulations of ten CMIP6 models ensemble (Eyring et al., 2016). These datasets were integrated into the Eco-crop model to compute the crop suitability by calculating the relative suitability of crop in response to the range of climate variables such as temperature, rainfall; and growing period, thereby generating a suitability index score ranging from 0 (totally unsuitable) to 1 (optimal/excellent suitability) as an output. The computations are done on a monthly time-step of the input data. Temperature and precipitation are dynamic predictors because they vary over time while parameters like soil pH, latitude, altitude, and other soil characteristics are regarded as static parameters in the model. The crop suitability index was computed for selected crops including millet, yam, cassava, maize, rice, sorghum, and wheat. The projected change shows that the suitability of wheat, sorghum, maize, and cassava will decline in the SCPZs based on the climate variables under the two scenarios (SSP245 and SSP585). Wheat is expected to be the most affected by climate change, especially in Kara and Kankan, where the change is statistically significant at 0.05 level under the two scenarios, while Sorghum and Maize will likely become less suitable particularly in Kara during the mid-century under SSP585 (Table 31). On the other hand, future climate conditions are expected to favor the production of rice, yam, and millet in the SCPZs. Rice mostly shows a general increase across the zones for the different scenarios and climate epochs. The production of yam and millet show almost similar pattern in Kara and Zinguinchor. The suitability of these crops is likely to reduce in other zones especially in Boke and Kankan.

Table 31. Projected change in crop suitability for selected crop types in the SCPZs for present-day and mid-century climate relative to the baseline (1981-2010).

Crop	Station															
	Kara				Zinguinchor				Boke				Kankan			
	SSP245		SSP585		SSP245		SSP585		SSP245		SSP5855		SSP245		SSP585	
	PD	MC	PD	MC	PD	MC	PD	MC	PD	MC	PD	MC	PD	MC	PD	MC
Wheat	*-0.054	*-0.098	*-0.043	*-0.106	-0.001	-0.001	-0.001	-0.001	-0.009	-0.009	-0.009	-0.009	*-0.039	*-0.064	*-0.036	*-0.072
Sorghum	-0.008	-0.01	-0.014	*-0.032	-0.027	-0.013	-0.005	-0.000	-0.020	-0.021	-0.01	-0.018	-0.026	-0.025	-0.012	-0.026
Maize	-0.037	-0.033	-0.047	*-0.084	-0.021	-0.009	-0.01	-0.006	-0.005	-0.006	-0.009	-0.016	-0.030	-0.025	-0.017	-0.025
Rice	0.037	*0.032	0.04	0.069	0.013	0.007	0.025	*0.005	*0.001	-0.008	0.009	0.009	0.023	0.0186	0.021	0.016
Millet	0.01	-0.001	0.003	-0.005	-0.002	-0.005	0.005	*0.013	-0.016	-0.015	-0.008	*-0.007	-0.01	-0.017	-0.002	-0.019
Yam	0.015	-0.00	0.006	0.002	0.002	-0.001	0.000	*0.027	*-0.002	0.001	-0.003	0.002	-0.01	-0.03	-0.008	-0.027
Cassava	-0.001	-0.008	-0.008	*-0.024	-0.018	-0.027	-0.009	-0.021	-0.016	-0.018	-0.011	-0.018	-0.017	-0.027	-0.011	-0.033

PC = Present-day climate (2011-2040); MC = mid-century climate (2041-2070)

Increase	Decrease	
		Not significant
*	*	**Significant at 0.05 level**

Consecutive Dry Days (CDD): Another useful indicator for assessing climate change impacts on agriculture beside changes in temperature and precipitation, is the maximum number of consecutive dry days (CDD). This is defined as a day without any agriculturally meaningful rainfall, which is generally defined by a threshold of 1 mm/day[119]. This indicator is an important metric for rain-fed agriculture as it directly impacts soil moisture, and thus crop growth. CDD in the three host countries is expected to increase through the end of the 21st Century (Figure 33). There are chances of CDD increase by 12 days in Boké and Kankan. The increase is significant in the north eastern parts of Boké. An eastward pattern of significant increase in CDD is possible in the north-west region of Senegal. A significant increase in CDD (i.e., great than 17 days) is likely around the eastern parts of Casamance. While the southern parts of Togo are expected to experience decrease in CDD, the northern parts including the Kara region will possibly have to cope with increasing CDD. Under the RCP8.5 emission scenario (Figure 34), Guinea and Senegal are expected to experience more dry days with the most significant event in the latter country. While the southern parts of Togo are likely to experience reduction in CDD during the last climate epoch of the 21st Century, the Kara region is likely to constantly suffer dryness across the three climate epochs. Higher number of CDD with little or no precipitation can lead to drought. When accompanied by higher temperatures, it increases evaporation thereby, adding more stress to limited water resources, with far reaching implications for irrigation and other water uses.

[119]https://climateknowledgeportal.worldbank.org/.

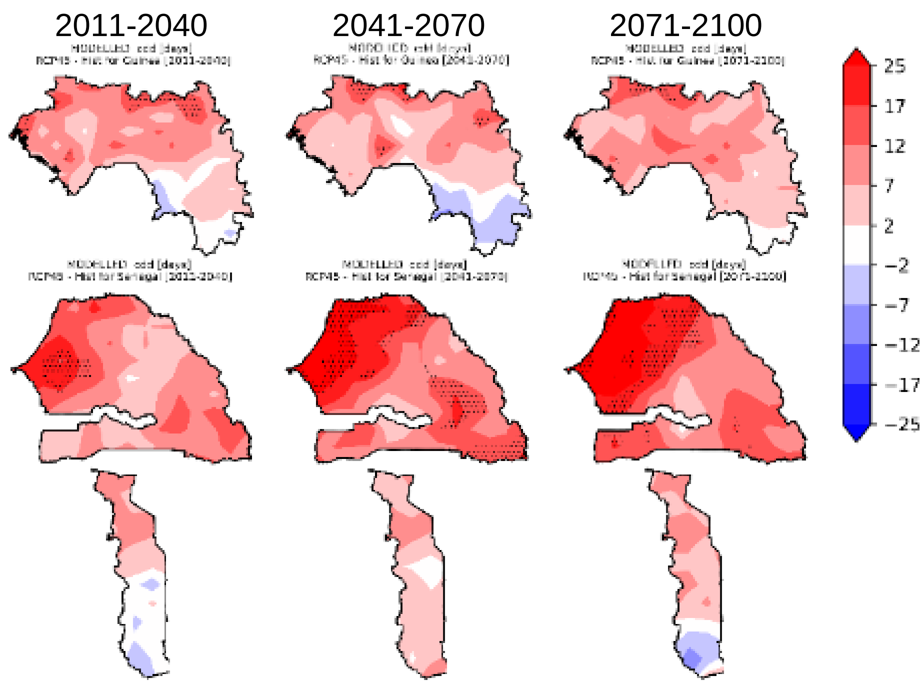


Figure 33. Projected change in consecutive dry days (CDD) (days) relative to the baseline (1976-2005) for the periods 2011-2040 (current-near future), 2041-2070 (mid-future) and 2071–2100 (far future) under the RCP4.5 emission scenario.

(Dotted areas indicate regions where the change is statistically significant at 0.05 significance level.)

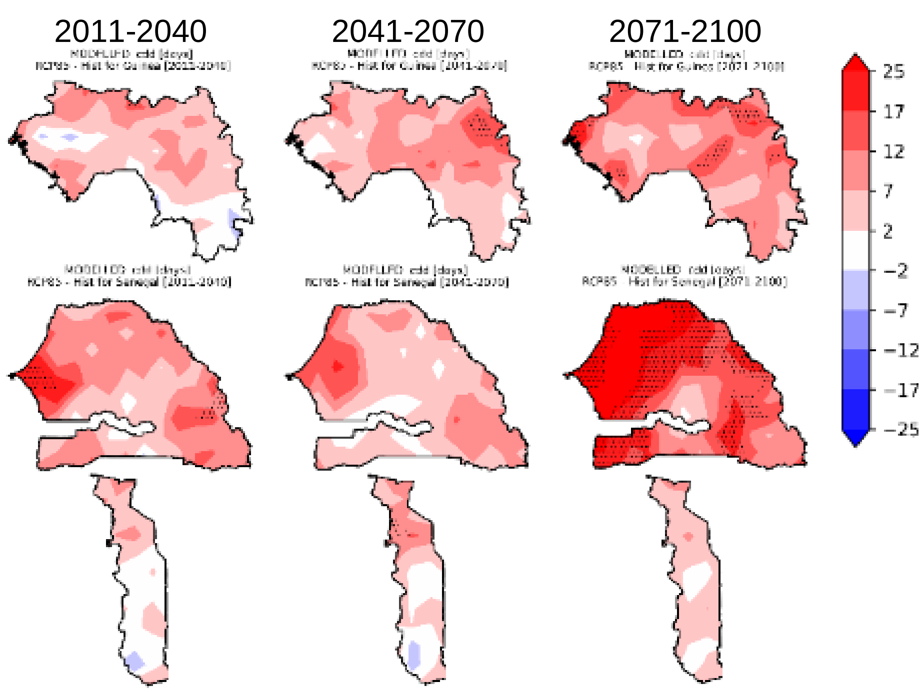
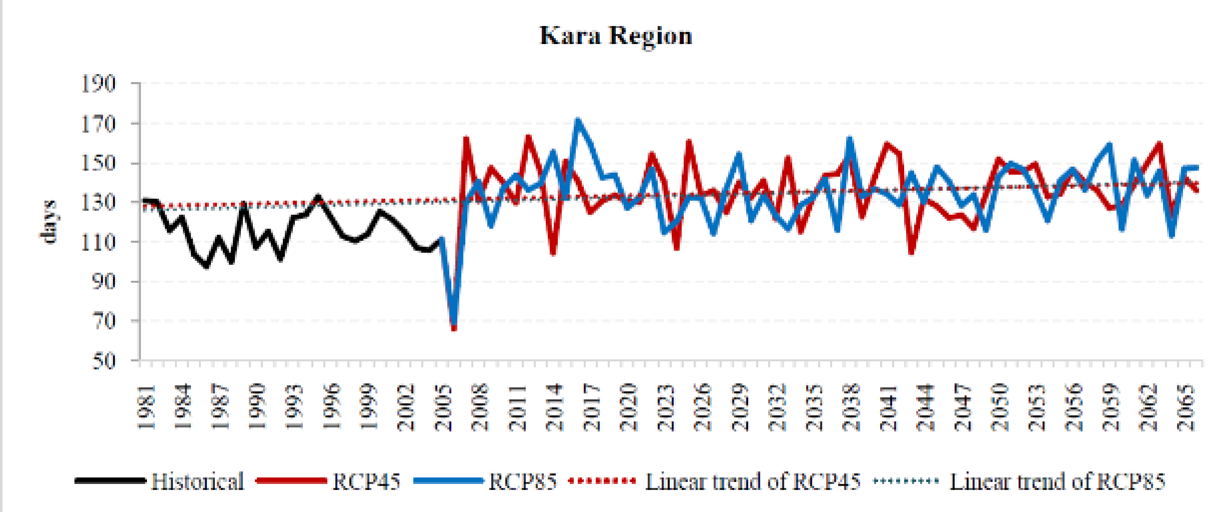


Figure 34. Projected change in consecutive dry days (CDD) (days) relative to the baseline (1976-2005) for the periods 2011-2040 (current-near future), 2041-2070 (mid-future) and 2071-2100 (far future) under the RCP8.5 emission scenario.

(Dotted areas indicate regions where the change is statistically significant at 0.05 significance level.)

In Figure 35, the historic and projected CDD for the Kara Region of Togo, Casamance Region of Senegal, and the Boke and Kankan Regions of Guinea, for the period 1981 to 2066 are presented. The black line indicates historic while the blue and red lines represent trends derived from the emissions scenarios RCP 4.5 and RCP8.5. Similar to Figure 33 and Figure 34, the average annual maximum number of consecutive dry days are projected to increase for both emission scenarios. However, the effects are more pronounced in Senegal than Togo and Guinea, where it is projected that the CDD could reach up to 200 days per year for most of the years. This means more drought conditions with far reaching implications for food security and poverty. Similar findings were obtained by Klutse et al 2018, using climate projections from a multi-model ensemble of 25 regional climate model (RCM) simulations to assess, the potential impact of 1.5 °C and 2 °C global warming on consecutive dry and wet days over West Africa. Consistent with our findings, the authors observed that more than 80% of ensemble members agree that CDD will increase over the most regions of West Africa.


Kara Region
days
190
170
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130
110
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70
50
1981
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2026
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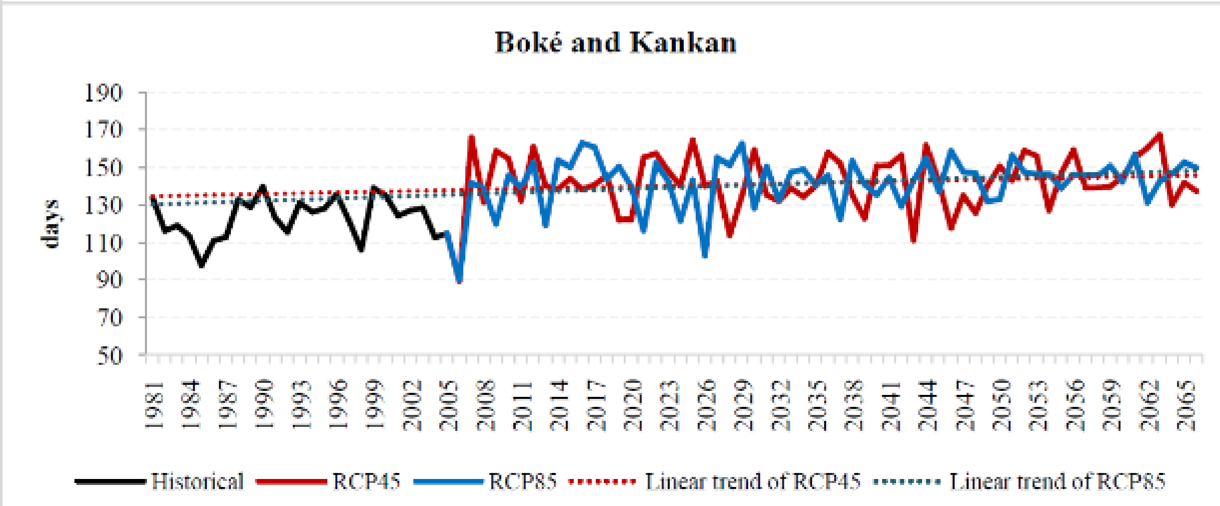
Historical
RCP45
RCP85
Linear trend of RCP45
Linear trend of RCP85


Boké and Kankan
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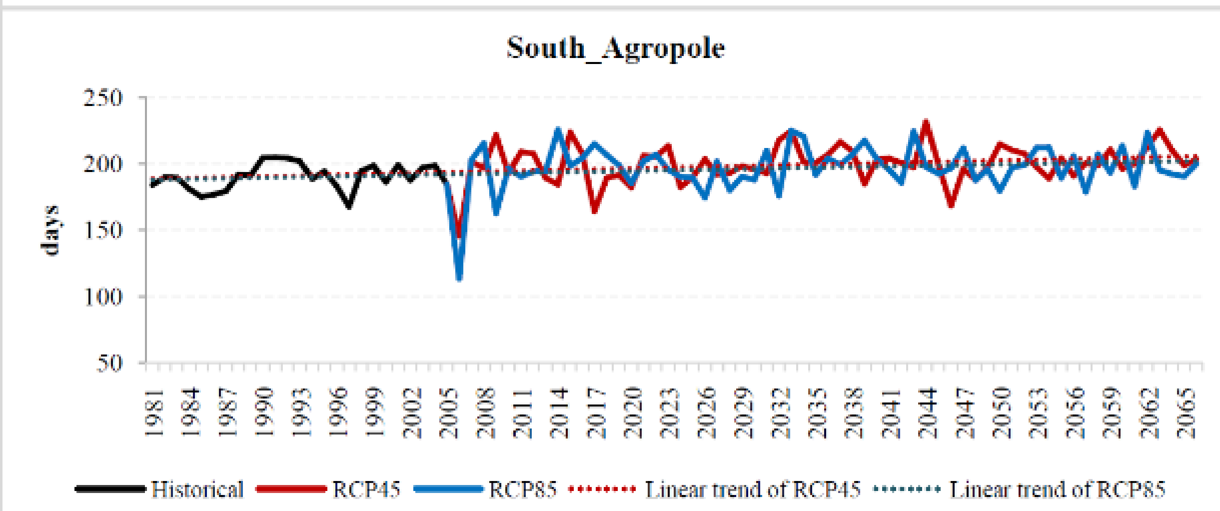
South_Agropole
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2065
Historical
RCP45
RCP85
Linear trend of RCP45
Linear trend of RCP85

Figure 35. Historic and projected maximum number of consecutive dry days (CDD) in the Kara Region of Togo, Casamance Region of Senegal, and the Boke and Kankan Regions of Guinea, for the period 1981 to 2066.The black line indicates historic while the blue and red lines represent trends derived from the emissions scenarios RCP 4.5 and RCP8.5.

Length of Growing Period (LGP): The Length of growing period (LGP) is defined as the period during the year when average temperatures are greater than or equal to 5^{o}C (Tmean >=5^{o}C) and precipitation plus moisture stored in the soil exceed half the potential evapotranspiration (P>0.5PET). It is an important indicator for crop forecasting, especially when planning agricultural programmes in the mist of changing climatic conditions[120] (Table 32). A normal growing period is defined as one when there is an excess of precipitation over pet (i.e., a humid period). Such a period meets the full evapotranspiration demands of crops and replenishes the moisture definite of the soil profile. An intermediate growing period is defined as one in which precipitation does not normally exceed PET but does for part of the year. No growing period is when temperatures are not conducive to crop growth or P never exceeds PET.

Table 32. Showing the range of uncertainty between climate projections and historical (Observed vs. Model) for the LGP

Station	Rainfall Onset (Days)		Rainfal Cessation (Days)		LGP (Days)		Difference (Days) from Historical					
							LGP		Onset	Onset	Cess.	Cess.
	(1)	(2)	(3)	(4)	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	(5)	(6)	(7)	(8)
KARA												
Historical (1981 - 2005)	118	109	304	309	**186**	**200**	**-**	**-**	-	-	-	-
Projections (2006 -2035)	106	105	310	310	**204**	**205**	**18**	**5**	12	4	-6	-1
Projections (2036 -2065)	110	109	312	314	**202**	**205**	**16**	**5**	8	0	-8	-5
SOUTH AGROPOLE												
Historical (1981 - 2005)	171	175	285	302	**114**	**127**	**-**	**-**	-	-	-	-
Projs. RCPs (2006 -2035)	179	178	305	297	**126**	**119**	**12**	**-8**	-8	-3	-20	5
Projs. RCPs (2036 -2065)	191	192	296	300	**105**	**108**	**-9**	**-19**	-20	-17	-11	2
KANKAN												
Historical (1981 - 2005)	127	142	308	307	**181**	**165**	**-**	**-**	-	-	-	-
Projs. RCPs (2006 -2035)	137	135	309	308	**172**	**173**	**-9**	**8**	-10	7	-1	-1
Projs. RCPs (2036 -2065)	141	140	310	310	**169**	**170**	**-12**	**5**	-14	2	-2	-3
BOKE												
Historical (1981 - 2005)	137	138	326	325	**189**	**187**	**-**	**-**	-	-	-	-
Projs. RCPs (2006 -2035)	134	136	321	321	**187**	**185**	**-2**	**-2**	3	2	5	4
Projs. RCPs (2036 -2065)	139	140	324	325	**185**	**185**	**-4**	**-2**	-2	-2	2	0

[a] the differences presented in rows (5) to (8) are relative to the historical period (1981 - 2005) for the two emission scenarios RCP 4.5 and RCP 8.5. And except for the historical period where (1) and (2) are observed onsets and (2) & (3) are model cessations, the projections are based on the two emission scenarios RCP 4.5 and RCP 8.5. Note that: (-) values show late onset or cessation while (+) values depict early onset or cessation for the two emission scenarios RCP 4.5 and RCP 8.5.

[120] CLIMPAG: Climate Impact on Agriculture | ADVICE AND WARNINGS | Agrometeorological Crop Forecasting (fao.org)

In Figure 36, the average length of growing period over the Kara region for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom), during historical climate and under different emission scenarios (i.e., RCP4.5 and RCP8.5) is presented. Again, the major feature of the observations is a slight shift in the rainfall cessation outwards in both the (b) 2006-2035 (middle) and (C) 2036-2065 (bottom) periods, leading to a longer growing period. This is consistent with the projections reported in Figure 61, which predicts early onset in April and with a cessation period in early October. This justifies the use of drip irrigation techniques in agriculture coupled with the adoption of climate resilient agricultural (CRA) practices for precision farming to ensure food security in the country.

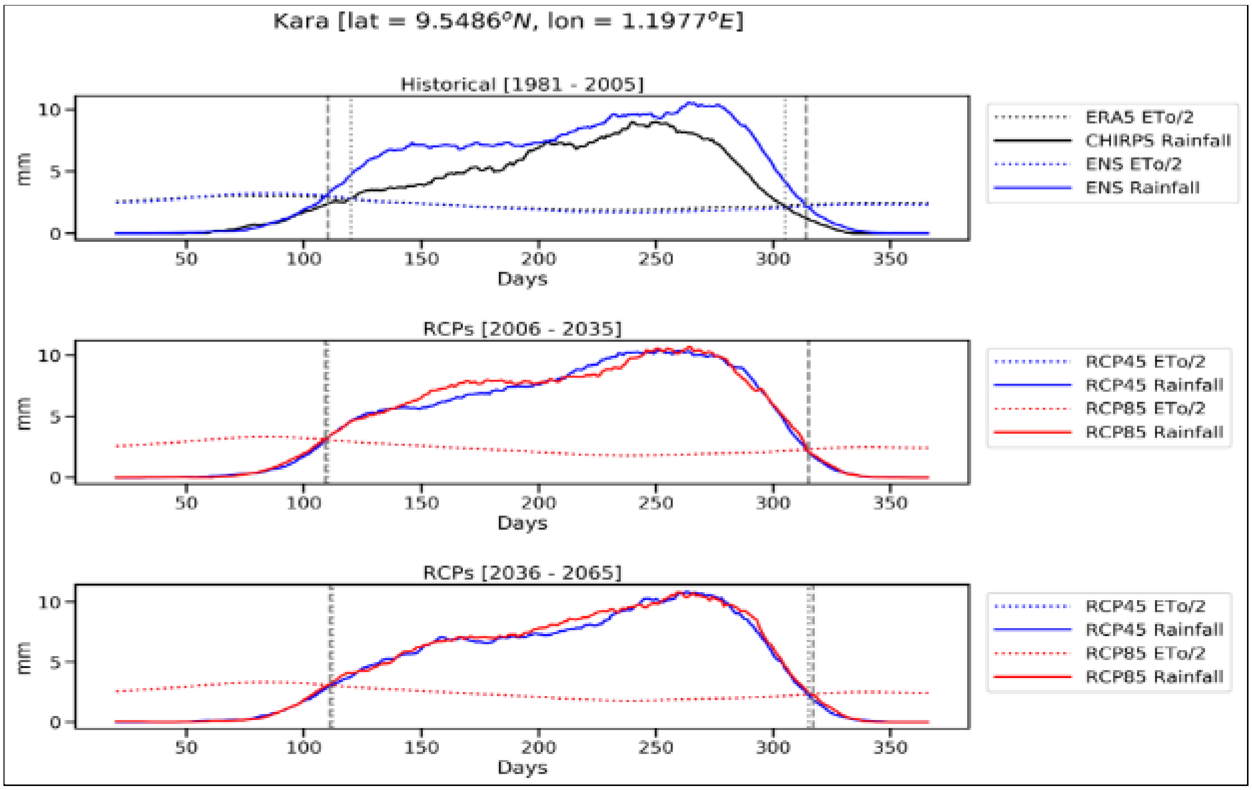


Figure 36. Average length of growing period over the Kara Region for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom), under different emission scenarios (i.e., RCP4.5 and RCP8.5)

(The continues lines indicate rainfall and the dotted line is 50% (half) of the evapotranspiration (ETo). Both lines are 20days running mean values. The vertical dotted and dashed lines mark the point of intersection between rainfall and half of ETo for observation (and RCP4.5) and model (and RCP8.5), respectively. (NOTE: The ETo is computed from minimum and maximum surface temperature following the Hargreaves method as described in the FAO56 documentation (http://www.fao.org/3/X0490E/x0490e08.htm#eto%20calculated%20with%20different%20time%20steps.)

In the Casamance region of Senegal (Figure 37), during the historical period, the observed onset of rainfall is earlier compared to the modelled onset, but the cessation is late in the ENS model runs than the observed. This is consistent to the projected scenario presented in Figure 53. For the period 2006-2035, rainfall cessation in RCP8.5 is early compared to RCP4.5 therefore making the former scenario to shorter growing period. There is, however, no significant difference in the growing period between RCP4.5 and RCP8.5 in the period 2036-2065, although the growing length is shorter compared to the historical and 2006-2035 periods.

Figure 38 shows the average length of growing period over Kankan for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom), under different emission scenarios (i.e., RCP4.5 and RCP8.5). As noted earlier, the time between the first and second intersection defines the growing period. During the historical period, the observed onset of rainfall is earlier compared to the modelled onset but the cessation is early in the model. For the period 2006-2035, onset in RCP8.5 is early compared to RCP4.5 therefore making the former scenario to longer growing period. While the cessation is almost the same in both scenarios, the growing period is shorter relative to the historical period. There is, however, no significant difference in the growing period between RCP4.5 and RCP8.5 in the period 2036-2065, although the growing length is shorter compared to the historical and 2006-2035 periods.

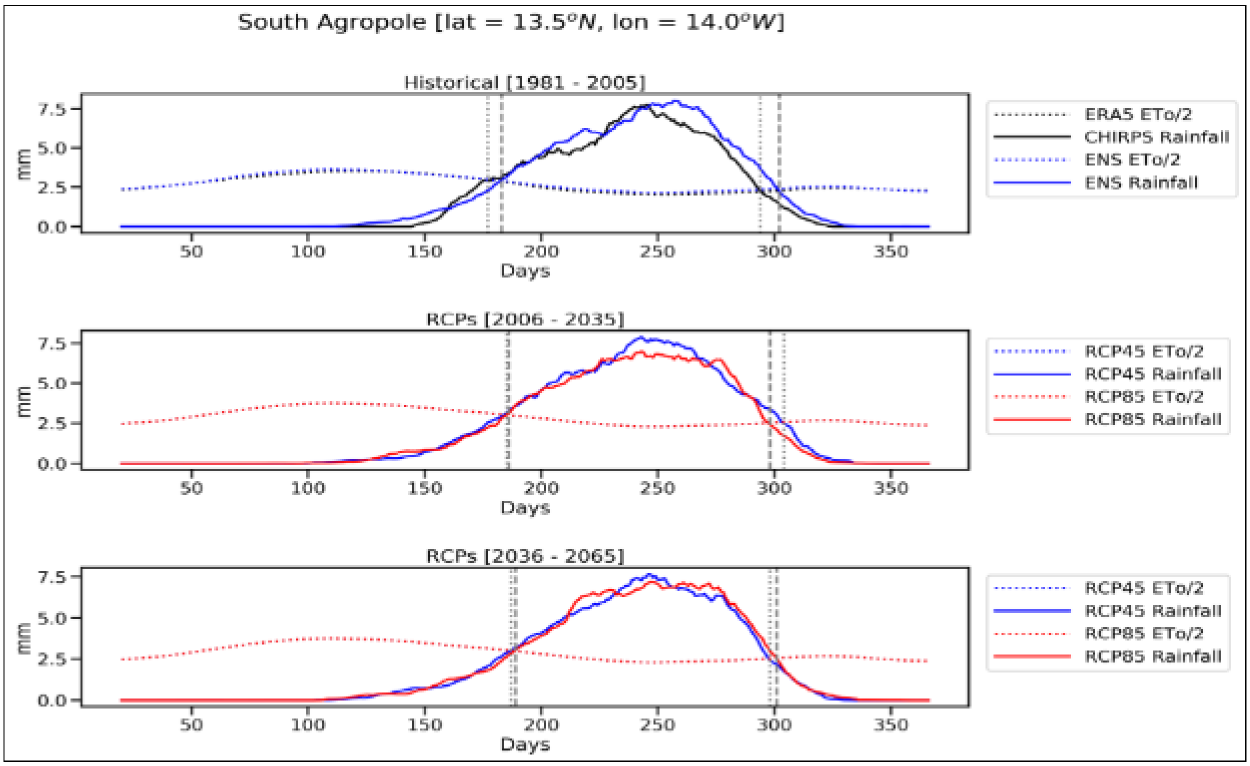


Figure 37. Average length of growing period over the Casamance Region of Senegal for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom), under different emission scenarios (i.e. RCP4.5 and RCP8.5)

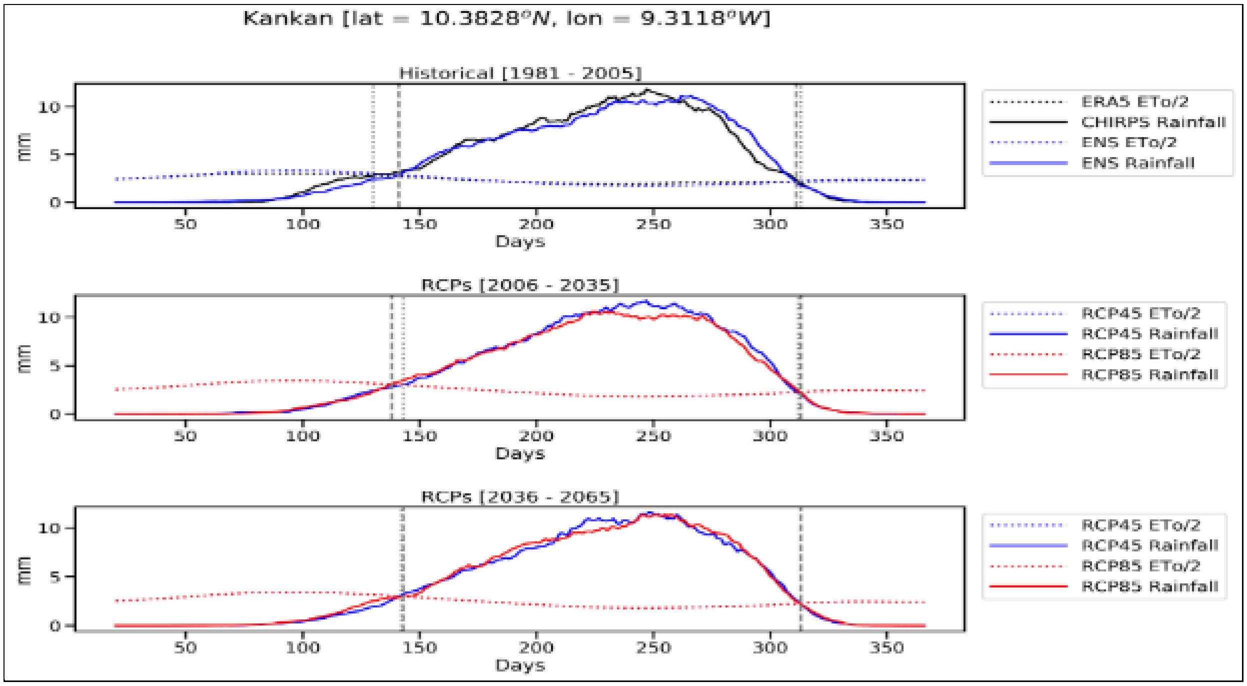


Figure 38. Average length of growing period over Kankan for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom) during historical climate and under different emission scenarios (i.e., RCP4.5 and RCP8.5)

Lastly, the average length of growing period over Boke for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom) during historical climate and under different emission scenarios (i.e., RCP4.5 and RCP8.5) is presented in Figure 39. Contrary to Figure 39, during the historical period, the observed onset of rainfall is early compared to the modelled. For the period 2006-2035, onset in RCP8.5 is early compared to RCP4.5 therefore making the former scenario to longer growing period. While the cessation is almost the same in both scenarios, the growing period is shorter relative to the historical period. There is, however, no significant difference in the growing period between RCP4.5 and RCP8.5 in the period 2036-2065, although the growing length is shorter compared to the historical and 2006-2035 periods.

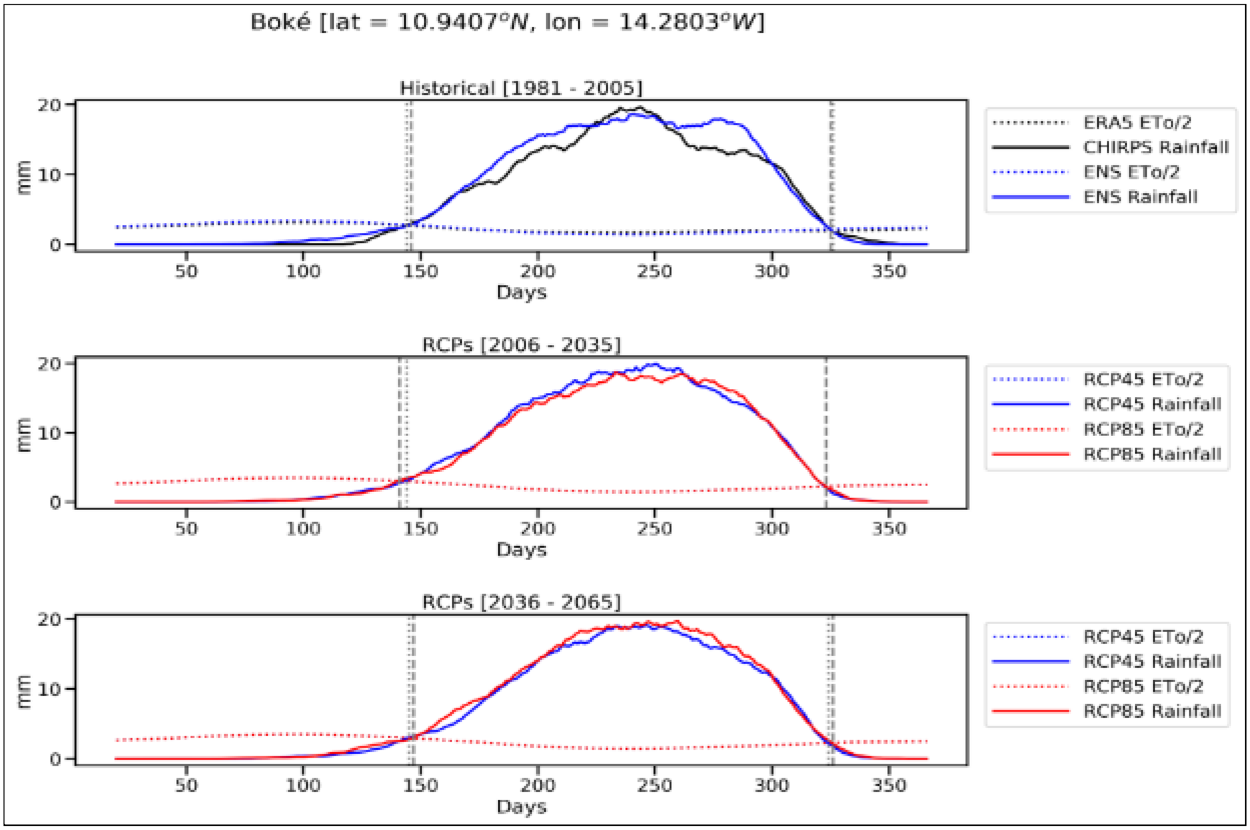


Figure 39. Average length of growing period over Kankan for the periods (a) 1981-2005 (top), (b) 2006-2035 (middle) and (C) 2036-2065 (bottom) during historical climate and under different emission scenarios (i.e., RCP4.5 and RCP8.5)

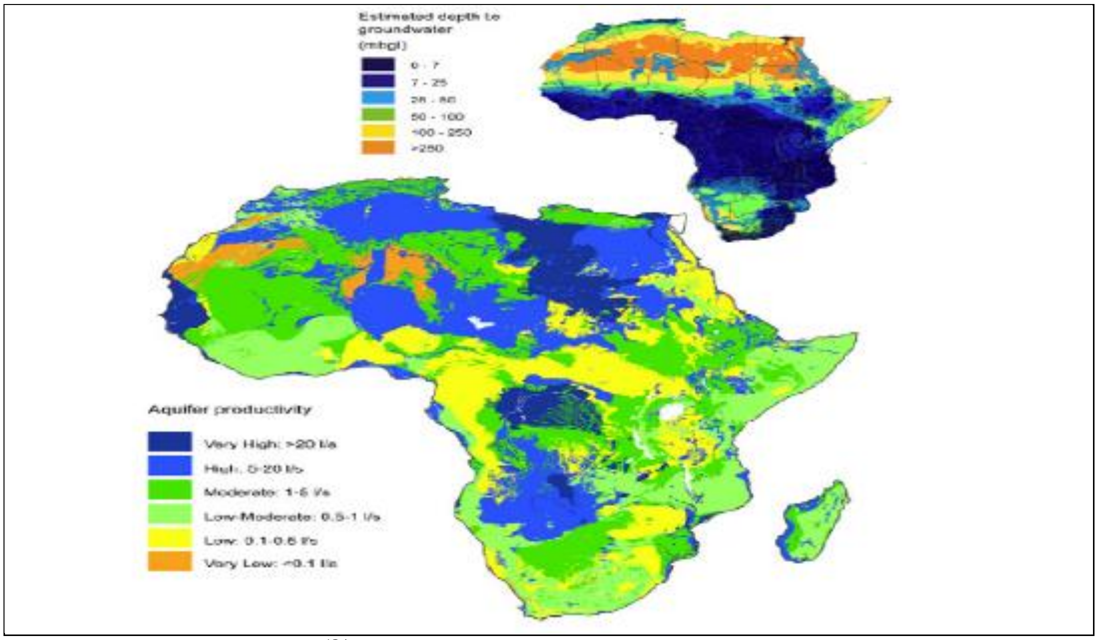
5.5. Ground and Surface Water Potentials for Irrigation in the Countries and Regions

According to FAO, expanded irrigation development and improved water management are keys to increasing agricultural production, under water scarcity conditions. In Togo, the figure is slightly lower with only 0.8 percent of the arable land of a smallholder being irrigated. The figure is slightly higher for Senegal, with about 5 percent of land under irrigation[121]. Though the water sector is at risk from climate change which limits the sector potentials for irrigation, many studies carried out in the three countries show mainly uncertainties and complexities in the climate change research, and also uncertainties associated with the impacts of future climate changes on water resources[122,123]. Even with future climate change uncertainty on water resources, these countries have abundant surface and ground water potentials quite suitable for irrigation. In the following Figure 40 and Table 33 – Table 34 we presented information about the water resources for the three countries.

1) Map of African aquifer productivity of ground water resources. Aquifer productivity simply describes the likely interquartile range for boreholes drilled and sited using appropriate techniques and expertise. As observed in the figure, the aquifer productivity for Togo, Senegal and Guinea ranges from high to moderate and therefore, very suitable for drilling of boreholes to support agriculture during periods of water scarcity.

[121] Word Bank (2017): World Development Indicator
[122] van der Wijngaart et al.(2019):Irrigation and irrigated agriculture potential in the Sahel: The case of the Niger River basin.
[123] Altchenko and Villholth (2015):Groundwater irrigation potential

Figure 40. Aquifer productivity for Africa. The inset shows an approximate depth to groundwater



Source: MacDonald et al. (2012)[124]

2) Data on water resources at a country level, as provided by FAO and the estimated ground water storage capacities each country, which are very moderate with good potentials for use in irrigation.

Table 33. Long-term annual renewable water resources by country (in km³/year, average)

	Togo	Senegal	Guinea
Surface water (produced internally)	10.8	23.8	226
Groundwater (produced internally)	**5.7**	**3.5**	**38**
Surface water entering the country	3.2	2.17	0
Surface water leaving the country	9.5	5.4	102.2

FAO (2020) AQUASTAT Core Database[125].

Table 34. Countries estimated groundwater storage capacity

Groundwater Storage (km^2)		
Country	Best Estimate	Range
Togo	541	133 – 1,935
Senegal	12,500	8,280 – 29,100
Guinea	297	102 – 879

[124] A M MacDonald *et al.* (2012): Quantitative maps of groundwater resources in Africa. *Environ. Res. Lett.* 7 024009.

[125] FAO (2020): *AQUASTAT Core Database:* www.fao.org/aquastat/statistics/query/index.html.

Source: MacDonald et al. (2012)

1) Qualifiers to appreciate the potential of groundwater resources of each region. To this qualitative assessment of the groundwater potential, are added estimates of the depth to groundwater in each region. The available few data on groundwater properties helped evaluating the suitability of the resource for irrigation based on FAO standards. As one can see in Table 35, the groundwater resource is in general abundant in each region and most of the physicochemical properties are within acceptable ranges (only few parameters, for some regions, have to monitor when using these resources for irrigation purposes).

Table 35. The permissible limits for classifying the suitability of irrigation water

Some of Irrigation water quality parameters	permissible limits in irrigation water	source
SAR	0-15	
Ec (µS/cm)	0-3000	
TDS (mg/L)	0-2000	
pH	6.5-8.4	
Na^+(meq/L)	0-40	Ayers and Westcot, 1985
Ca^{2+} (meq/L)	0-20	
Mg^+ (meq/L)	0-5	
CO_3^{2-}+ HCO_3^-(meq/L)	0-10	
Cl^-(meq/L)	0-30	

Table 36. Groundwater Availability, Properties and Degree of Restriction for Irrigation at the Regional Levels

(Degree of restriction expressed following Ayers and Westcot 1985; and Müller and Cornel 2017.Blue box = no restriction, Green box=slight to severe-i.e., use on sensitive crops must be cautioned.)

		Togo	Senegal	Guinea	
		Kara	**Casamance**	**Boké**	**Kankan**
Groundwater (GW) potential		Moderate[o]	High to very high[n]	Probably low to high[p]	Low to moderate[p]
Depth to GW (mbgl)		0-25[l]	0-25[l]	0-25[l]	0-25[l]
Groundwater property	**Temp. (ºC)**	26-32[k]			
	pH	5.4-7.9[k]	3.8-8.3[m]	6.31-6.39[r]	6.31-6.39[r]
	Electrical conductivity (µS/cm or µmho/cm)	42-982[k]	38.7-7160[m]		
	Total alkalinity (mg/l)				
	Total dissolved solids (ppm or mg/l))		20.6-3900[m]		
	Turbidity (NTU)			0.40-050[r]	0.40-050[r]
	Nitrogen (mg/l)	0[k]	0.0[m]	3.34-4.01[r]	3.34-4.01[r]
		10[k]	342.0[m]		
	Na+ (mg/l)	1.8-96[k]	4.5[m]		
			1726[m]		

	Sodium adsorption ratio				

4) Qualifiers to assess surface water potential in each region and evaluate the suitability of the resource for irrigation based on surface water properties, although information on surface water properties are limited in the literature (Table 36 and Table 37). There are more or less major rivers within each region, implying important surface water potential. For drip irrigation purposes, this surface water could complement the groundwater resource in each region.

Table 37. Surface Water availability, properties and degree of restriction for irrigation at the Regions

(Degree of restriction expressed following Ayers and Westcot 1985, blue color = no restriction, green=slight to severe-i.e., use on sensitive crops must be cautioned.)

		Togo	**Senegal**	**Guinea**	
		Kara	**Casamance**	**Boké**	**Kankan**
Surface water potential (River)		Sufficient[u] (Kara)	Significant[v] (Casamance river)	Importante[r] (Nunez)	Importante[r](Milo, Bafing)
Surface water property	**pH**	5.5-8.5[z]			
	Electrical conductivity (µS/cm or µmho/cm)	20-240[z]			
	Total dissolved solids (ppm or mg/l))				
	Sodium adsorption ratio				

[k]Zoulgami et al. 2015 (Physico-chemical study of groundwater in the Northeast of Kara region (Togo) DOI: 10.4314/ijbcs.v9i3.49)
[l]Ouedraogo 2017 (Mapping groundwater vulnerability at the pan-African scale, Thesis UCL Louvin).
[m]Ndoye et al. 2018 (Groundwater Quality and Suitability for Different Uses in the Saloum Area of Senegal, https://www.mdpi.com/2073-4441/10/12/1837)
[n]Africa Groundwater Atlas- Hydrogeology by country-Hydrogeology of Senegal http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Senegal#Groundwater_Quantity)
[o]Africa Groundwater Atlas- Hydrogeology by country-Hydrogeology of Togohttp://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Togo
[p]Africa Groundwater Atlas- Hydrogeology by country-Hydrogeology ofGuineahttp://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Guinea
[r]Sidibe and Oulaye (L'eauenGuiée, Presentation https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjYxNDZrtDuAhWBKewKHeYNB94QFjAAegQIARAC&url=https%3A%2F%2Funstats.un.org%2Funsd%2Fenvironment%2Fenvpdf%2FUNSD_TogoWorkshop%2FSession%25207b_Guin%25C3%25A9e_L%2527Eau%2520en%2520Guin%25C3%25A9e.pdf&usg=AOvVaw0u4y4HcXhoqQteNFetzSyl)
[u]Nizar et al. 2018 (An Index-Based Approach to Assess the Water Availability for Irrigated Agriculture in Sub-Saharan Africa. DOI: 10.3390/w10070896).
[V]Dia 2010 (Water Resources issues in Senegal What approach in Rural Arid zone?INTERNATIONAL SYMPOSIUM, Sao Carlos ,BRAZIL 13-17th September 2010)
[z]Boukari et al. 1999 (characterization of some Togo surface water)
Ayers and Westcot 1985 (Water quality for agriculture. Food and Agriculture Organization of the United Nations Rome, 1985, FAOhttp://www.fao.org/3/T0234E/T0234E00.htm)
Müller and Cornel 2017 (Setting water quality criteria for agricultural water reusepurposes, https://doi.org/10.2166/wrd.2016.194)

5.5.1. Impact of Climate Change and Water Resources in the Target Regions: A Literature Review

In West Africa, a desk study by USAID (2013)[126], shows that by 2030-2050, changes in temperature and precipitation due to climate change will have variable impacts on surface water levels in some areas of the region. The Sahel water resources will be the most vulnerable in the region because of higher temperatures and lower rainfall. With the inclusion of climate projections, major area river flows are expected to decline by 15-20 percent (2020) and 20-40 percent (2050). The desk study further asserts that, the climate variable with the most direct influence on water supply in the region is precipitation. For the region as a whole, reductions in precipitation have been accompanied by declines in runoff; however, at the subregional level, the relationships between precipitation, runoff, and discharge are complex and are expected to remain so in the future. Indeed, a high level of uncertainty persists in regard to the amount of runoff and discharge the region will experience.

Still in West Africa, Sylla et al. (2018)[127], investigated the West Africa's hydrological potential to increase agricultural productivity through the implementation of large-scale water storage and irrigation. The authors used a 23-member ensemble of Regional Climate Models (RCMs) to assess changes in hydrologically relevant variables under 2 °C and 1.5 °C global warming scenarios according to the UNFCCC 2015 Conference of Parties (COP 21) agreement. Changes in crop water demand, irrigation water need, water availability and the difference between water availability and irrigation water needs (hereafter, basin potential), are presented for ten major river basins covering entire West Africa. Under the 2 °C scenario, crop water demand and irrigation water needs are projected to substantially increase with the largest changes in the Sahel and Gulf of Guinea respectively. At the same time, irrigation potential, which is directly controlled by the climate, is projected to decrease even in regions where water availability increases. This indicates that West African river basins will likely face severe freshwater shortages thus limiting sustainable agriculture.

A summary of the brief review carried out above, suggest that climate change will potentially impact water resources in the future for all the three countries. This certainly calls for better approach to water resources management in these countries.

5.5.2. A Study on Impact of Projected Climate Change on Water Resources in the SCPZs

5.5.2.1 Background

This study was conducted as part of the Global Center on Adaptation (GCA's) Technical Assistance Program to "Access and Leverage Climate Finance" (TAP) through the Africa Adaptation Acceleration Program (AAAP) to investigate the potential impact of projected climate change on water resources in the proposed SCPZs. The Staple Crops Processing Zone (SCPZ) program that is implemented in three African countries namely Guinea, Senegal and Togo, will help rationalize interventions in the agriculture sector of the program countries towards activities that contribute to emission reduction from agricultural activities and improves resilience of agroecosystems, agricultural assets, and beneficiaries. The program aims to reduce

[126] USAID (2013). Climate Change and Water Resources in West Africa: Transboundary River Basin. U.S. Agency for International Development.
[127] Syllla et al. (2018). Climate change to severely impact West African basin scale irrigation in 2 °C and 1.5 °C global warming scenarios, Sci Rep. 2018; 8: 14395, doi: 10.1038/s41598-018-32736-0

climate change vulnerability and greenhouse gas (GHG) emissions within the agricultural value chains in these three highly indebted poor countries in Africa. This will help stimulate productivity and value addition, competitiveness, generate employment and increase incomes of the most vulnerable people and communities in these countries. With a large proportion of the population in these countries, depending on rainfed agriculture for daily subsistence, the situation could become even more precarious with the impact of climate change due to changing patterns of rainfall and temperature which will affect both agricultural and other sectoral water requirement and availability.

There are eight SCPZs in the three countries namely Boke and Kankan in Guinea, Casamance in Senegal and Kara in Togo at various stages of development.

One adaptation approach in the SCPZs is increasing the access to water efficient irrigation systems or climate resilient agricultural practices such as drip irrigation to small scale farmer to cope with reduced water availability and ensure sustained production.

In order to understand the projected water availability and changes in demand assessment especially under future climate scenario. This analysis which are reported herein had the objective to answer the following major questions for the SCPZ water sources catchments

1. What is the currently available surface water and how will it be impacted by projected climate?
2. How will groundwater availability be impacted by projected climate?
3. What are the changes in the future water demand related to agriculture in the SCPZ?

5.5.2.2 Methodology

a. Conceptual Approach

Projected Climate Impact on Surface and Groundwater Resource

In order to quantify the currently available surface water and how will it be impacted by projected climate; it is necessary to understand the relationship between climate (precipitation and Evapotranspiration) and streamflow for a particular catchment by use of a rainfall-runoff model calibrated for each SCPZ using the methodology explained in the next section. The model will then be fed with future project climate to understand future water availability and this compared with the current period.

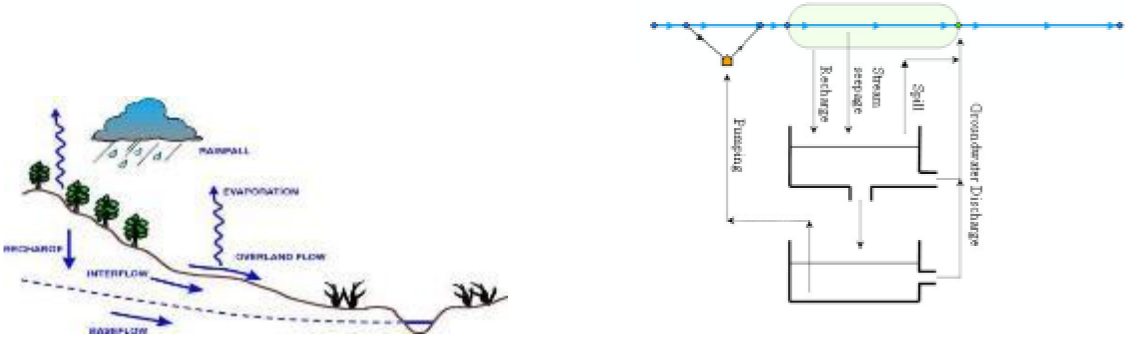
Climate change impact on groundwater will be assessed from the supply side through changes in the recharge using a combined groundwater-surface water model.

b. Modelling Approach

From the field visit to the SCPZs, both surface (including lakes) and groundwater were identified as the potential water source for both irrigated agricultures as well for the agro-processing activities. Thus, modelling the impact of climate and water use both surface (streams and lakes) and groundwater is necessary; however, groundwater modelling is complex and the available data for calibration is not enough. As such the approach to be adopted is to quantify the potential recharge to groundwater and assess the changes with projected climate.

In this study, Mike Hydro model which is combined surface and groundwater model was used. The model has both a rainfall-runoff, water resources and groundwater modules which exchange data seamlessly. The rainfall-runoff modelling is done by the rainfall-runoff module named NAM, the groundwater module calculates the GW balance with outputs such as recharge and pumping (Figure 41). The model is calibrated and validated with available observed data.

Figure 41. Mike Hydro basin modelled processes, left is surface water and right is groundwater



i. Selection of study period and Input Data: The Baseline data was selected as 1981-201. Due to the fact that precipitation and evapotranspiration is the main driver for water resources availability and lack of dense network of observed long-term data availability in the SCPZ, the availability of free satellite precipitation CHIRPS and model driven TerraClimate evapotranspiration data was used for the baseline assessment period.

The future climate period for this study was taken as 2011-2040 and 2041-2070. The proposed model to be used for this study is the Rossby Centre regional atmospheric model (RCA4 with a horizontal grid spacing of the simulation is 0.44 degrees (about 50 km). The choice of the RCA model for this analysis was based mainly on the fact that it is one of the models used in the analysis reported in the FP as well as the availability of the model outputs for the three different scenarios (RCP 2.6, RCP 4.5, and RCP 8.5) and having evapotranspiration data.

ii. Data Processing and Modelling Steps

This study involved the following steps

- Delineation of the catchments in the SCPZs using a 90m SRTM DEM. The Groundwater aquifer boundaries was assumed similar to the surface water catchment boundaries as most for countries aquifer boundaries maps were not available.
- Processing of the Regional climate model to extract precipitation and PET data for the three scenarios RCP 2.5, 4.5 and 8.5 for the reference period 1981-2100
- Estimation of Delta-change factors for three future periods, the “Current” 2011-2040, “near future” 2041-2070 and the “far future” 2071-2100 using 1981-2010 as the reference period to produce catchment forcings data for the projected precipitation and PET for projected climate. This was also important for bias correction.
- Setting up of a Mike-Hydro/NAM rainfall runoff model for the 14 sub basins.
- Calibration and validation of the Mike-Hydro/NAM for the period 1981-2010
- Production of new input data for the three scenarios and three future periods using the remotely sensed/observed data and delta change factors. This makes nine input data sets for each SCPZ/Catchment.
- Running of the calibrated & validated Mike hydro/NAM model using the nine datasets for the three scenarios and three periods as input data.
- Assessment of the results on aspects such as changes in flow regime and impact on water users and uses in the catchments

iii. Water Demand Assessment
The water demand for agriculture is driven by the potential ET and crop growth stage. Actual ET is a product of the PET and crop growth co-efficient (Kc). The Kc value varies from 0.6 to 1.2. Thus, since no detailed data on the drips system is available, this demand was estimated based on Potential evapotranspiration data (ETo), an average crop co-efficient factor and the effective rainfall. This will be calculated for current and future climate projections and implication of changes discussed and where necessary recommendations given.

5.5.2.3 Data Preparation

a. Data Requirement
Rainfall and potential evapotranspiration are necessary data to run the hydrological models, observed river discharge and water use data are needed to calibrate the model and assess the impact of flow variability and change. In case of precipitation and evaporation at least 30 years daily data was required to run the model for the baseline scenario. Due to lack of observed daily data for precipitation and evaporation or temperature coupled with the fact that the area has low density of gauge stations necessitated use of alternative data sets.
For Precipitation, the Climate Hazards Group Infra-Red Precipitation with Station (CHIRPS[128]) data was used. This precipitation data starts from 1981 to date at spatial resolution of 0.05o and 0.25 o (approximately 5 and 25km over the Equator) and at daily 5 & 10 days and monthly time steps. It incorporates infra-red satellite imagery blended with ground observation (where available) to create the gridded rainfall. This data has been quality controlled before release and is freely available to the public. Using the CHIRPS daily precipitation data, Catchment area average daily rainfall was produced for the period 1981-2010 for the modelled sub catchments.

For Potential Evapotranspiration, Penman-Montieth evapotranspiration from the TerraClimate datasets was used as the input Potential ET. TerraClimate is a dataset of monthly climate and climatic water balance for global terrestrial surfaces produced by the Climatology Lab of the University of California[129]. The Reference PET data has monthly temporal resolution and a ~4-km (1/24th degree) spatial resolution. Catchment area average monthly PET was produced for the period 1981-2010 for the modelled sub catchments in each SCPZs.
For River Discharge, observed streamflow data is necessary for calibrating the hydrological models, thus for the each SCPZ hydrological model, catchment delineation was undertaken at the location of available streamflow data (Table 38).

Table 38. Streamflow level gauges for models' calibration and validation

NO	NAME	River	SCPZ	Country	Catchment Area (km^2)
1	Kolda	Casamance	Casamance	Senegal	3,880.0

[128] Funk, C., Peterson, P., Landsfeld, M., Pedreros, D., Verdin, J., Shukla, S., Michaelsen, J. et al. (2015). The Climate Hazards Infrared Precipitation with Stations—A New Environmental Record for Monitoring Extremes. Scientific Data, 2, Article ID: 150066. https://doi.org/10.1038/sdata.2015.66
[129] Abatzoglou, J.T., S.Z. Dobrowski, S.A. Parks, K.C. Hegewisch, 2018, Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958-2015, Scientific Data

2	Cogon Pont	Cogon	Boke	Guinea	3,577.0
3	Tingulinta	Tingulinta	Boke	Guinea	1,921.5
4	Dailakora	Niger	Kankan	Guinea	70,775.0
5	Nnaboupi	Kara	Kara	Togo	5,454.0

Best fit was assessed based on graphical comparison of daily, monthly and cumulative time series, while considering, correlation co-efficient (R^2), the Nash-Sutcliffe coefficient of efficiency (NSE) and water balance error (WBE) criteria values.

b. Future Climate Data

Climate were based three on representative concentration pathways—RCP8.5, 4.5 and 2.6. The model used for this study is the Rossby Centre regional atmospheric model (RCA4 with a horizontal grid spacing of the simulation is 0.44 degrees (about 50 km). The choice of the RCA model for this analysis was based mainly on the availability of the model outputs for the three different scenarios (RCP 2.6, RCP 4.5, and RCP 8.5), as well as the fact that it is one of the models used in the analysis reported in the FP. There is good agreement between the CHIRPS and the RCA4 in the baseline period. Figure 42 showing an example of the comparison for the Kankan Catchment.

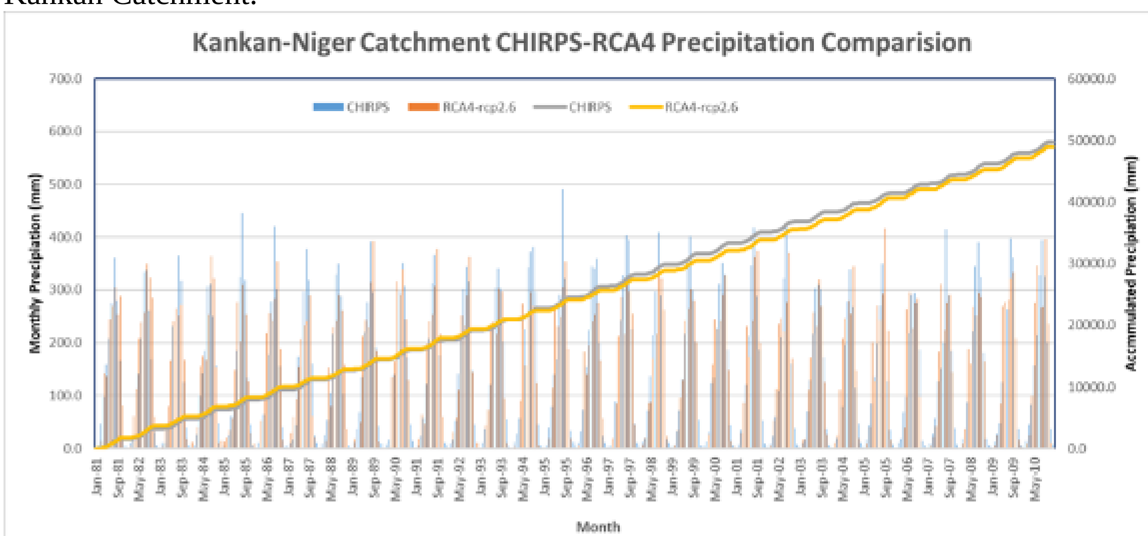


Figure 42. Comparison of CHIRPS and RCA4 precipitation for the baseline period

Senegal-Casamance

The Casamance SCPZ has the Casamance river which drains to the Atlantic and groundwater as the source of water. There exists one river gauging station at Kolda for which data was available. The total Catchment area of the Casamance basin (Figure 44) is 14,347km^2 while the area for the Kolda station is 3880km^2. The mean annual precipitation is 1,013mm and the mean annual PET is 1,772mm (Figure 43 & Figure 45). The precipitation is monomodal and received in the months of June to October while the PET peaks in March to May. The 2011-2040 basin areal precipitation is projected to slightly less than the baseline while the PET will be more than the baseline for all the emission pathways.

Figure 44. Casamance SCPZ Catchment

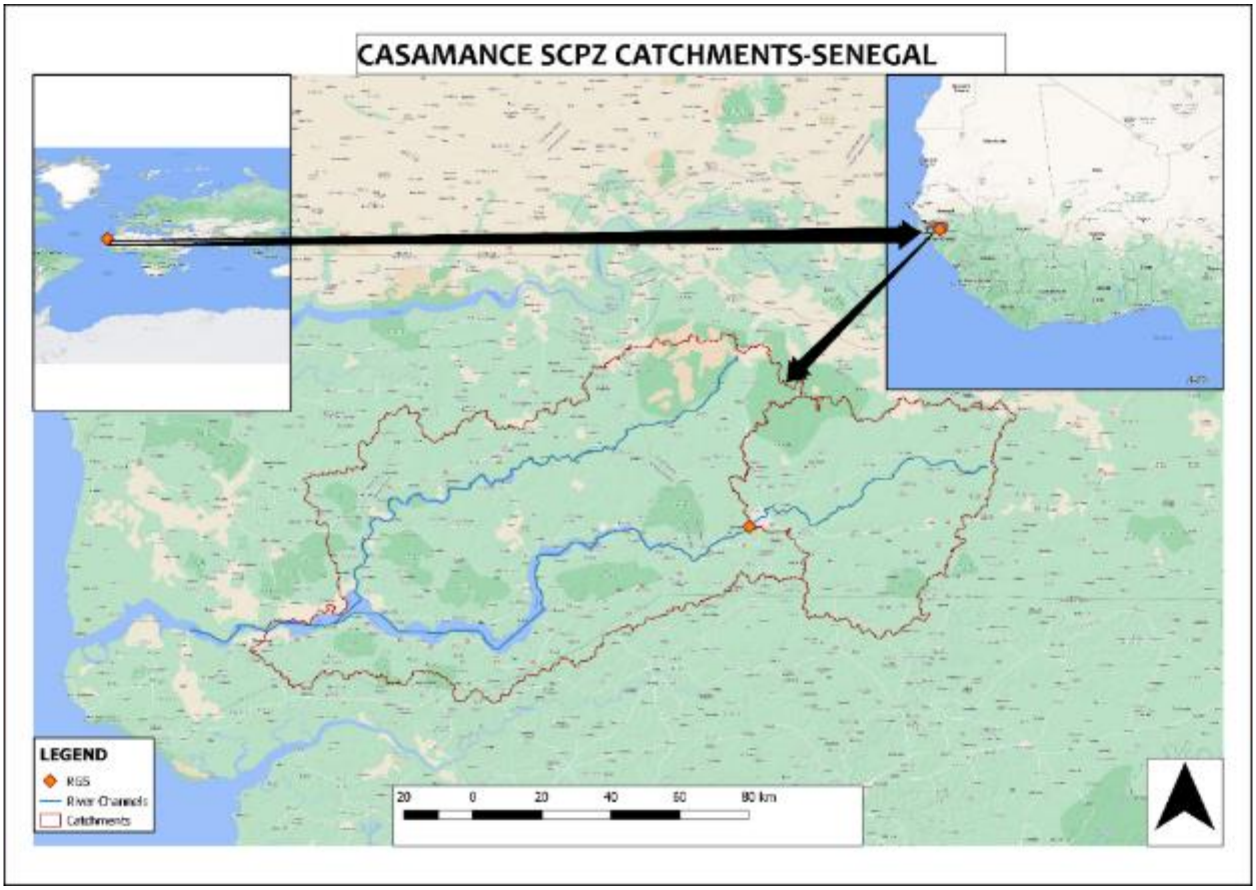


Figure 43. Projected PET Trend Casamance catchments 2011–2040

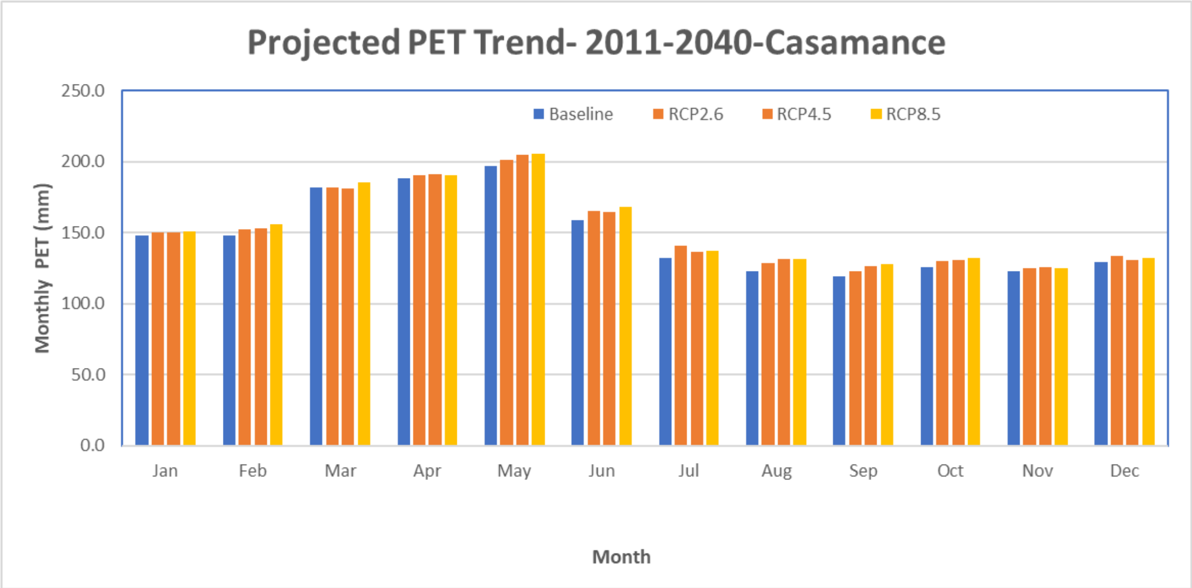
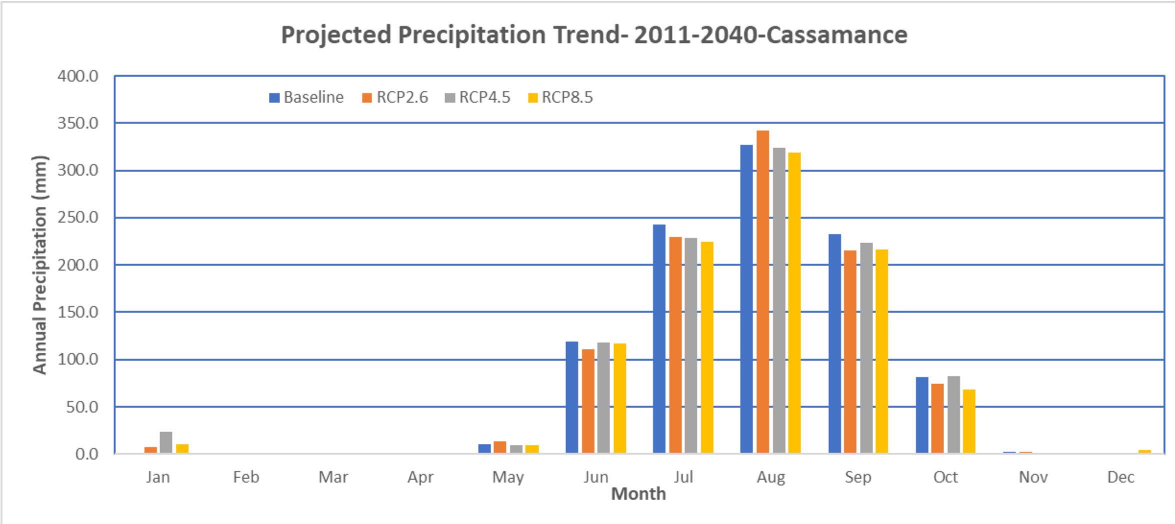


Figure 45. Projected Precipitation Trend Casamance catchments 2011–2040



Guinea- Boke and Kankan

Boke

The Boke SCPZ lies in the west of Guinea and has two main rivers the Cogon and Tingulinta as the main source of water both flowing westward and draining into the Atlantic Ocean (Figure 47). The total catchment area is 13,115km^2 with two river gauging stations, Cogon Pont with a catchment area of 3577km^2 in the Cogon River and Tingulinta station for the Tingulinta river with a catchment area of 1921.5km^2. The baseline period mean areal annual precipitation and PET is 2187mm and 1711.3mm (Figure 46& Figure 48), respectively. The projected climate shows a slightly increasing trend for RCP8.5 for precipitation and as well as increasing PET for all the three emission pathways.

Figure 47. Boke SCPZ Catchments – Guinea

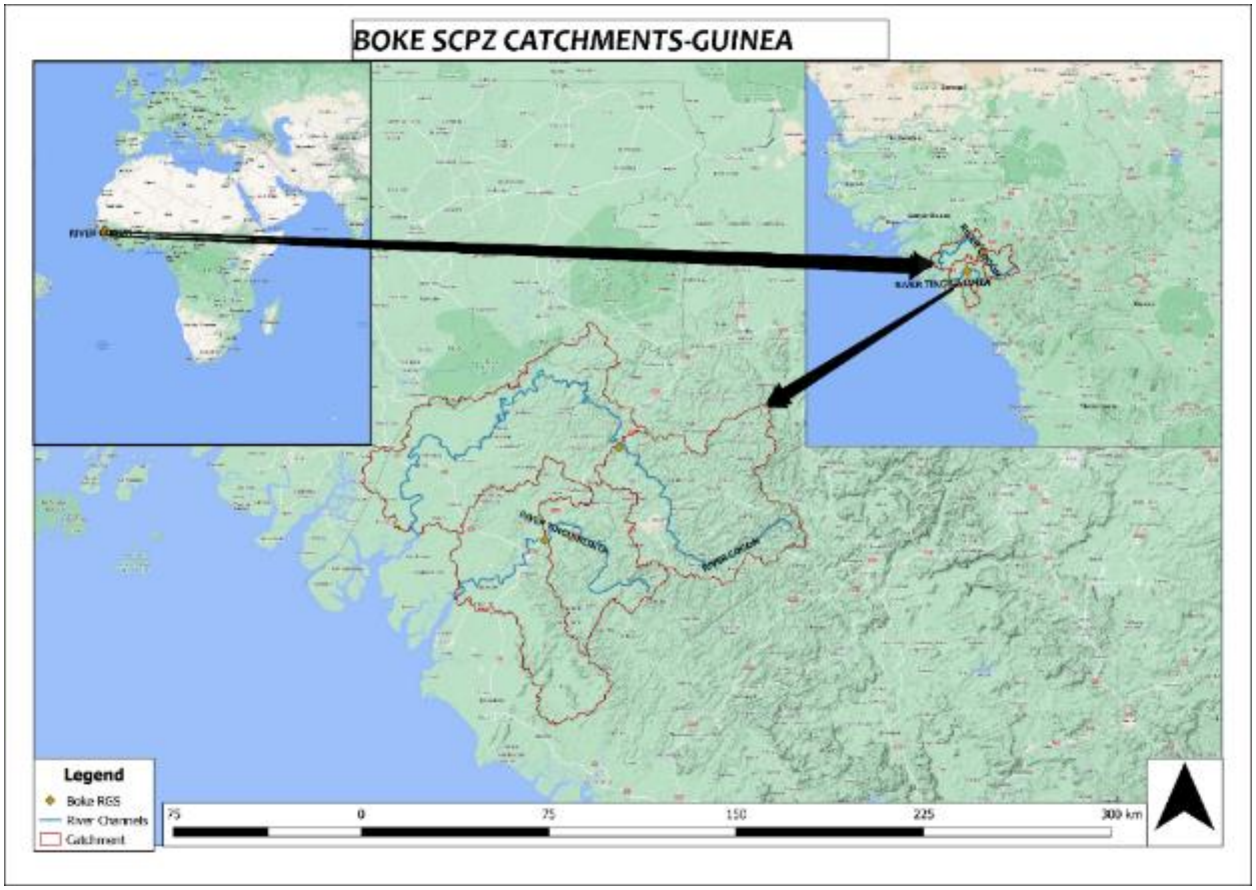


Figure 46. Projected Precipitation Trends for Boke Catchments (2011–2040)

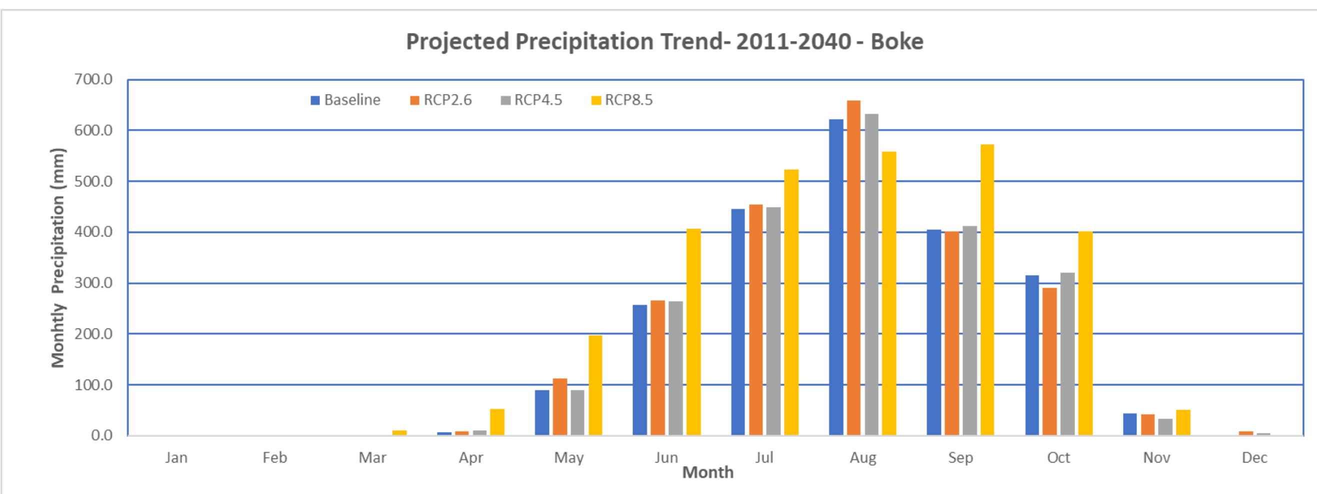
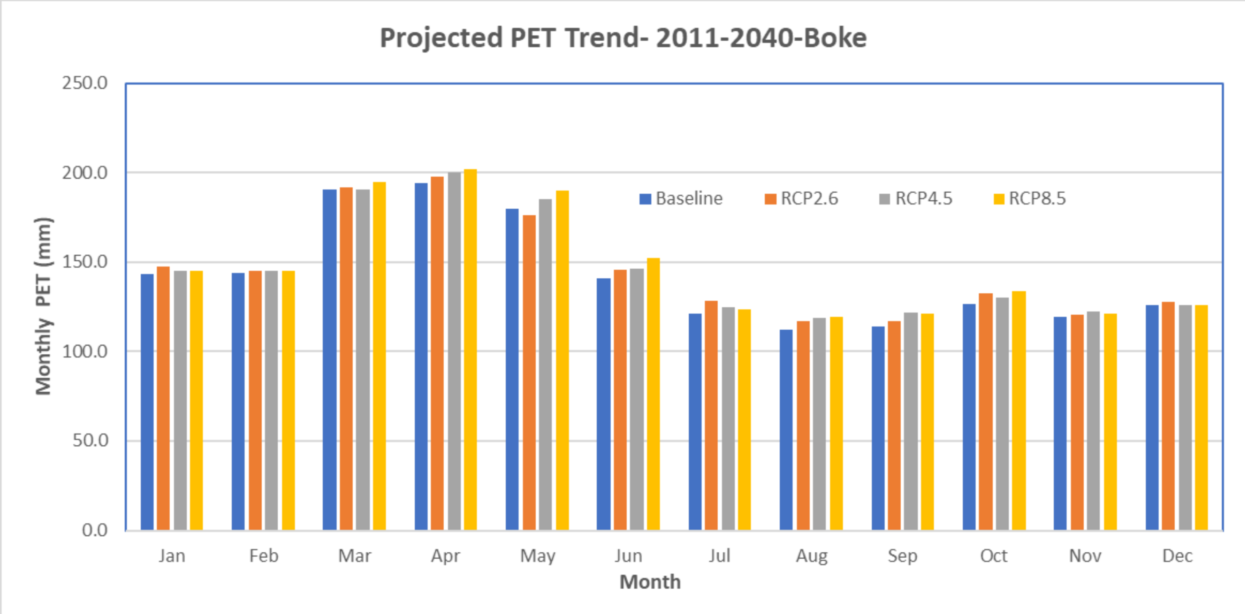


Figure 48. Projected PET Trends for Boke Catchments (2011 –2040)



Kankan

The Kankan SCPZ lies on the east of the Guinea bordering Mali and forms the headwaters of the Niger River basin (Figure 49). The total catchment area of the Niger Basin within Guinea is 70,775km^2 at the Dailakora river gauging station near the border with Mali. The mean annual areal rainfall and PET for the baseline period is 1,664mm and 1,636mm (Figure 50 & Figure 51), respectively. The projection for 2011-2040 period shows a trend of slight increase in precipitation and similar PET compared to the baseline.

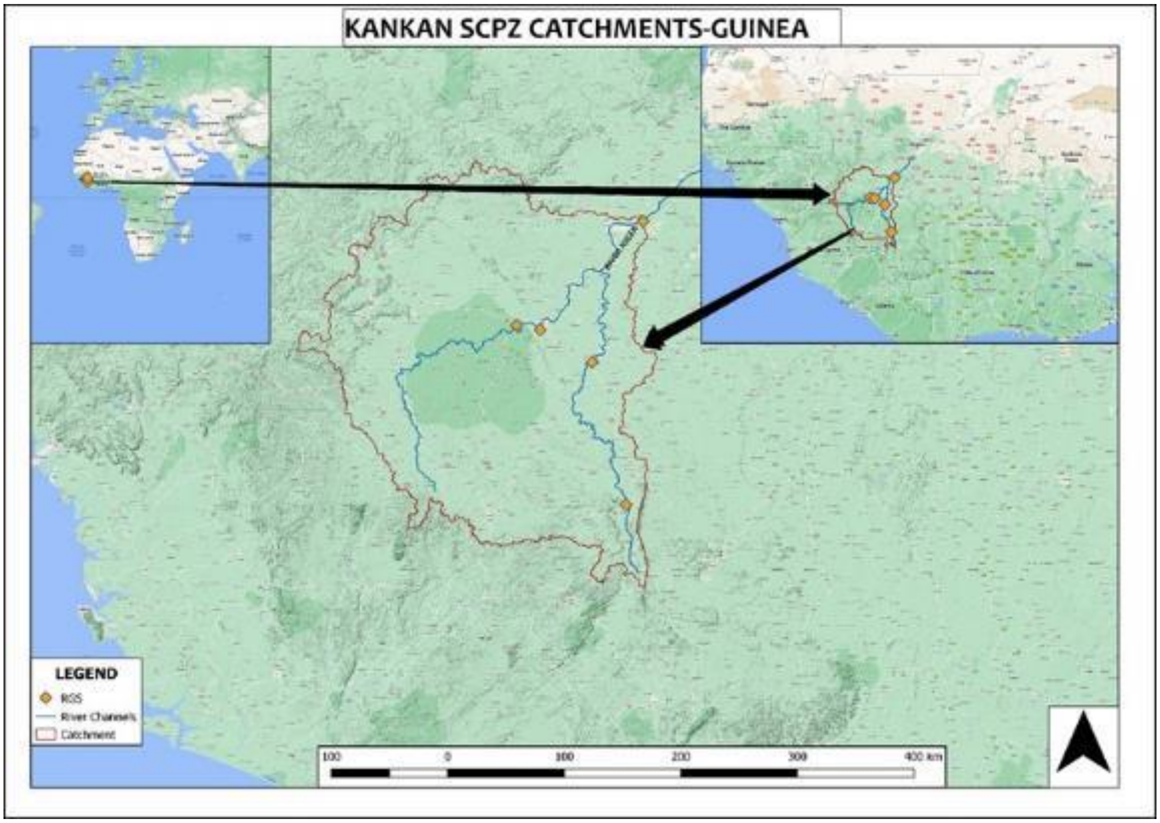


Figure 49. Kankan SCPZ Catchment – Guinea

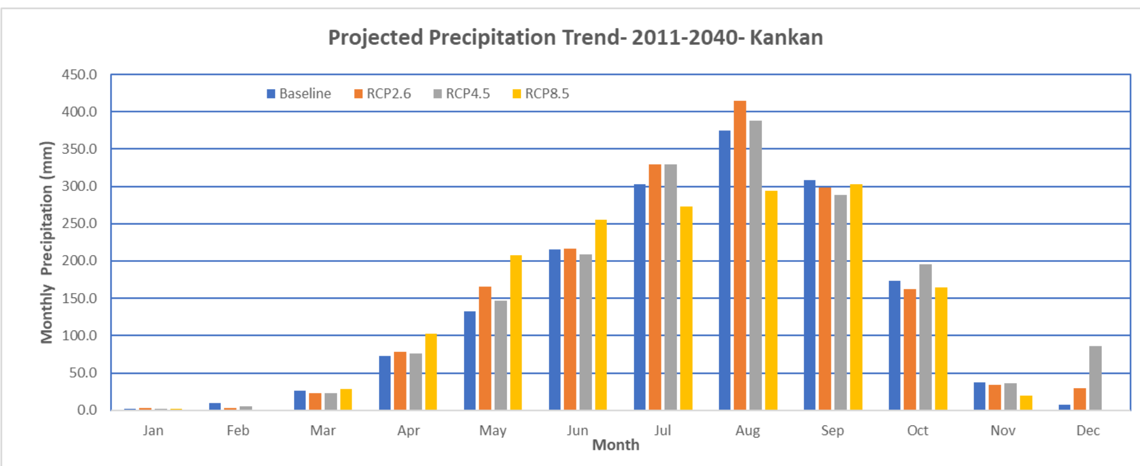


Figure 50. Projected Precipitation Trends for Kankan River Niger Catchment- 2011-2040

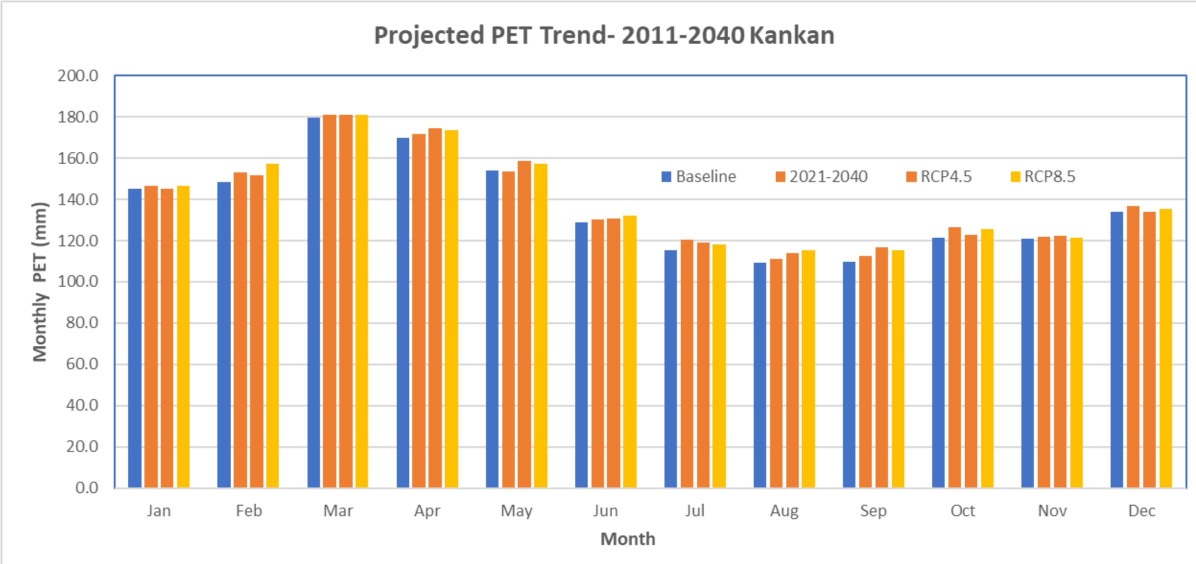


Figure 51. Projected PET Trends for Kankan River Niger Catchment (2011–2040)

Togo - Kara

The Kara River is located in the north of Togo and is a tributary of the Volta River basin and is transboundary between Benin, Togo and Ghana with the major area in Togo (Figure 52). The catchment area at the Nnaboupi river gauging station is 5,454km^2. The mean annual areal precipitation and PET over the basin during the baseline period is 1272mm and 1662mm (Figure 53 & Figure 54), respectively. The trend for the 2011-2040 period shows a reduction in precipitation for two of the three pathway and an increase in one (RCP8.5) and an increase in the PET for all the three pathways compared with the baseline period.

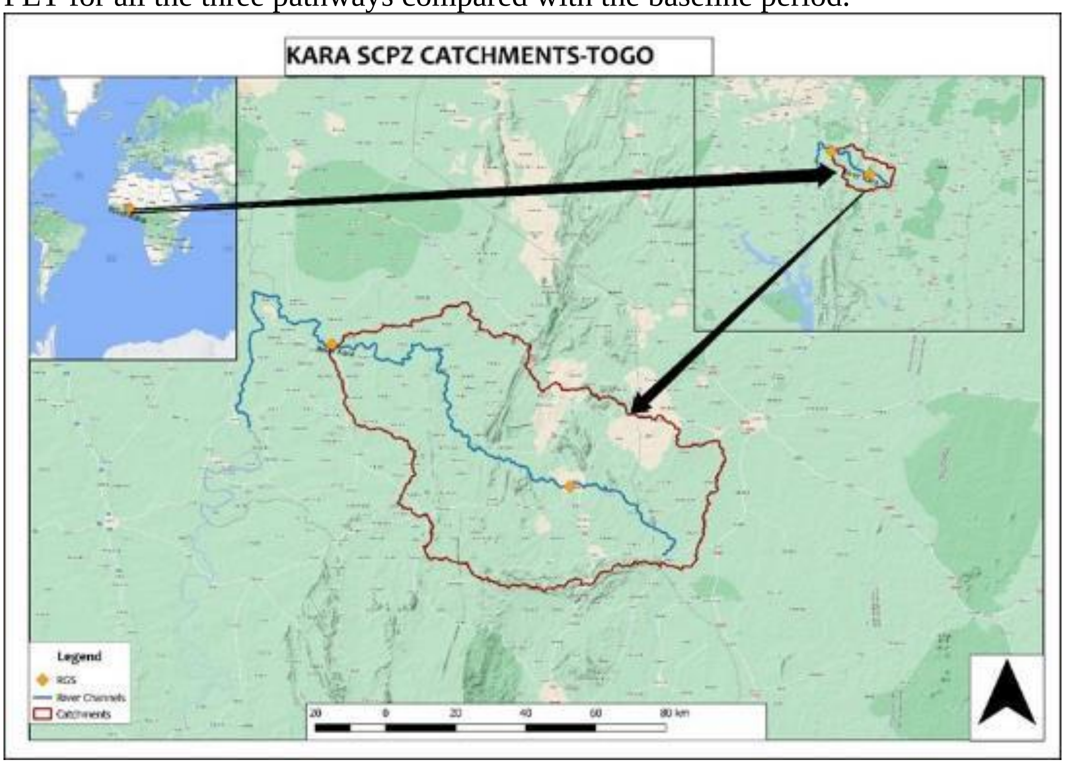


Figure 52. Kara SCPZ Catchment in Togo

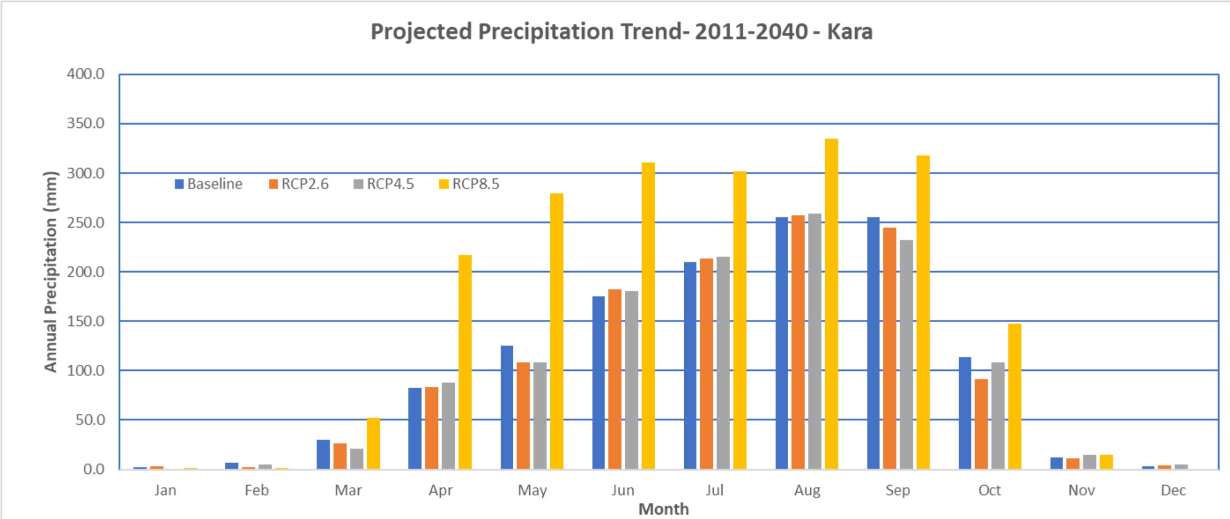


Figure 53. Projected Precipitation Trends for Kara River Catchment (2011–2040)

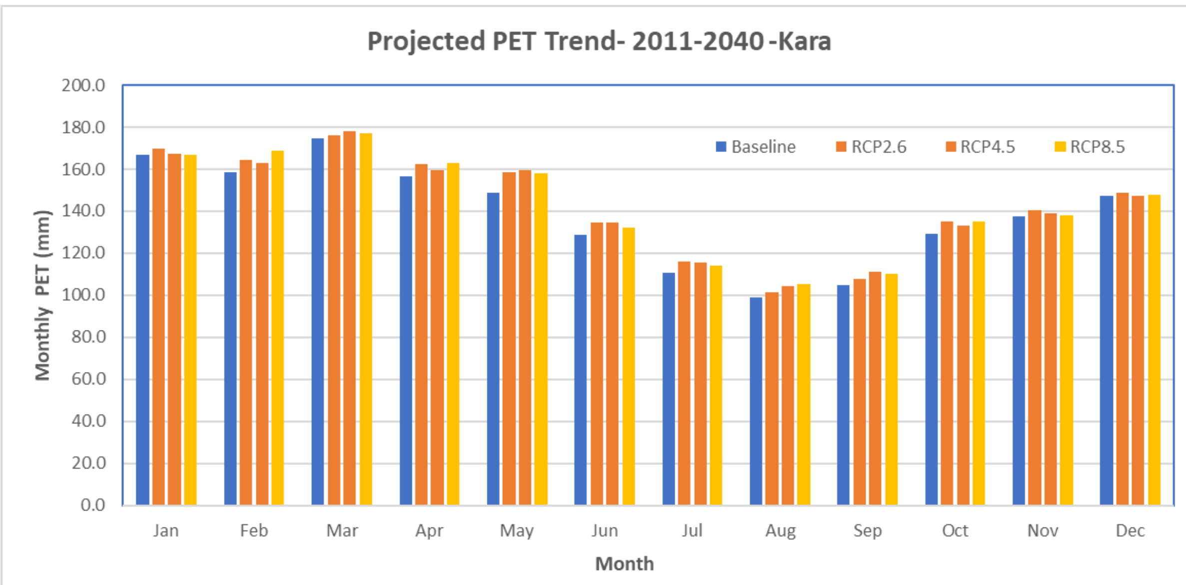


Figure 54. Projected PET Trends for Kara River Catchment (2011-2040)

5.5.2.4 Results and Discussion

a. Model Calibration and Validation Results

Simulated streamflow sequences were calibrated against observed flow records through the iterative adjustment of the NAM model parameters until the best fit between the simulated and observed flow records was within acceptable standards. Based on data continuity the calibration and validation period were selected using a split approach and is shown in Table 39.

Table 39. Calibration and Validation periods for the SCPZs Models

No	River Gauging Station Code	Calibration Period	Validation Period
1	Kolda	01/01/1982-31/07/1994	01/05/1998-31/032004
2	Tingulinta	01/01/1991-31/12/1999	01/01/2000-31/12/2010
3	Cogon-Pont	01/01/1997-31/12/2004	01/01/2005-31/12/2010
4	Dailakora	01/01/2006-30/09/2007	01/10/2007-30/06/2006
5	Nnaboupi	01/01/1982-31/12/1990	01/10/1991-31/12/1999

Calibration criteria performance is shown in Table 40 and examples of calibration plot is shown in Figure 55 to **Error! Reference source not found.**. For most stations good results were obtained, however the NSE for the Kolda station was not good even though the water balance error was acceptable. The model had difficulty predicting well the high flows hence the low NSE values. The simulation results are deemed acceptable considering also that there were several gaps in the data.

Table 40. Calibration and Validation Results

SCPZ	Gauge	Criteria	Daily		Monthly	
			Calibration	Validation	Calibration	Validation
Casamance	Kolda	R^2	0.26	0.24		
		NSE	-0.85	-3.09		
		WBE (%)	7.4	-56.59		
Boke	Tingulinta	R^2	0.68	0.50		
		NSE	0.40	0.38		
		WBE (%)	-51.9	-20.3		
Boke	Cogon-Pont	R^2	0.60	0.47		
		NSE	0.48	0.42		
		WBE (%)	33.4	29.28		
Kankan	Dailakora	R^2	0.86	0.80		
		NSE	0.84	0.52		
		WBE (%)	11.4	-37.90		
Kara	Nnaboupi	R^2	0.36	0.65		
		NSE	0.14	0.61		
		WBE (%)	-49.7	-25.37		

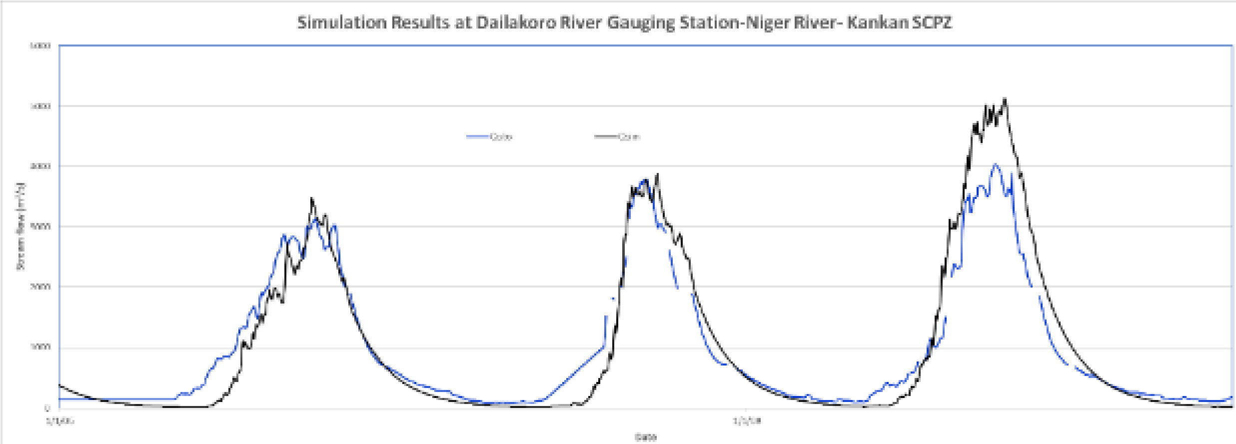


Figure 55. Simulation Results for Dailakoro River Gauging Station for Niger River-Kankan SCPZ

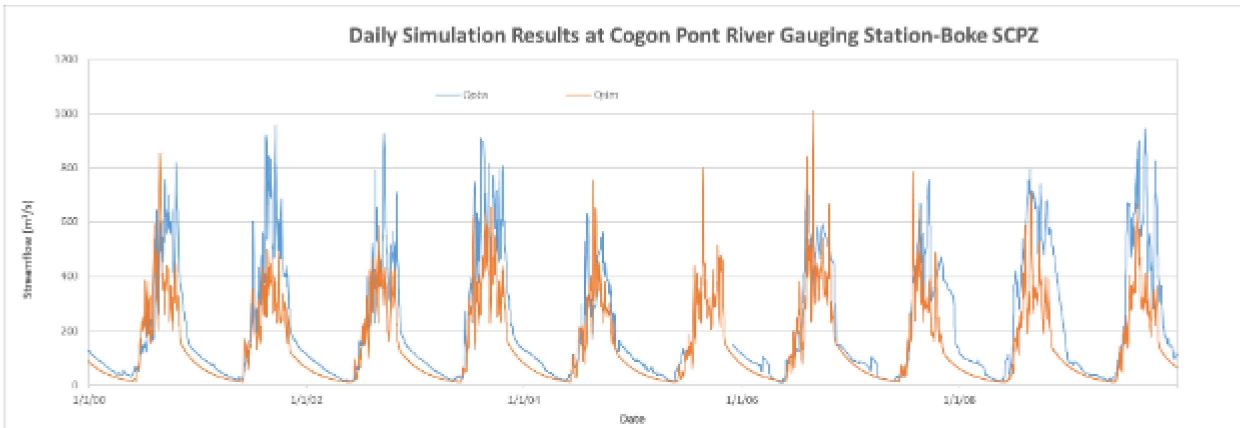


Figure 56. Simulation Results for Cogon Pont River Gauging Station for Cogon River-Boke SCPZ

Baseline and Projected Future Water resources availability

The water resources as predicted by the prepared and calibrated hydrological model and forced with projected climate data. The Surface water (streamflow) and potential groundwater recharge and changes compared to the baseline as predicted by the models are shown in Table 41 and Table 42, Figure 57, Figure 58 and Figure 59 respectively and discussed for each SCPZ hereunder.

Casamance

The results for all the RCPs and future period show a reduction total annual streamflow and groundwater recharge of up to 55% for streamflow and slightly over 68% for groundwater. This is a result of reduced projected precipitation and increased PET. RCP 4.5 and 8.5 for projected climate periods have had the biggest impact on water resources availability in this SCPZ which also has a mono modal rainfall pattern. Seasonally, there is a reduction of streamflow in all the months but more in the peak flow months of June to September.

Boke and Kankan

For Boke, three simulations for total volume of water indicate more surface water resources will be available compared to the baseline, two show slightly less water while the remaining 4 show

no change. For the Kankan region which forms the headwaters of the Niger river, the water resources are projected to be either the same or higher in all the RCPs and periods.
Seasonally in Boke, the RCP 2.6 and 4.5 have similar peak streamflow values but RCP 8.5 shows enhanced flows across all the three periods. In the Kankan, however the RCP 8.5 have enhanced flows during the period May-July but below average flows in the peak rainy season of August to October.
Groundwater recharge increase is less than that of surface water across all RCP scenarios and period but follow the same pattern as the surface (streamflow) pattern.

Kara
Six out of the nine simulation show reduced streamflow discharge in the Kara River, only the RCP 8.5 scenario for the three future period show increased flow. The highest increase is projected for the RCP 8.5 for the period 2071-2100 period. The RCP 8.5 show increased streamflow during the April-June for which the baseline and all the other scenario show to be dry season indicating a shift of season. The RCP 8.5 show enhanced streamflow above the rest of the scenarios from April to November. The groundwater recharge for the Kara River follows the same pattern as the surface water.

Table 41. Surface Water availability in the SCPZs for the baseline and 2011-2040 Period

		Baseline		**rcp2.6**		**rcp4.5**		**rcp8.5**	
SCPZ	**Basin**	**m3/s**	**BCM/yr**	**m3/s**	**BCM/yr**	**m3/s**	**BCM/yr**	**m3/s**	**BCM/yr**
Kankan	Niger	1271	40.1	1396	44.1	1326	41.8	1273	40.2
Boke	Cogon	312	9.8	317	10.0	311	9.8	444	14.0
	Tingulinta	226	7.1	231	7.3	229	7.2	285	9.0
Kara	Kara	54	1.7	48	1.5	47	1.5	152	4.8
Cassamance	Cassamance	21	0.7	13	0.4	12	0.4	13	0.4

Table 42. Potential Groundwater Recharge in the SCPZs for the baseline and 2011–2040 Period

	Baseline	**RCP 2.6**	**RCP 4.5**	**RCP8.5**
	MCM/yr	**MCM/yr**	**MCM/yr**	**MCM/yr**
Kankan	46.177	50.777	48.127	46.103
Boke	47.023	47.233	46.292	53.598
Kara	20.366	18.176	17.786	17.786
Cassamance	3.562	2.216	2.051	2.051

Figure 57. Changes in Mean Stream Flow for Projected Climate Scenarios Compared to the Baseline

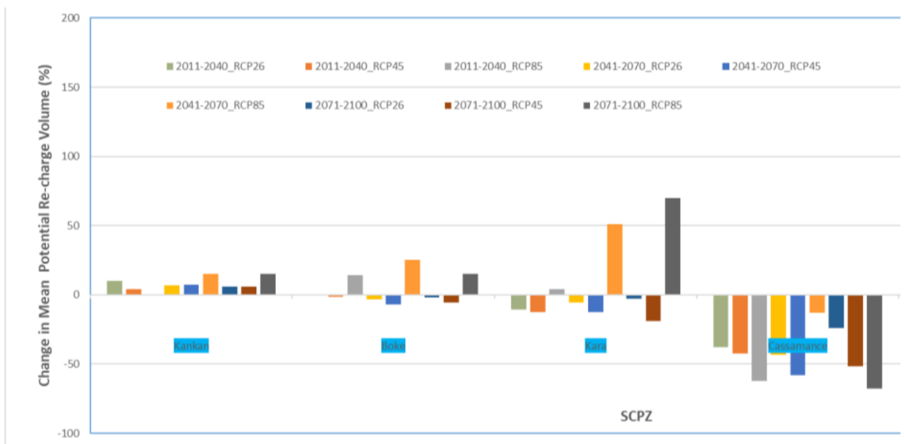


Figure 58. Changes in Potential Groundwater Recharge for Projected Climate Scenarios Compared to the Baseline

Water Demand for baseline and projected Climate

As shown in sections 3.2 to 3.4 the projected climate show and increase in PET irrespective of the trends in projected precipitation in all the SCPZ, which is as a result of increase in projected temperature. When effective rainfall is taken into account the resultant net PET for which crop need water to be supplied also show an increase in all the SCPZs and future periods and RCPs with the exception of RCP 8.5 for Boke and Kara SCPZs (Figure 59).

The increase of net PET means that more water will be necessary to sustain agricultural production against the background of reduced water availability in most SCPZs. In such a situation a few aspects to reduce the impact of this situation is discussed hereafter.

Drought tolerant varieties with less water requirement can withstand drought, this will be ideal for subsistence farming and ensure food security for farmer families. These analyses assume efficient irrigation systems as such it will be important to reduce agricultural water losses through efficient and sustainable technologies such as drip irrigation system. On farm and off farm storage facilities to store flood waters for use during the dry season is also necessary measure to reduce the overall water supply-demand deficit and adapt to the water resources reduction brought about by projected climate change. Overall careful matching of agricultural development with available water resources and its sustainable use is also important.

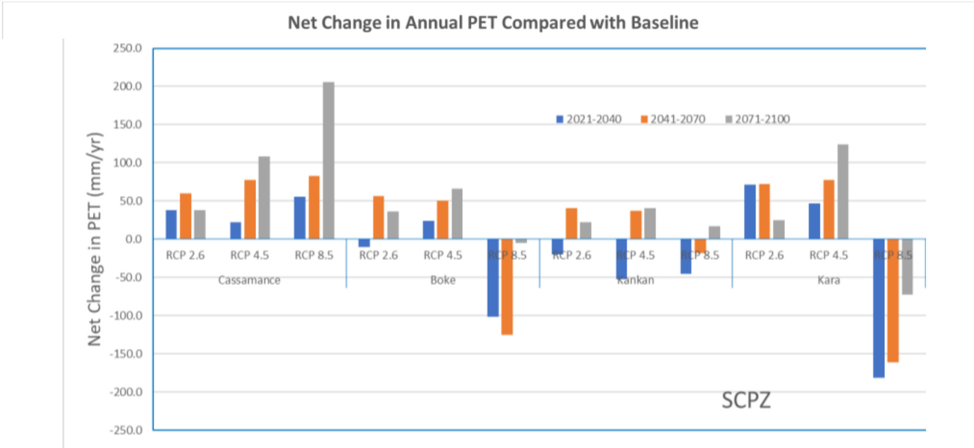


Figure 59. Changes in Net Annual PET Compared to the Baseline

5.5.2.5 Conclusion and Recommendations

a. Conclusion

- Seven basins were delineated in the six SCPZs, rainfall-runoff models setup and calibrated with observed data. Good results of R2, NSE and WBE were obtained for the models.
- Future water availability simulations were done for the three pathways RCP 2.6,4.5 and 8.5 emission scenarios and for three future periods of 2011-2040, 2041-2070 and 2071-2100.
- The water availability included both surface water represented by streamflow and potential groundwater recharge as a measure of groundwater availability.
- All the future projected emissions scenarios and periods or nine out nine simulations for the **Casamance** SCPZ basin indicate a reduction of both surface and groundwater availability.
- Four simulations show near baseline water availability for projected future climate, while three simulations indicate above baseline while two simulations indicate below baseline water availability for the **Boke** SCPZ.
- All the nine simulations for the **Kankan** SCPZ show near baseline or above baseline water availability for both surface and groundwater.
- Six out of the nine simulation show reduced streamflow discharge and potential groundwater recharge in the **Kara** SCPZ, only the RCP 8.5 scenarios for the three future period show increased water availability for both surface and groundwater.
- With the exception of 8.5 for Boke and Kara all the simulation for all SCPZ and future periods indicate an increase of net PET compared with the baseline.

b. Recommendation

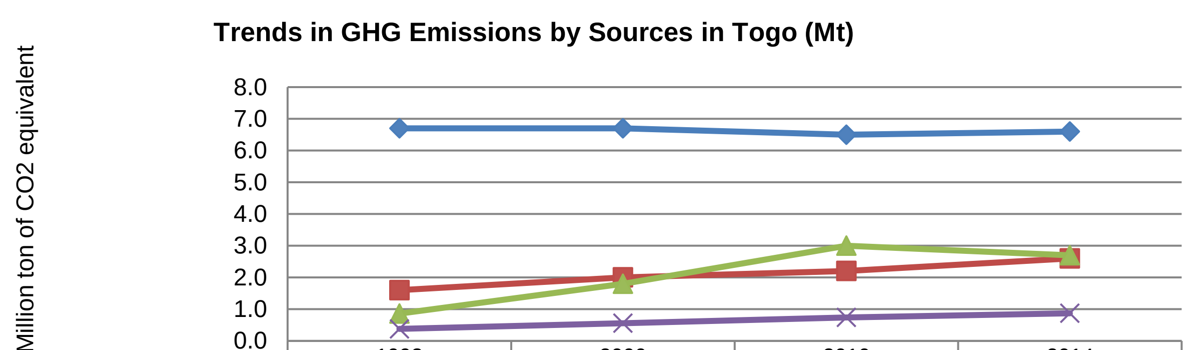
From the analysis on the impact of projected water resources availability in the SCPZ, it is clear that there is likely to more water in most SCPZs accompanied with increased crop water demand due to climate change. This will require actions for sustainable water management, it is therefore recommended to

- Encourage and support on-farm efficient water storage that takes advantage of the rains to meet the farmers off-season water needs. These storage facilities should be covered to reduce increased evaporation losses and seepage.
- Encourage off-farm storage particularly in water tight SCPZs of Casamance and Kara
- Encourage crops with less water requirement and are drought tolerant in order to reduce the overall water demand and reduce risk of crop failure in case of severe drought.
- Carry out catchment management including re-afforestation to improve low flows and reduce sediment flows. This will reduce the maintenance cost associated with removing sediments from storage facilities and ensure that these facilities take maximum advantage of the runoff.
- Enhance the capacity of the small-scale farmers to take advantage of the rains and only irrigate when needed.
- Equip monitoring boreholes in the SCPZ where groundwater utilization will be undertaken for long term monitoring of groundwater to check against over abstraction.
- Enhance the capacity of local water resources management and agricultural development institutions to carry out sustainable water management including sustainable irrigation development and demand management activities.

5.6 Agriculture and Greenhouse Gas (GHG) Emissions

(1) Togo

As at 2014, Togo's total GHG emissions stood at 13.7 $MtCO_2e$ and largely driven by emissions from LUCF (6.6 $MtCO_2e$), followed by energy (2.68 $MtCO_2e$), agriculture (2.6 $MtCO_2e$), waste (0.8 $MtCO_2e$) and Bunker Fuels (0.30 $MtCO_2e$) as shown in Figure 60. As observed in the figure, the LUCF sector is the leading source of CO_2 emissions in Togo, emitting an average of 6.93 $MtCO_2e$ per year from 1990 to 2014. This represents 58% of Togo's total greenhouse gas emissions over the same period and largely attributed to biomass loss for energy consumption and shifting agriculture[130]. According to FAO, in 2000, Togo had approximately 600kha of tree cover that extended over 11% of its land area. However, by 2018, Togo had lost over 50.7kha of tree cover, equivalent to a 9.1% decrease since 2000, and 10.4Mt of CO_2 emissions (575kt per year)[131]. Approximately 80% of households in Togo use charcoal and firewood for cooking, which comes from the forest. It is estimated that at least 15,000 hectares of forest are cleared annually, which leads to forest degradation and deforestation, with resulting loss in carbon sinks. Thus, under a business-as-usual scenario, the carbon footprint of the agricultural and LUCF sectors are expected to increase, as Togo continues to pursue agricultural production increases (6% growth), and value addition through land use changes.



	1993	2000	2010	2014
LUCF	6.7	6.7	6.5	6.6
Agriculture	1.6	2.0	2.2	2.6
Energy	0.86	1.8	3.0	2.7
Waste	0.38	0.56	0.74	0.87

Figure 60. Trending Profile of GHG Emissions by Sources in Togo (Mt)

Thanks to measures already in progress, Togo will unconditionally reduce its emissions by 11.14% compared to the baseline scenario in 2030. Togo undertakes to back its adaptation capacity-building strategy and its development imperatives against a carbon-lean growth trajectory that will translate into a conditional reduction of its GHG emissions by 31.4% by 2030. The key sectors for mitigation and enhanced removals are energy, agriculture, and land use, land-use change and forestry (LULUCF). As reported in Togo's INDC, the total cost of mitigation and enhanced removals from these three keys sectors is estimated at over US$1.1

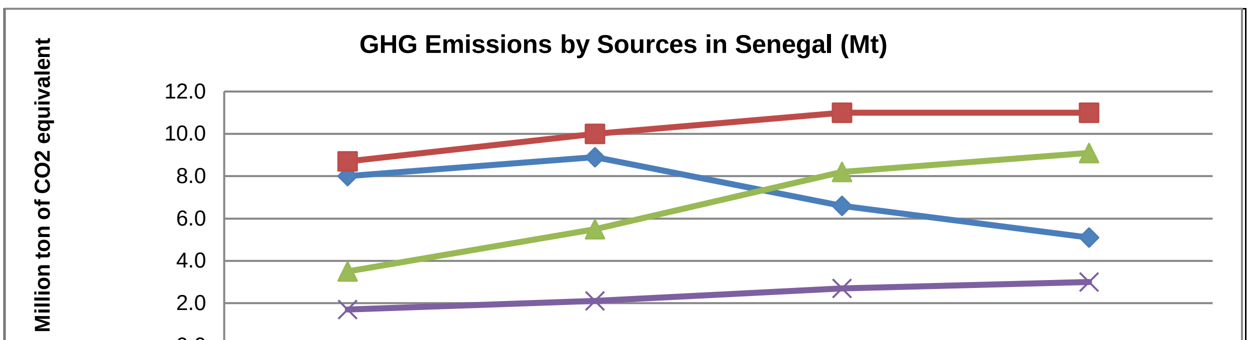
[130]CAIT Climate Data Explorer. World Resources Institution
[131] Global Forest Watch.

billion. Also, gases covered in Togo´s INDC mitigation contribution include Carbon Dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O).

Togo's Agropoles Strategic Development Plan (ASDP) of 2017-2030' is critical to achieving part of the country's adaptation and mitigation targets identified in the areas of LUCF, agriculture, and energy. Specifically, the Kara SCPZ project will promote the use of climate resilient agricultural practices, enhance the use of good agroforestry on cultivated land, support renewable energy generation from biomass, plus solar that can promote the roll-out of energy-efficient stoves, which can yield 50-60% savings in wood and charcoal consumptions among others. However, without critical support fom the GCF, this may be impossible to achieve under the current baseline programme.

(2) Senegal

Senegal is now being classified as one of the top emitters of GHG in West Africa. Between 1990 and 2014, total GHG emissions grew by over 43%, and largely dominated by emissions from the agricultural sector (36%) and energy (27%), followed by emissions from land-use change and forestry (LUCF) (22%), waste (9%), and industrial processes (7%) as depicted in Figure 61. As observed in Figure 61, while emissions from the agricultural and energy sectors increased steadily upwards during this period, the emissions trajectory for LUCF followed a declining trend. This is not surprising as the LUCF sector in Senegal is becoming more of a net carbon sink rather than a source of emissions. For example, just in 2005 along, the GHG inventory for Senegal reveals that the LUCF sector absorbed over 11.4 $MtCO_2e$ compared to 7.2 $MtCO_2e$ emitted by activities in the LUCF sector that same year[132]. Thereafter, the trend has continued with the LUCF sector playing the role of a net carbon rather than a source emitter



	1993	2000	2010	2014
LUCF	8.0	8.9	6.6	5.1
Agriculture	8.7	10.0	11.0	11.0
Energy	3.5	5.5	8.2	9.1
Waste	1.7	2.1	2.7	3.0

Figure 61. Trending Profile of GHG Emissions by Sources in Senegal (Mt)

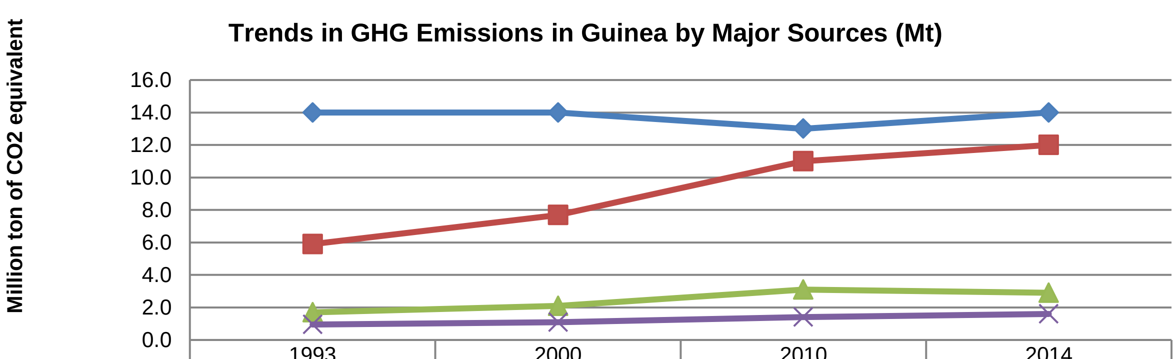
However, contrastingly, GHG emissions from the agricultural and energy sectors grew steadily upward during the same period. In the agricultural sector for example, the growth of GHG emissions have been largely attributed to enteric fermentation (4.0 $MtCO_2e$), burning savannah (3.9 $MtCO_2e$), manure left on pasture (2.8 $MtCO_2e$), and others (0.5 $MtCO_2e$) as a result of extensive livestock farming to support more than 30% of the population and the clearing of savannah areas more favourable to rain-fed agriculture. In the energy sector, charcoal and firewood consumptions as well as illegal logging are the main drivers of increasing GHG

[132] USAID 2016. Greenhouse Gas Emissions in Senegal. USAID, December, 2016.

emissions from the sector. According to Senegal's Third National Communication (TNC) to the UNFCCC, 2016, over 55.5% of households in Senegal use fuel wood for cooking and 11% use charcoal. The report further states that in 2013 alone, households consumed over 1,735,219 tons of fuel wood and 482,248 tons of charcoal, equivalent to a total harvest of 3,778,326 m3 of forest wood resources. From 2001 to 2018, Senegal lost close to 3.43kha of tree cover, equivalent to a8.7% decrease since 2000, and 670kt of CO_2 emissions. Also, about 15% of all tree cover loss occurred in areas where the dominant drivers of loss resulted in deforestation and degradation. In view of the above, Senegal through its INDC submission in September 2016, has agreed to unconditionally reduced GHG emissions by 3%, 4% and 5% respectively in 2020, 2025, and 2030, compared to the BAU emissions in those years. This is through mitigation actions in the energy, agriculture, forestry and other land use, industry, and waste sectors. Gases covered in the mitigation contribution include Carbon Dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O). The Special Agro-Industrial Transformation Area Project (PZTA) in the Southern Region of Senegal is one of the 27 flagship projects under the Emerging Senegal Plan (PES) designed to support these efforts. Specifically, the PZTA project will promote the use of climate resilient agricultural practices, promote the use of good agroforestry on cultivated land to support land restoration and management, reduce emissions from waste through the installation of Biodigester at the farm household level, promote renewable energy generation from biomass, plus solar PV that can promote the roll-out of energy-efficient stoves, which can yield 50-60% savings in wood and charcoal consumptions in Senegal. However, without GCF support, this may also be impossible under the current programme.

(3) Guinea

Like Senegal, Guinea is also classified as one of the top emitters of GHG in West Africa. Between 1990 and 2014, total GHG emissions grew by 40%, and mainly associated with activities from the land-use change and forestry (LUCF) sector, which accounted for 46.9% of total GHG emissions. This is closely followed by the agricultural sector that emitted 37.4% of total GHG emissions, energy (9.5%), and finally emissions from waste and industrial processes that together accounted for less than 6.1% of total emissions. The trending profile for these GHG emissions sources are presented in Figure 62.



	1993	2000	2010	2014
LUCF	14.0	14.0	13.0	14.0
Agriculture	5.9	7.7	11.0	12.0
Energy	1.7	2.1	3.1	2.9
Waste	1.0	1.1	1.4	1.6

Figure 62. Trending Profile of GHG Emissions by Sources in Guinea (Mt)

As observed in Figure 80, the LUCF sector is clearly the leading source of CO_2 emissions in Guinea, emitting an average of 14.7tCO_2e per year from 1990 to 2014. This represents 54% of Guinea's total GHG emissions over the same period. This is largely attributed to emissions from forest land (12.44MtCO_2e), followed by biomass burning (1.2 MtCO_2e), and cropland ((0.8 MtCO_2e). According to FAO, as of 2000, 33% of Guinea was tree cover. However, just 18 years later, the country lost over 16% of tree cover, resulting to a total release of 306 MtCO_2e (17.0Mt per year) into the atmosphere[133]. This suggests an annual deforestation rate of 0.54%, higher than the Western and Central Africa average of 0.46%. Deforestation in Guinea is mainly driven by agricultural expansion, population growth, fuel wood harvesting, slash-and burn agricultural practices, uncontrolled logging, mining, and other human activities, with far reaching implications for GHG sequestration[134]. According to the FAO, almost 80% of the energy used in the country is provided by biomass, resulting in the disappearance of almost 37,000 ha of forests per year. Guinea's dense tropical forest has declined sharply (from 14 million ha in 1967 to 700,000 in 2002).

Next to the LUCF sector is GHG emissions from agricultural activities that increased by over 117% from 1990 to 2014. This is 100% higher than the increased in GHG emissions from LUCF sector during same period (1%). This has been attributed to enteric fermentation (3.9MtCO_2e), rice cultivation (3.5MtCO_2e), manure left on pasture (3.3MtCO_2e), burning Savannah (0.6MtCO_2e), and other types of agriculture (0.6MtCO_2e). This is not surprising as rice represents the largest share of agricultural production in Guinea. Rice farming is associated with methane, a potent greenhouse gas emitted from flooded rice fields as bacteria in the waterlogged soil produce it in large quantities. Scientists at the US-based advocacy group the Environmental Defence Fund have suggested that about 2.5% of human-induced climate warming can be attributed to rice farming[135]. The same can be said about livestock farming where about 30% of Guinean derives their income from. Due to the growth and size in the livestock population, a lot of methane is also being emitted as a by-product during decomposition and fermentation of food in the digestive systems of livestock.
In view of the above, the Guinean Government through its NDC submission in September 2016 has pledged to undertake drastic GHG mitigation actions. These include: 1) to produce 30% of its energy (excluding wood-energy) from renewable energy sources leading to 34MtCO_2e GHG reduction BY 2030; 2) to support the dissemination of technologies and practices that are energy-efficient such as biomass and solar PV that can promote the roll-out of energy-efficient stoves, which can yield 50-60% savings in wood and charcoal consumptions; and 3) to enhance sustainable forest management among others. Condition upon receipt of international support, the implementation of these mitigations actions in Guinea would result in reducing GHG emissions by approximately 13% compared to BAU scenario by 2030. That is, excluding the storage capacity from LUCF.

The Special Agro-Industrial Processing Zones Development Programme (PDZTA-BK) targets a 6% growth rate of agricultural value added while reducing GHG emissions from the agricultural and LUCF sectors. With GCF support, it will specifically contribute in producing additional

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[133] Global Forest Watch, Guinea.
[134] USAID 2018. Greenhouse Emissions in Guinea, USAID, November, 2018.
[135] https://www.independent.co.uk/environment/rice-farming-climate-change-global-warming-india-nitrous-oxide-methane-a8531401.html.

renewable production from installed biodigester and Solar PV, support the dissemination and uptake of climate resilient agricultural practices and technologies, and help in the sustainable management of forest resources and land restoration.

6. FIELD & MARKET STUDY FOR AN ESCO SOLUTION IN THE SCPZs

6.1. Stakeholders Engagements

In order to address the comments raised by iTAP, a mission to Senegal, Guinea, and Togo, from 13 to 28 March 2022 was undertaken. The objective of the mission is to collect more detailed climate and hydrological data to improve resilience aspects in the Funding Proposal (FP) submitted to the GCF. The African Development Bank (AfDB) has been working closely with the Governments of the three countries to prepare a funding proposal to seek additional financing to introduce mitigation and adaptation measures within the SCPZ Projects and their beneficiaries including smallholder farmers and cooperatives

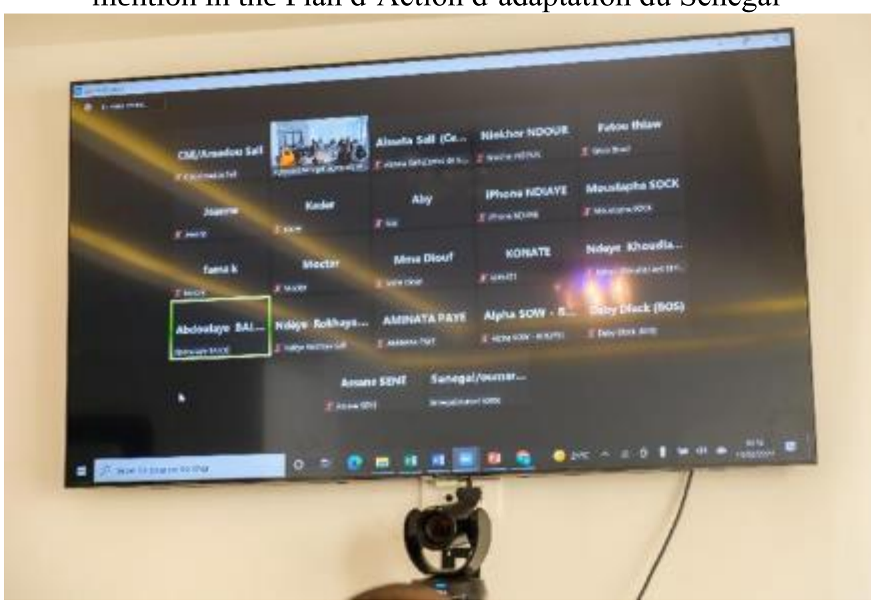
The summary of the mission outcomes per country is as follows:

Senegal: The mission Team worked in Senegal from 14 to 16 March. Work sessions (virtually and plenary) were organized in Dakar with national authorities, technical Institutions, Agro-Hydro and Met services. The mission travelled to Ziguinchor in Casamance to meet regional authorities, famers organizations, Civil Society Organizations, NGOs, SMSs, ESCOs and visited the site of the ADEANE Agro-Park one of the most important infrastructures of the South Agro-Industrial Processing Zone Project (PZTA-Sud).

The PZTA-Sud aims to contribute to the transformation of the agro-industrial sector, with a view to inclusive agricultural growth, reducing poverty and food imports and generating employment. The total cost (net of taxes) is approximately EUR 87.75 million, broken down as follows: (i) ADB loan: EUR 43.1 million; (ii) IsDB loan: EUR 27.85 million, and (iii) the State: EUR 16.8 million. The project comprises 3 components: (a) Support for the establishment of a business ecosystem conducive to private investment in agribusiness; (b) Sustainable improvement of the capacity of agro-industrial producers; (c) Coordination, management and monitoring/evaluation.

The main points;

- With the upcoming setting up of the agro industrial park, the local communities are looking forward to a boost in socio-economic activities. There are however key climate issues including shortage of water due to prolonged dry season that needs to be addressed to boost production in the South Agropole and to enable more households to have access to green and reliable sources of electricity.
- There is high-level ownership for the project at the MDIPMI and PIU/Agropoles and all stakeholders are very keen on securing additional funding from the GCF. The coordinator is the key focal point for the provision of information.
- The high price of electricity is a deterrent for farming communities to sustainably expand their activities.
- A summary of the other complementary projects currently being undertaken in the agro processing zone has been requested for better aid coordination

Day and date	Activity	Highlights
Monday 14 March	Mission Day 1 in Senegal	**Morning:** **Inception meeting with stakeholders at the Cellule d'Execution Bureau du Project Agropoles – Chaired by National Coordinator Dlily Lo:** Key stakeholders present (online and remotely): NDA, Minstere de L'entreprise, Economie, Senelec, ASER, ANER, representatives from Agropoles, Centre d'etudes Ecologiques, etc. Key discussion points: • There is strong political will to successfully complete the project as the development of the agropoles is a governmental priority • High energy cost is a key concern for farming communities in Senegal • There is a strong will from agricultural communities to produce their own electricity • The sale of electricity is regulated (new regulations being developed to encourage competitive distributed production and generation) • Senelec and Azer operate electrical networks in the south and energy production is about 20% RE (including off grid) • There exists a conducive fiscal environment to encourage investment in RE • Increased soil salinity is also a factor worsened by CC • There is a EWS in place in South Agropole but which can benefit from more met stations • There is a need for support to collect rainwater which is mention in the Plan d'Action d'adaptation du Senegal 

Tuesday 15 March	Mission Day 2 in Senegal	**Morning:** **Site Visit to in Naguisse** Meeting with Sous Prefet of the Prefecture de Naguisse. Key points: • Local communities are very keen on sustainable development of Agropoles. • There is a need to sensitize youth on the opportunities for employment associated with greening of agropoles. • The local government will provide all necessary support to the execution of the project Meeting with deputy mayor, village chief (representing 30+ families), villagers, and employees of Agropole sud at Banganga (site of the centralised agro processing zone). Key points: • Farming communities are looking forward for the setting up of the processing facility for their crops and cattle. Main produce are mangoes, maize, and nuts • Not all farmers are connected to the SENELEC- in some places the electrical network does not reach. The use of PV Moon and Baobab 220 W kits that can connect lamps and low load equipment. The kit costs CFA300k and is repaid over a few years • Villagers have access to meteorological data. For CFA1000 per year, they get weekly sms on weather conditions and alerts • It has been noted that weather patterns have shifted and with it they are facing more threats from pests • None of the villagers had a biogas kit. Vegetable waste are partly for compost and are partly nit used and allowed to decomposed. Animal waste is used as fertilizers. Farmers will prefer a domestic kit which can provide them with their electricity • The average electrical bill for a household is CFA 3000 -4500 • None of the farmers had a drip irrigation system and only one solar pump was available and is sometime clogged with mud. They struggle for water in the dry season and other wells are operated manually

		 **Afternoon:** Meeting with the community representatives of the south agropoles, with the University of Zinguichor, Deputy Mayor, ANACIM representative of the south, representatives of the women group, Agro ecologique, etc. Key points: • Community is keen on the implementation of sustainable agro processing activities. However, communities are concerned with the high electricity cost and the lack of water during dry season. Some farmers have also been disconnected from the grid because of incapacity to pay their power bills • Recently new starters in agro business have taken a long time to break even in their investments because of the various constraints including CC • The lack of water can sometime lead to conflicts between cattle owners and planters and cattle will tend to graze in plantations when there is lack of fodder • Women play a critical role in the agro- processing chain and it is very much a family undertaking. However, there is a need to focus on awareness and training on women to help them better understand new agro processing techniques as well as green technologies. Women have strong entrepreneurial skills and can be effective champions of the new measures/ systems to be put in place • They're very few planters throughout the agropole having access to DIDS – the cost is prohibitive, and rodents and bird damage the infrastructure • The University of Ziguinchor fully endorse the project and will provide all necessary support in its implementation (data collection, sharing, capacity building, etc.)

		• Solar solutions for lighting and pumping are highly sought after. Solar pumps should however be designed to be able to provide power for irrigation at night. Quality of some solar panels have also been sub standards; • It is estimated that less than 1 % of all the farmer and farmer groups have drip irrigation system in place in their premisses • Some 4 families have benefitted from biogas kits (20L) under certain conditions under the Programme National de Biogas. However, project was not extended further and of the 4 biodigesters provided in the community, only 1 is operational. Picking up cow dung is an issue as it is time consuming if area to be covered is large • Other issues mentioned for the biodigesters include financing constraints, issues with construction and sizing of the biodigesters. The University has also done extensive research on bio digestion. • It is estimated that 2.5% of the livestock headcount can be used for bio digestion • It was mentioned that in case community based biodigesters are set up, a model is to be developed to ensure that farmers proving organic material for the bio digesters are compensated • As per SOCAAS (Societe cooperative des acteurs de l'Agropole Sud) there are private companies willing to invest in RE systems to supply agricultural communities • There is a need for capacity building on have to better use biomass • USAID funded the establishment of an early warning system in the region- farmers have access to climate data throughout the year for CFA 1000. However, the coverage is not 100%. the development of an audio based EWS mechanism in French and Wolof is being developed • The occurrences of forest fires are not covered in the EWS. The EWS can also be used as medium for educating population on CC. there is a need to increase collaboration between ANACIM and University of Ziguinchor • The sharing of the climate date is subject to a fee as it is regulated by a presidential decree. Discussion will be held by the Senegalese stakeholders to see how this can be waived as it will benefit the country • A survey for the willingness to pay for the ESCO services will be circulated to the farmers and some 40-50 replies are expected by 26 March

		
Wednesday 16 March	Mission Day 3 in Senegal	**Morning:** **Wrap up meeting with stakeholders at the Cellule d'Execution Bureau du Project Agropoles – Chaired by National coordinator Dlily Lo:** • The NDA reiterated their strong support for the project. • The way forward for the climate data will be discussed at govt level. It was pointed out that project will support ANACIM through project activities • The information for the water levels, mapping of wells and evaporation rate etc will be provided by the direction générale gestion et la planification ressources en Eau (DGPRE) • SENELEC has been providing better power quality in the southern region and will provide necessary information on the electrical network and its reach in south agrople • Agence Sénégalaise d'Electrification Rurale (ASER) has some network coverage in the south • The need to carefully consider the regulatory aspect of integrating private power producers on the grid or off grid should be assessed • The gender disaggregation of data for some sectors is available • The need for DIDS has again be reiterated and is cross cutting for the use of biogas. DIDS will allow efficient use of water in the dry season and will allow growing of fodder for cattle which in turn will result in increased organic matter for bio digesters • As per the Agence Natioal d'Energioe Renouvebales (ASER), the national biogas programme established by government is working with the private sector for the development of a bio

		digesting kit. Recent experiments indicate that small portable kits are preferred

Guinea: The mission worked in Guinea from 17 to 20 March. Work sessions have been organized in Conakry with national authorities, technical Institutions, Agro-Hydro-Met services. The Team travelled to BOKE to meet regional authorities, farmers organizations, SMSs, ESCOs and to visit the site of the Agro-Park, one of the major infrastructures of the Boké and Kankan Special Agro-Industrial Processing Zones Development Programme (PDZSTA-BK). The PDZSTA-BK is the first phase of a programme to develop ten (10) Agro-Parks. Its goal is to contribute to the reduction of food imports and improve Guinea's food and nutrition security by establishing private sector-driven agro-industrial development hubs. The programme will be implemented through the following three (3) components: (i) Establishment of governance in the Special Agro-Industrial Processing Zones (APZ); (ii) Development of processing and access infrastructure; and (iii) Programme coordination and management.
In summary;

- Very little progress has been made on the setting up of the agro processing parks in Kankan and Boke with administrative delays noted. However, the team at ADAZZ, Project PIU and the AfDB are committed to ensure that no further delays are encountered as communities in Boke and Kankan are extremely keen on these infrastructure for the socio-economic development of the regions.
- The GCF project will complement the planned activities as the communities are suffering from lack of appropriate infrastructure to climate proof agro pastoral activities. Low access to energy and longer dry seasons has been listed as key issues faced by the communities in both Boke and Kankan
- The team at ADAZZ is extremely proactive and provides full support and collaboration. High level of state ownership has also been observed and the project is being followed very closely by government
- The community representatives were very vocal on how much the support of AfDB and GCF is necessary for them to be face climatic challenges as well as improve their quality of live t

Day and date	**Activity**	**Summary or meeting**
Thursday 17 March	Mission Day 1 in Guinea	**Morning:** Meeting at l'Autorite de Developpement et de l'Administration des Zones Economiques Spéciales (ADAZZ) in Conakry chaired by Oumar Barry Deputy National Director of the Ministry of Economy, Finance and Planning. Were also present, Mr Mohamed Gassama, Director ADAZZ, Mr Laye Sako (National Coordinator), Alhassane Toure, Procurement Specialist. Participants included representatives of authorities responsible for the rural electrification, Electricite de Guinee, Renewable Energy, Met Services, Utility regulator, Ministry of Agriculture, Water resources management, Ministry of Industry, Ministry of Fisheries The key points discussed in the meeting are as follows:

		• The Chairperson reiterated that the government is committed to ensure that the implementation project funded by AfDB gathers pace and that the GCF project for Guinee is also high in the governmental priorities. The GCF funded project is aligned with the country's NDCs, and will help in alleviating poverty while at the same time leveraging private sector investment which is critically needed • The setting up of the full organisational structure for the AfDB funded project is yet to be put in place and core team is operating from Conakry • Climate data is available from the National Statistical Office (yearly) as well as from the Met Services but daily records might have gaps. The Office of statistics collected data through the support of the Bank • Weather stations are present in both Boke and Kankan, but equipment condition is not optimum and there is a lack of capacity to maintain these equipment • Under a UNDP/GEF project, 26 automatic weather stations are being installed with connectivity services (including a server in Conakry) for early warning system. The project is expected to be completed by end 2023 and will help establish a general early warning system that will be communicated in local language. However, the system will not be used specifically for agricultural activities • Due to lack of resources, there are capacity gaps and shortage of personnel at the Met Services to operate new equipment as per WMO standards. The bulk of the equipment in place is dated and it is challenging to install new equipment given the lack of stable power supply. Some stations use solar PV but are not regularly maintained resulting in data gaps from some stations • Insolation and wind data is being collected at Kankan and another site by Electricite de Guinee as part of a resource mapping exercise. • There is no national plan for drip irrigation distribution systems (DIDS) although there is some awareness at community level on the benefits of the systems. DIDS are however needed in Boke and Kankan due to the observed prolonged dry season and excessive heat. Support for the establishment of greenhouses with DIDS will help ensure crop rotation during dry season. • Classical irrigation systems used are not efficient and result in losses. In some areas of Kankan, the evaporation rate is extremely high. • Most of sources of water include surface water and shallow wells (less than 10 m). There is little to no data on underground water and lack of water is really affecting communities, particularly in dry region of Kankan.

		• The Direction Nationale de l'hydrologie has very little records on level of underground sources. • UNDP/GEF funded a pilot project on the installation of biodigesters. There was no follow up on the project after completion and it is unclear how many of the installed biodigesters are still in operation. The prospect of using waste for generating biogas and electricity is appealing for some communities although some communities use agro waste as fertilizers. Cow dung is usually not collected but if incentivised, it can encourage communities to promote collection for use in biodigesters. Given the spread of the communities with Boke and Kankan, small bio digesting units might be the preferred choice. • There is currently no ESCO operating electricity plant run by biogas in Guinea. There is however a market for ESCOs operating diesel generator plants to supply communities in the agro parks. Some of these private companies are connected to the network of EDG and PPAs for supply of electricity on the network are signed. Some IPPs also supply their own distribution networks in areas with no network coverage from EDG • EDG is only present in some localities of Boke and Kankan and most farmers do not have access to electrical power from the grid. Although there is no data available, many communities in Boke and Kankan buy electricity from private operators of use solar panels commercialised by Orange. • The regulator is in the process of developing methodology for determining tariff for electricity. At the moment, private sector operators connecting to the grid, negotiate their tariffs with the Ministry of Energy. Regulations to promote further private sector investment in the rural sector is being developed

		  **Afternoon:** Meeting with Met Services, Direction National de l'hydrologie, Stats Office The key points discussed in the meeting are as follows: • The data set for 30 years for the Kankan and Boke regions are available but there are data gaps. There are not many weather stations in Boke and the information on the evaporation rates can be found from the water services • For the level of ground water, there is no long duration data (less than 1 year available for a few spots only) • The DNH licenses the use of water for mining purposes only. There are no regulations on the use of water for agricultural purposes.

		• The mining sector taps in water for washing purposes and this dirties the water in some locations thus affecting agricultural use. Farmers usually use artisanal irrigation purposes. For rice production, water pumps are used in some places • There is no data being fed to the MWO network. One met station is being installed to be able to send data as per WMO standard by mid-year. There is however a need to train technicians on how to properly code the data • There is no dedicated system in place for EWS for farmers although the backbone for an EWS is being set up under a UNDP GEF project (see above) • There is an urgent need to build capacity in all institutions dealing in environmental matter and data collection Meeting with AfDB Country Manager (CM) The key points discussed in the meeting are as follows: • The logistical arrangements for the site visit to Boke were finalised • AfDB is working in close collaboration with the Gov of Guinea to ensure that the implementation of the Agropole project is stepped up to meet the project targets • Agriculture has a high economic potential in Guinea given the coverage of fertile land and the availability of cheap labour. Better access to good and sustainable infrastructure is key to catalyse the sector • Further funding is in the pipeline for the next development of the agro processing zones in the next funding window at the level of the Bank
Friday 18 March	Mission Day 2 in Guinea	**Morning:** **Site Visit to in Boke (leaving Conakry at 0530 reaching Boke at 1300)** **Afternoon:** Meeting with the community representatives of Boke chaired by the Secretary General of the Governor of Boke in presence of the regional administration team. Were also present representatives of SMEs (in agro industries) Youth groups, women organisation, farming communities, civil society. The key points discussed in the meeting are as follows: • The Chairperson welcomed the delegation and stressed on the commitment of the communities in the Boke region to provide all necessary support to ensure the finance for the GCF project is secured. The project alongside the AfDB funded project is seen as crucial for the socio-economic development of the region and more awareness session on the AfDB and GCF projects ae encouraged to ensure there is timely buy in of the communities.

		The various group leaders echoed their concerns on the delays in the start of the AfDB agropole project in the Boke community. • The local government has a investment plan focussed on the development of the sector and aligned with the national priorities but will required financial and technical support to come to fruition. • Private sector is willing to invest in agricultural infrastructure in the region but investment costs are high • There is a strong entrepreneurship culture in the Boke communities and increased awareness and capacity building will be very helpful to help meet developmental goals through local entrepreneurs. • Bio agriculture is favoured by the young entrepreneurs and there is a strong need for training on climate resilient agriculture • The region has a strong potential for economic growth through sustainable agriculture and there is a need to build capacity and provide necessary infrastructure to fully tap in this potential. Some produce like cashew production is not fully exploited- only the nut is used while there is potential to extract the juice and use the pulp also. • The use of PV (small kits) is widespread in the community. However, the quality is poor and due to lack of maintenance, some kits fail eventually. Although there are no figures, it is estimated that around 3 out of 4 farmers use solar kits (that allows connection of 5 lamps, 1 tv and charging points). These kits are commercialised by Orange or have been provided by the mining companies. • Access to energy is a major barrier in the overall development of the communities in Boke. Communities are already paying private sector operators for access to electricity (mostly through fossil fuels), but it is important that regulations are put in place to ensure that tariffs are not excessive. The grid of EDG is only in Boke with little to no connectivity to the grid in the neighbouring villages. • The women entrepreneurs are very keen on the use of PV kits in the transformation process of agricultural goods. There are a few systems in place which have broken down due to lack of maintenance • If there is a possibility of having access to small biogas kits, villagers will be willing to collect organic waste as access to electricity will enable them to improve their productivity. • It is estimated that 2% of the livestock headcount can be used for bio digestion • Farming communities are affected by the expansion of the mining industry

		• Population growth means that the need for stable energy supply is becoming more and more critical and so is the need for employment. With the natural resources available, agriculture is the favoured economic activity. However, youth are more and more engaged in the mining sector as it offers more economic stability • There is a critical need to modernise local production techniques. Lack of water, proper production, harvesting, storage and processing facilities result in the local rice being more expensive that imported rice • Water scarcity is a real issue during the dry season and DIDS are a real solution but access to these systems are restricted due to the excessive costs. Farmers who do not have access to surface water or rivers usually use artisanal wells (less than 10 m deep) for their supply of water. None of the farmers present used DIDS as it was too expensive and only used by large private sector groups • It has been observed that the water levels over the years during the dry season is reducing gradually • More extreme temperatures are noted in the dry season, and this affects the production of vegetables and other produce. • There are no biodigesters being used in the communities and depending on the size of cattle owned and agricultural practice, some farmers are very keen to collect organic matter for use in bio digester. However, the cost of the biodigester is prohibitive. • The Boke area also has a great potential for sustainable fisheries but there is lack of technical and financial support for artisanal fishers 

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Site visit to the location shortlisted for the setting up of the agro processing park (to be funded by AfDB)
Feasibility studies are being undertaken to determine which of the 2 sites are best suited for hosting the agro processing park. The tendering exercise will be initiated based on the recommendation of the studies (expected by mid-2022);
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<td>Saturday 19 March</td>
<td>Mission Day 3 in Guinea</td>
<td>Morning:
Visit at a cashew storage facility under construction in Kolaboui:
Diaoune et Freres is setting up a cashew storage and processing plant in Kolaboui on 3 ha of land. The company is already operating in Kankan and is expanding its business in the Boke region.</td>
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The storage facility will be powered by generator sets (diesel). Water is being sourced from a well (64m) which has been drilled by a specialised international firm

Visit to a rice processing plant in Denken

Private operator is cultivating 500+ ha of rice fields and has set up a processing and storage facility. The rice produced is for local market
The fields are only productive during the rainy season with no infrastructure in place to store water or access water from the nearby river.
The area is also rich in cashew nut trees fields
With better water management, at least 1 more harvest is possible. During the dry season the company generates revenue from the growth of vegetables under greenhouse using water sourced from wells and supplied through drip irrigation
The facility is powered by a 1.4 MW diesel gen set with a spare 1 MW set. Lighting is provided through solar panels

</td></tr>
</table>

		 DENKEN	

		  **Afternoon:** Return to Conakry (leaving Boke at 1330, reaching Conakry at 21hrs) Wrap up meeting with Mr Mohamed Gassama, Director ADAZZ, Mr Laye Sako (National Coordinator), Alhassane Toure, Procurement Specialist and Mohamed Bangoura (Communications Coordinator for the government): • Government will provide full support to ensure that the GCF funding proposal can be resubmitted • Communications is a key tool to ensure that communities are aware of the project and have full ownership and government

		will provide necessary support to communicate on the project and also help leverage further climate finance

Togo: The mission worked in Togo from 21 to 23 March and work sessions were held in Lomé with national authorities, technical Institutions, Agro-Hydro and Met services, as well as KARA Regional authorities, farmers' organizations, SMSs, ESCOs. Due to the long distance, the mission was not able to travel to KARA to visit the site of the Agro-park (Broukou) and other Infrastructure for aggregation and access to agricultural inputs and services (ATCs). However, the concerned stakeholders from KARA have joined the meeting in Lomé.

The Togo Agro-Food Processing Zone Project (PTA-Togo) aims to: (i) facilitate private investments in key areas thanks to policy support, governance, and incentive measures; (ii) promote the development of priority value chains through the establishment of infrastructure to support production, storage and processing; and (iii) build the capacities of stakeholders in priority agro-industrial areas. The total pre-tax cost of about UA 45,066,070 (about CFAF 35.194 billion), broken down as follows: (i) ADF loan: UA 8.04 million (17.8%); ADF grant: UA 4.046 million (10.3%); TSF loan: UA 8.32 million (18.5%) (ii) BOAD: UA 12,804,920 (28.4%); (iii) Saemaul Globalization Foundation: UA 3,524,190 (7.8%); and (iv) State: UA 7,741,950 (17.2%). The project has four components: (a) support policy, governance and incentive measures; (b) infrastructure for processing and accessing agricultural inputs and services; (c) capacity building for actors in priority agricultural chains; and (d) coordination, management, monitoring and evaluation.

In summary.

- The setting up of the Agricultural Transformation Centers (CTA) is at an advanced stage (works ongoing) and the government is extremely keen to ensure that the project is successfully completed for replication in other parts of the country.
- The government counterparts and representatives of farmers have unanimously welcomed the support from the GCF project as it will help the communities be better prepared to face climate threats and be more self-sufficient in energy. Limited access to electrical energy and to water in the dry season have limited socio-economic development in the region
- L'UGP-Kara under l'Agence de promotion et de développement des agropoles du Togo (APRODAT) has a very dynamic team, and the project is being followed at the highest level at the central government level as it is one of the key economic pillars of the governmental programme. The coordination team is already providing the data required for the update of the GCF SCPZ FP
- The representatives of the farming community expressed high interest in the project particularly as it will help them fight the impacts of climate change and also improve their livelihoods through adapted agro forestry practices, and increased access to both biogas and solar energy

Day and date	Activity	Summary of meeting
Monday 21 March	Mission Day 1 in Lome, Togo	**Morning:** Virtual meeting with the Permanent Secretary (PS) of the Ministry of Economy and Finance and his team on the purpose of the mission. AfDB's Senior Agricultural Officer and The key points discussed in the meeting are as follows:

		• The PS welcomed the AfDB team and highlighted how strategically important the modernisation of the agro processing zone is to the socio-economic development of Togo and pledged the full support of the government for the project to materialise. • All relevant stakeholders have been convened to the meeting and will be providing all necessary support to ensure that the required information is provided on a timely basis • The midterm review of the AfDB supported project is well underway and government is looking forward to implementing similar set ups throughout the country. • The inclusion of a climate resilient component to the agro processing zone is aligned with the government priorities and the expectation from government is that the project implementation is started in early 2023 so that it can be recorded in the mid-term review of the 2020-2025 governmental programme. Moreover, the project team established for the AfDB co-funded project is now in place and has the capacity to implement the • He highlighted that the agricultural production in the north is being affected by lack of water which is increasing the extent of arid lands • He wished the team all the best for the mission **Afternoon:** Meeting at 'l'Agence de promotion et de développement des agropoles au Togo (APRODAT)'. The meeting was attended by the National Coordinator for the Agropoles project, the representative of the GCF National Designated Authority for Togo and representatives from the following organisations: • Farmer associations in the region of Kara • Ministry responsible for matters of environment • Forestry services • Irrigation • Ministry of finance and economy • Meteorological services • Renewable energy agencies (public and private) The following points were discussed: • Meteorological data is not available for all stations in Kara for 30 years. However, some stations outside of Kara region have daily records for the last 30 years and in some cases, there might be data gaps • The full cartography of the location of the boreholes is available. However, there has been no water level monitoring

		• The water discharge from boreholes is not monitored and is usually mostly used for domestic purposes. The use of water is regulated under the 'Code de l'Eau' • Besides from boreholes, the Kara region is also supplied in water through 3 dams and the construction of a dam for a hydroelectricity project is currently in the pipeline • For the early warning system, the Agence Nationale de Protection Civile (ANPC), works closely with the meteorological services and relays critical information to regional offices who further share the information through social media or national local media (press, radio, etc). The information relayed is mostly about the weather events (flooding) and is not tailored for agricultural purposes. Improvements are required for better real time warnings and to account for landslides, violent winds, pest invasion and bush fire. • The EWS for flooding was put in place by the Red Cross using buoys in waterways. All information related to the EWS is channelled through governmental agencies • The backbone of the EWS was set up with the support of the World Bank and UNDP and has helped to significantly reduce the number of flood victims. • The met services are planning to install more meteorological stations to gather more detailed information in order to better serve agricultural and fishing communities. However, capacity building is required to ensure the EWS can be tailored for agricultural purposes. 

		• The use of Drip Irrigation Distribution System (DIDS) is not common practise in the region of Kara despite its benefits being widely known. The state has planned to procure DIDS for 5,000 ha throughout the country for deployment through a subsidised approach. However, this will not be enough for most farmers including in the Kara region. • Artisanal irrigation is the most common type of irrigation system used in the region. The unavailability of water during the dry season results in communities focusing on cattle breading and hunting during the dry season. However, the communities would prefer to continue farming as it is a more reliable source of income • it has been noted that the dry season is notably longer. This has caused migration from the north (Sahel region) and competition for land and water resources is increasing. The migration from the north has also brought more cattle and this has further accentuated the competition for water and land resources • There is no national biogas programme in the country. However, experimentation has shown that use of biogas for electricity generation and fertiliser production can be very beneficial for the farming communities. There is a need to create awareness on biogas technology as lack of understanding of the concept and benefits is also limiting uptake of the technology. • It is estimated that 10% of the livestock headcount can be used for bio digestion • Auctioning/ sale of cattle is conducted on a regular basis in specific locations in Kara and the potential to collect organic matter in these centres for biogas production is significant • In terms of electrification of the rural zones, the construction of a 24MW hydro plant is planned to power 29 localities in the Kara region. • Despite the good insolation rate, there is no grid scale solar PV projects in the region, but the Togolese government is planning the distribution of discounted PV kits to enable access to electricity to remote communities • There are regulations in place for small scale distribute degeneration. Usually, installation of less than 32 kW does not require permits for operation • Youth groups are very keen on using latest clean technologies for entrepreneurship purposes in the agricultural sector • Women also have a key role in agricultural processes at both production and processing stages but lack the support in terms of appropriate equipment – lighting and electricity for storage and transformation

Tuesday 22 march	Mission Day 2 in Lome	**Morning :** **Wrap up meeting at l'Agence de promotion et de développement des agropoles au Togo (APRODAT)** The same stakeholders and in Day 1 were present and the following were discussed: • The main produce of the Kara region include corn, soja, rice, sesame, cashew, vegetables, fish and poultry • The setup of the agro processing zone in Kara was presented including the infrastructural requirements for water communications and power • The agro processing zone in Kara is a pilot and will be the basis for the implementation of similar structures throughout the country. The kara region covers approximately 700,00ha of agricultural lands • The agro processing zone will assist the local economy by encouraging transformation of agricultural produce for local consumption and export • The agro processing zone in Kara will consist of 14 sites and will directly support 400 youth and women to set up micro enterprises. Water wells were rehabilitated and 60 more put in operation to support the agro processing zones and the different production and processing areas • A matrix for the information required was developed with the project stakeholders to identify the key focal points for each sector and assign submission deadlines. 

		
Saturday 19 March	Mission Day 3 in Lome	**Morning:** **Travel to Addis Ababa**

6.2. Overview of the Energy Sector in the three Countries

Senegal has a strong reliance on fossil fuels to meet in electricity demands and has known continuous economic growth resulting in an increasing demand for energy. As of 2020, on 66% of the country had access to electricity [136] with low electrification rates in rural areas. The renewable energy constituting 26% of the installed capacity (predominantly solar) but accounting for only 15% of the energy generation.
The updated NDC of Senegal sets a conditional target of increasing the installed capacity of RE by 1GW by 2030 including 335MW from solar power and 50MW from biomass.[137]

136 https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Senegal_Africa_RE_SP.pdf
137 https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Senegal%20First/CDNSenegal%20approuv%C3%A9e-pdf-.pdf

New legislation is being developed to promote RE investment in the country as it is seen as a key pillar of economic and social development and benefits from the increased interest of promoting sustainable and inclusive development. The Government adopted the Plan Sénégal Emergent (Emerging Senegal Plan - PSE) in 2014 to foster economic growth and to ensure energy demand for growth is met, Senegal's electricity sector has undergone a major transformation [138]aimed at improving the supply of electricity and participating in the country's development objectives by opening to the private sector. A key milestone for the energy sector includes the five-yearly publication of a Lettre de Politique de Développement du Secteur de l'Energie (Policy for the development of the energy sector - LPDSE). Senegal is also introducing a policy on Feed-in-Tariffs (FiTs), and the harmonisation of tariffs.
The following key institutions are involved in the energy sector and fall under the aegis of the Ministry of Oil and Energy:

- Commission de Régulation du Secteur de l'Electricité/ National Electricity Regulator (CSRE)
- Agence pour l'Economie et la Maîtrise de l'Energie/ National Agency for Energy and the Economy (AEME)
- Agence Sénégalaise d'Electrification Rurale/ Rural Electrification Agency (ASER)
- Agence Nationale pour les Energies Renouvelables/ National Agency for Renewable Energy (ANER)
- Société Nationale d'Electricité du Sénégal/ Sénégal national electricity utility (Senelec)

To promote use of RE in rural areas, the Government approved the Programme National d'Électrification Rurale (National Rural Electrification Programme – PNER) as the new rural electrification strategy document in 2015. In the Casamance area, the national utility (Senelec) is present, but the electrification rates remain low due to the connection costs and high tariffs.

Guinea: With one of the lowest Human Development Indicator in the world, (178 out of 189) [139], the Republic of Guinea faces two main challenges: eradicating poverty and ensure food security. As at 2018, 45% of households have access to electricity with a higher connection rate in urban areas while only 19% of rural households are electrified. The country has an enormous RE potential (hydro, biomass and solar), with renewable energy constituting of 60% of the installed capacity in 2020 and 63% of the energy generated[140]
To boost the country's economy and support human and social development, a post-Ebola recovery plan for 2015 to 2017 was developed, followed by the 2016 to 2020 Plan National de Développement Economique et Social (PNDES National Economic and Social Development Plan). PNDES seeks to put the country back on the path toward a sustainable development, focusing on stimulating strong and high-quality growth to improve well-being, and to initiate structural transformation of the economy. The key investment pillars to sustain the economy include ambitious infrastructure projects, particularly in the energy and transport sectors to improve low electricity access and road coverage rates of the country.

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138 https://greenminigrid.afdb.org/sites/default/files/senegal-3.pdf

139 https://hdr.undp.org/en/countries/profiles/GIN

140 https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Guinea_Africa_RE_SP.pdf

As per the Nationally Determined Contributions, the country targets to achieve 80% of RE energy in the mix by 2030 with major hydro projects in the pipeline and through electrification of the rural areas by diversifying the portfolio and including more solar energy and biogas. [141]
The main public sector entities that make up the energy sector are the Ministère de l'Energie et de l'Hydraulique (MEH - Ministry of Energy and Water Resources), the Autorité de Régulation des Secteurs de l'Electricité et de l'Eau (ARSEE - Electricity and Water Sector Regulator), and the country's grid-based utility Electricité de Guinée (EDG – Electricity of Guinea). The MEH is the ministry responsible for overseeing energy sector development by planning and creating new energy policies and strategies. ARSEE acts as the sector regulatory authority specifically tasked with setting tariffs for the utility and ensuring market performance in the electricity sector through regulation.[142]
The Government of Guinea's long-term strategy for the energy sector is set out in two key documents. Both layout the high-level objectives in terms of meeting growing energy demand, extending the grid, and increasing the contribution of renewables. The two documents are:

i. The 2012 Lettre Politique de Développement du Secteur Energétique (LPDSE – 2012 National Energy Development Policy)
ii. 2016 to 2020 Plan National de Développement Economique et Social (PNDES - National Economic and Social Development Plan)

In terms of electricity access in the regions of Boke and Kankan, it is mostly power sector operators (using fossil fuels) who sell electricity to EDG through IPPs but the largest portion of population having access to electricity in these areas is through standalone systems or basic solar kits (for lighting only)

Togo: Most of the Togo's generation capacity is thermal. Togo generates some of its own electricity but imports most of its needs from Nigeria and Ghana.[143] It is estimated that 50% of the Togolese population has access to electricity with renewable energy technologies representing 30% of the installed capacity (in 2020) and providing and providing 33% of the generation power through mostly hydro and solar energy [144]. As in the case of many West African countries, access to energy in rural areas is lower with the electrification rate in the kara region is estimated at 20%[145].
In terms of the institutional set up for electricity sector, The Ministry of Energy and Mines has the overall responsibility of providing policy support for the development of the energy sector. The other key stakeholders include:

i. The Compagnie Energie Electrique du Togo (CEET) which is mandated to provide transmission and distribution of electrical energy;

141 https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Guinea%20First/CDN%20GUINEE%202021_REVISION_VF.pdf
142 https://greenminigrid.afdb.org/sites/default/files/guinea-english-3.pdf
143 https://www.usaid.gov/powerafrica/togo
144 https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Togo_Africa_RE_SP.pdf
145 https://rise.esmap.org/data/files/library/togo/Documents/Energy%20Access/Togo_Electrification-Strategy-Short-EN-Final.pdf

ii. l'Agence Togolaise de l'Electrification Rurale et des Energie Renouvelables (AT2ER) to oversee the electrification of the rural communities in Togo with RE

The following measures have been taken by the government is committed in setting up a conducive environment for the sustainable electrification of the country and are reflected in the updated NDCs of Togo[146]:

i. The establishment of the AT2ER in 2016 to promote renewable energy in rural areas
ii. The enactment of law 2018-018 for the promotion of renewable energy in Togo
iii. The National Development Plan[147] which outlines the electrification roadmap by increasing the share of renewable energy
iv. The Electrification Strategy for Togo which sets the target of achieving 100% electrification by 2030 through Public Private Partnerships with government operating the transmission and distribution networks and private sector contributing in energy generation
v. The Bioenergy National Action Plan (Plan d'Actions National de la Bioenergie)[148], which is currently under development promoting increased access to biogas technology in rural areas with the target of having 15% of the rural population with access to biogas by 2030

6.3. Conduciveness for an ESCO Solution in the three Countries

An analysis of the conduciveness of the institutional framework was conducted for all three countries and private sector operators were consulted for their willingness to participate in the SCPZ programme (refer to Annex 1 – Survey to determine the feasibility of an ESCO solution for the operation of renewable energy supply installations in Staple Crops Processing Zones (SCPZ) in Senegal, Guinea, and Togo)

Senegal's electricity sector has undergone a major transformation aimed at improving the supply of electricity and participating in the country's development objectives by opening to the private sector[149]. A key milestone for the energy sector includes the five-yearly publication of a Lettre de Politique de Développement du Secteur de l'Energie (Policy for the development of the energy sector - LPDSE). Senegal is also introducing a policy on Feed-in-Tariffs (FiTs), and the harmonisation of tariffs.[150]. A key milestone for the energy sector includes the five-yearly publication of a Lettre de Politique de Développement du Secteur de l'Energie (Policy for the development of the energy sector - LPDSE). Senegal is also introducing a policy on Feed-in-Tariffs (FiTs), and the harmonisation of tariffs.

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146 https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Togo%20First/CDN%20Revis%C3%A9es_Togo_Document%20int%C3%A9rimaire_rv_11%2010%2021.pdf

147 https://www.republiquetogolaise.com/documents-officiels/listes

148 http://www.ecreee.org/sites/default/files/procurment/attachments/modele_de_plan_dation_national_togo.pdf

150 https://greenminigrid.afdb.org/sites/default/files/senegal-3.pdf

Regulations are in place in Senegal for the production sale, purchase of electricity from ESCO services subject to licensing with government authorities. Governmental agencies have experience with IPPs since 1996 and national policies conducive for RE expansion through ESCOs. To promote ESCO development in rural areas, the government has set up a structure to execute urgent emergency programmes to accelerate access to electricity, to meet its 2025 universal access target. Currently, Senegal counts 163 mini-grids, of which 121 are hybrid, 37 entirely solar and four are diesel generators. The Government is seeking to significantly reinforce the presence of mini-grids in the country and plans on developing ~600 mini-grids with the support of grant donors to hele achieve the NDC targets.

There are currently many operators offering technical services for assessment and sizing of energy options (including RE – solar and biogas) for various consumer categories (small residential to industrial). The main concern highlighted by the private sector operators is the high capital cost of the technologies and the re-financing capacity of farming communities. It is to be noted that most of the existing mini grids in rural areas in Senegal have been established with grant support from donors[151].

To encourage private sector investment in the rural areas, the government is developing FiTs and working on the harmonisation of tariffs.

Guinea: The increased involved of the private sector is one of the avenues identified for the decentralised electrification of rural areas as per the 2021 NDCs. The Ministry responsible for Investment and Public Private Partnership acts as the focal points for partnerships with private sector on priority areas of intervention including sustainable electrification of rural areas[152].

The 2012 Lettre Politique de Développement du Secteur Energétique (LPDSE – 2012 National Energy Development Policy) is the first energy policy document whose ambitions for the energy sector include:

i. Guaranteeing the security of supply to contribute to national security
ii. Reducing the dependency on fossil fuels
iii. Increasing electricity exports by exploiting Guinea' hydro potential
iv. Promoting renewable energy and energy efficiency programmes

In 2017, the government enacted the necessary laws to further leverage private sector investment in energy project[153]. Regulations allows IPPs to finance, build exploit and maintain power plants. For Boke and Kankan region, the legal framework allows for technologies <of a capacity not exceeding 500kW.

Presently, only a handful of private sector organisations are involved in rural electrification but there is interest to leverage on the nascent market for renewable energy solutions in the areas of Boke and Kankan given the demand and potential for economic growth.

One of the main barriers hampering private investments in mini-grids is the low affordability levels in Guinea due to the poverty of the population and uncertainty with regards to rural tariffs. Rural communities in Guinea on average have a very low consumption.

151 https://greenminigrid.afdb.org/sites/default/files/senegal-3.pdf
152 https://www.invest.gov.gn/page/secteurs-d-opportunites?onglet=presentation
153 https://greenminigrid.afdb.org/sites/default/files/guinea-english-3.pdf

Togo: The Government of Togo is interested in increasing private sector investment in the power sector and attracting off-grid companies to increase access to electricity in rural areas[154]. In 2018, Togo approved another IPP for a 65 MW Thermal power generation plant and has taken significant strides to reform its legal framework to attract private-sector investment. Togo has established a regulatory body, passed a public private partnerships (PPP) law and a public procurement decree, and established an agency to promote rural electrification. As part of its national strategy for universal access by 2030, Togo is exploring a legal framework to promote renewable energy and a new off-grid rural electrification strategy. It is also currently in the planning stages of revising its national energy law to strengthen the role of the regulator.
The Electrification strategy for Togo has already identified a list of potential local and international partners to help achieve its long-term electrification goals. Regulations updated to promote ESCO solutions for RE production and Electricity Tariffs for energy systems throughout territory in place through the 'Arrete No 019/MME/MEF/MPR-PDAT/MCPSP'
There is a very competitive ESCOs market in Togo with the majority operating in the urban areas. High capital costs for technologies and lack of access to financing are cited as main barriers for ESCO expansion in the rural areas, the following factors are also cited:

i. Lack of access to appropriate electrical infrastructure for export of power
ii. Need for stronger legal framework that promotes local companies
iii. Need to create more awareness on low carbon solutions and provide incentives to the population to invest in RE
iv. More capacity building required
v. Lack of feasibility studies in the region

Despite the above listed barriers, the companies having responded to the survey were keen on the modality proposed through the SCPZ programme i.e., through PPPs with the private sector handling the Design, Construction, Operational and Maintenance (DCOM) following public procurement (see Annex 2 – Survey results)

6.4. Willingness to pay for ESCO Solution in the three Countries and Biodigester Sizing

To demonstrate that there is an interest for renewable energy solutions amongst the farming communities including Agricultural Cooperative Societies, Farmer-based Organizations or Smallholder farmers) a survey was developed (refer to Appendix 3) and shared trough the community leaders and representatives of farmer unions in the three countries. The aim of the questionnaire was to gather basic data about their activities, record their interest in RE solutions (solar and biogas) and through a discrete choice survey assess their preference for either solar or biogas (Figure 63) as well as their willingness to pay 5% more for clean energy technologies as compared to non-renewable sources of energy. For the same extra cost, they were also asked to choose whether they prefer an energy mix with lor or medium/high proportion of RE:

[154] https://data.worldbank.org/country/togo

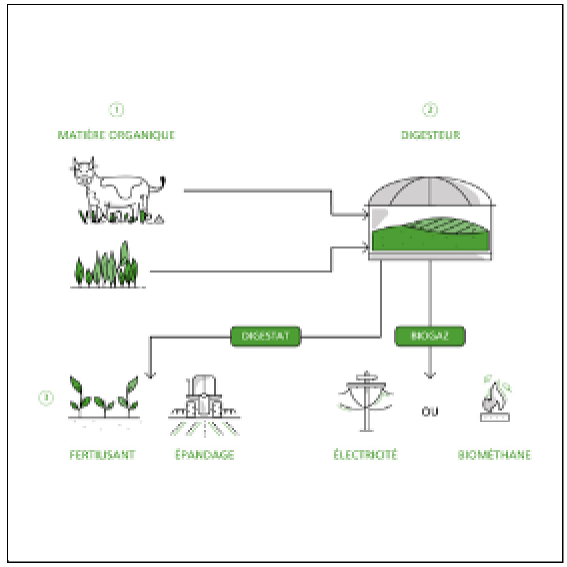

Figure 63. Setup of solar and biodigester systems

The Biodigester sizing was also computed based on data collected on site (refer to Annex 3 of the FP)

Senegal: A total of 63 individuals from the regions of Ziguinchor, Kolda et Sedhiou responded to the survey and the key findings are as follows (Table 43):

Table 43. Summary of findings from WTP survey in South Agropople

Total number of respondents	**43**
No of male respondents	35
No of Female respondents	8
Total plantation size	392ha
Total number of employees	282
% with access to grid electricity	44%
Average cost of electricity bill (FCFA)	14,000 CFA (USD23)
% farmers having a Drip Irrigation Distribution System (DIDS)	2%
% of farmers willing to pay 5% more in energy bills for RE electricity through ESCOs	**100%**
Preferred technology	Solar (67%)

The following observations were also noted in the survey response:

- Farmers having large livestock have expressed a strong desire to also have access to biodigester facilities
- The price for the installation of DIDS is seen as excessive
- Price of electricity from the grid is high

- The respondents are unanimously willing to pay slightly more in order to have access to reliable and clean energy technologies as it will help them improve their revenue streams sustainably and improve their quality of life

Based on the feedback from communities, it is estimated that 2.5% of the livestock headcount can be used for biodigester

The following data was also collected for the livestock in the Casamance area (Table 44).

Table 44. Statistics of livestock in the Casamance area

Livestock	Headcount	Source
Cattle	668,440	Field survey conducted in March 2022
Sheep and Goat	1,327,800	
Pig/ Swine	200,370	
Poultry/ Chicken	4,251,903	

Guinea: Responses representing the opinion of 522 individuals from the Boke through community leaders. Given the high level of illiteracy, the farmers were convened and their views on the survey was collected and the key findings are as follows (Table 45):

Table 45. Summary of findings from WTP survey in Boke, Guinea

Total number of respondents	**522**
No of male respondents	150
No of Female respondents	372
Average plantation size per farmer	3.8 ha
% with access to grid electricity	0%
Average cost of electricity bill (GNF)	-
% of farmers willing to pay 5% more in energy bills for RE electricity through ESCOs	0%
% of farmers willing to pay 5% more	100%
Preferred technology	Solar and Biogas

The following observations were also noted in the survey response for the communities in Boke:

i. Most farmers have small to large livestock have expressed a strong desire to have access both solar and biogas solutions
ii. The price for the installation of DIDS is seen as excessive
iii. The respondents are unanimously willing to pay slightly more in order to have access to reliable and clean energy technologies as it will help them improve their revenue streams sustainably and improve their quality of life
iv. Based on the feedback from communities, it is estimated that 2% of the livestock headcount can be used for biodigester

The following data was also collected for the livestock in the Boke area (Table 46).

Table 46. Statistics of livestock in Boke area

Livestock	Headcount	Source
Cattle	1,549,000	Field survey conducted in March 2022
Sheep and Goat	1,214,000	
Pig/ Swine	3,410	
Poultry/ Chicken	400,247	

For the Kankan region feedback was received from 18 respondents (Table 47):

Table 47. Summary of findings from WTP survey in Kankan, Guinea

Total number of respondents	**18**
No of male respondents	13
No of Female respondents	5
Average plantation size per farmer	3.2 ha
% with access to grid electricity	22%
Average cost of electricity bill (GNF)	96,400 (USD 10.4)
% of farmers willing to pay 5% more in energy bills for RE electricity through ESCOs	0%
% of farmers willing to pay 5% more	100%
Preferred technology	Solar

The following observations were also noted in the survey response for the communities in Kankan:

i. because of the high insolation, farmers are keen to exploit the potential of solar power
ii. The price for the installation of DIDS is seen as excessive
iii. The respondents are unanimously willing to pay slightly more in order to have access to reliable and clean energy technologies as it will help them improve their revenue streams sustainably and improve their quality of life
iv. Based on the feedback from communities, it is estimated that 2% of the livestock headcount can be used for biodigester

The following data was also collected for the livestock in the Kankan area (Table 48).

Table 48. Livestock statistics in Kankan area

Livestock	Headcount	Source
Cattle	1,757,000	Field survey conducted in March 2022
Sheep and Goat	954,000	
Pig/ Swine	3,658	
Poultry/ Chicken	269,852	

Togo: A total of 64 individuals from the Kara district responded to the survey and the key findings are as follows (Table 49):

Table 49. Summary of findings from WTP survey in Kara

Total number of respondents	**64**
No of male respondents	25
No of Female respondents	39
Average plantation size	8ha
Total number of employees	2026
% with access to grid electricity	70%
Average cost of electricity bill (FCFA)	6,550 CFA
% farmers having a Drip Irrigation Distribution System (DIDS)	0%
% of farmers willing to pay 5% more in energy bills for RE electricity through ESCOs	100%
Preferred technology	Solar 78%

The following observations were also noted in the survey response:

i. Farmers having large livestock have expressed a strong desire to also have access to biodigester facilities
ii. Despite that 70% of farmers are connected to the grid, they are all interested in Re solutions to support on the transformation process
iii. The price for the installation of DIDS is seen as excessive
iv. The respondents are unanimously willing to pay slightly more in order to have access to reliable and clean energy technologies as it will help them improve their revenue streams sustainably and improve their quality of life
v. Based on the feedback from communities, it is estimated that 10% of the livestock headcount can be used for biodigester as collection of cow manure is easier.

The following data was also collected for the livestock in the kara area (Table 50).

Table 50. Statistics of livestock in the Kara area

Livestock	Headcount	Source
Cattle	98,537	Field survey conducted in March 2022
Sheep and Goat	705,914	
Pig/ Swine	161,554	
Poultry/ Chicken	3,347,182	

7. THE ADDITIONAL PROGRAMME INTERVENTIONS

As indicated earlier under section 4, the additional programme interventions or activities sort from the GCF, are meant to complement the baseline programme financed by AfDB and other investors. The additional interventions together with the baseline components will help to **'trigger' a paradigm shift towards low-emission, and climate-resilient development pathways** along the agricultural value chains in these countries.

7.1. Description of the Additional Programme Interventions

Activity 1.1.1: Support access to small-scale agricultural water management (AWM) infrastructure

In the context of rainfall unpredictability and high climate variability, sustainable agricultural water management (AWM) practices are fundamental to agricultural development across the arid environment in Africa (Zougmoré et al., 2016; FAO, 2012). The idea that expanding the use of efficient irrigation and agricultural water management technologies is essential to sustainably increasing yields in semi-arid zones is widely recognized (Venot et al., 2014). Unfortunately, the advocated and eagerly awaited revolution in the use of these technologies such as drip irrigation technology has still been in its infancy in arid and semi-arid regions in Africa. As a result, hand buckets and watering cans are still common water lifting technologies for small holder farming in Africa (Van Wesenbeeck et al., 2014;You et al., 2010; Pasternak et al., 2006).

Drip irrigation technology is a way of supplying water in frequent small amounts to the exact place where crop plants can use it, the root zone, through a system of plastic pipes supplied to smallholder farmers as kit packages. These kits work using low water pressure and can be effectively used for localized irrigation on small plots from a few square meters to up to 500 m² (20m X 25m). Drip irrigation kits consist of a water tank or reservoir, main pipes (16 mm diameter or more) with valves and a filter, and a series of secondary pipes (1m density) fitted with drip emitters (1.2 mm diameter and 40cm density). The system requires a very simple and inexpensive maintenance consisting in a periodic cleaning of the filter component to prevent the drip emitters from the risk of choking. Technically, a water tank of 1000 litres (cf. photo) is emptied in approximately 15 mn over a plot size of 250 m2, while the irrigation efficiency may reach 90%. Depending on crop type, root depths, soil type and weather conditions, water application may be different. For instance, with similar soil and rooting conditions, 250 m2 lettuce in the Sudano-Sahelian weather conditions requires 600 litres of water per day (crop development stage), against 900 litres per day in the Sahel. The same figures stand at 750 and 1125 litres per day, respectively, for tomato. Compared to the other irrigation techniques (hand-bucket, watering can or sprinkler, etc.), drip irrigation allows up to 30% water saving. It includes many other advantages such as: (1) increases in yield due to continuous and adequate water/fertilizer supply in function of the needs and depending strictly on the development stages; (2) decreases in labour and energy costs; and (3) significant decreases in disease attacks since water is not applied to the foliar system.

With the introduction of drip irrigation, the use of scares water resources become even more advantageous in these countries. Besides, it has been identified as one water management technology to draw useful policy lessons for the design of phase II of the programme in other RMCs. IIt is less expensive to install and used compared to other AWM technologies as shown in the programme feasibility study. Besides, it can use ground or surface water resources at minimal additional cost. Research by Bajwa et al. (2018) on Design and Implementation of an IoT System for Smart Energy Consumption and Smart Irrigation in Tunnel Farming155, indicate that drip irrigation has between 80 to 90% water efficiency compared with sprinkler irrigation, overhead irrigation, sub irrigation, level basin and surface irrigation that have relatively lower water efficiency. Drip irrigation also has higher energy efficiency than these systems. Drip

[155] Bajwa (2018). https://www.researchgate.net/project/http-wwwmdpicom-1996-1073-11-12-3427-pdf.

irrigation is also noted to "save water by reducing the size of the wet soil surface, thus decreasing the amount of direct evaporation and excess percolation through the root zone. Unlike sprinklers, drip irrigation is practically unaffected by wind conditions, nor is it affected by soil surface conditions. Soil is maintained in a continuously moist condition. Nutrients can be applied through the drip systems, thus reducing use of fertilizers and improving quality of returned water. Increases in water use efficiency in drip irrigation, compared to conventional basin/furrow irrigation, are attributed to both water savings and the increase in yields resulting from favorable soil moisture and nutrient regimes. Due to the relative suitability to drought conditions that are typical of these countries, applicability on small-scale and complementarity with solar systems, drip irrigation is gaining widespread use in Africa. For example, IRENA cited a solar-powered drip irrigation project by Solar Electric Light Fund installed for Solar Market Gardens in the Kalale district of northern Benin, on an average of half hectare farm operated by a co-operative composed of 35-45 women. The solar-powered drip irrigation system provided a safety net for farmers especially during drought period. It also reduced their daily task to a weekly or bi-weekly activity since it takes only a few minutes to water each plant bed, saving each woman up to four hours a day.156

The new activity will therefore, facilitate access to finance for smallholder farmers to invest in drip irrigation technology powered by solar pump. This will support horticulture and market gardening of vegetables and fruits including other cash crops in at least 59,732.3 ha. It is expected this activity will directly empowering more than 784,358 people in the 4 pilot countries of which, more than 50% will be women.

Activity 1.2.1: Improving Agricultural Cooperative Societies (ACSs) and Farm Based Associations (FBAs) Value Chains Infrastructure

One of the biggest challenges confronting the agricultural sector in SSA is losses associated with post-harvest handling of staple food crops, due to non-availability of efficient food processing technologies, storage facilities and the inability of farmers to readily have access to markets. FAO estimates that as much as 37 percent of food produced in SSA is lost between production and consumption while for cereals alone, the loss is close to 20.5 percent. For post-harvest handling and storage loss only, the FAO estimate is 8 percent, while the African Post-harvest Losses Information System (APHLIS) estimate it at 10-12 percent.[157] In Senegal for instance, losses in Maize, Cassava, Yam and Rice from post-harvest handling amounts to over 35.1 percent, 34.6 percent, 24.4 percent and 6.9 percent respectively. These losses are as a result of ineffective food processing technologies, and inefficient post-harvest handling practices. It is also due to damages during transportation because of bad roads, inappropriate market practices and inadequate storage facilities. The situation is not much different for Togo and Guinea where post-losses range between 40% and 60% respectively. This is also attributed to ineffective food processing technologies, careless harvesting and inefficient post-harvest handling practices poor storage facilities. Sadly, only 5-15 percent of food products traded in Senegal, Togo and Guinea is processed, and the total volume of processed food crops exported is relatively low.

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[156] IRENA (2018). ttps://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Solar_Pumping_for_Irrigation_2016.pdf

[157] https://www.worldbank.org/en/programs/africa-myths-and-facts/publication/is-post-harvest-loss-significant-in-sub-saharan-africa

The new activity financed by the GCF will therefore support investment in improving ***post-harvest handling of staple food crops in the targeted countries. This will involve strengthening the capacity of 4,000 agricultural cooperative societies (ACSs), women-led agribusiness enterprises (WABEs) and FBAs, including over 130,000 smallholder farm households (SHFHs) to process, dry, store and package staple food crops to enhance competitiveness. This entails the installation of 14.69MW of solar energy for lighting, processing, drying and packaging*** of staple food crops. In addition to processing, drying, storage and packaging of staple food crops by these value chains actors and communities, the willingness to use renewable energy and energy-efficient technologies at every stage of agricultural value chain will be the key determining criteria for participation in the programme. This will ensure GHG emissions reduction while increasing the value added to staple food crops especially for export.

Activity 1.2.2: Deploying low-carbon energy technologies for enhanced resilience
As extensively discussed under section the highlights the baseline programme gaps, waste from ruminants such as cattle, sheep and goats, human waste (liquid and solid waste), food and agro wastes from the IAIPs in the three countries are actually sustainable “resources” that could be transformed into clean and affordable energy to help improve accessibility and reliability of energy supply in these countries. Thus, the ***focus of this new activity is to specifically reduce GHG emissions in the agricultural value chains in the three selected countries, through the use of low carbon energy*** sources. This will involve ***the installation of 10.24 MW of renewable energy from biogas generation or about 24,577m^3 of biogas digester***[158] to treat livestock manure and produce biogas for heating or power generation. The energy provision will support processing of produce, powering of cold storage facilities where applicable to ensure that farmers can offer their produce with the required market standards. The energy will also provide them with opportunities that will help them diversify their sources of income.
The new interventions financed by the GCF, together with the baseline interventions will promote a new paradigm shift that will change the implementation of agriculture in the normal "business as usual" way, to one that integrated the entire value chain from the production to processing stages. In other words, the resilience of each aspect of the value chain including its actors will be made more climate resilience thus, overcoming these barriers. First, at the production stage, the programme will invest in the development of agricultural access infrastructure and support for the development of integrated agro-industrial parks (IAIPs) such as Agro-Processing Hubs (APHs) and Agricultural Transformation Centres (ATCs). It will also involve the construction of access facilities such as roads that are resilient to extreme weather events, administrative building and storage warehouses, as well as facilities to support production. Also at the stage, the programme will support the rehabilitation/upgrading of small-scale agricultural water management (AWM) technologies such as equipped boreholes, wells and small reservoirs/dams including rain water harvesting technologies. Furthermore, the use of drip irrigation technology will be widely promoted especially among the most vulnerable group (women), to increase production of vegetables and fruits, and to engage in climate resilient agricultural management practices. Second, at the processing stage, linkages between farmers and cooperative societies will be established including the rehabilitation and /or establishment of new ones to facilitate cooperatives' cross-border and trans-national activities. Equally at this stage, renewable energy efficient drying, processing and packaging technologies will be introduced to improve post-handling of staple crops to reduce losses and waste after harvest, and

[158] See biogas estimation model for the basis of this figure.

add market value especially for cashew, mango, coffee and other cash crops. At each investment stage, women will constitute at least 54% of the target beneficiaries.

Activity 1.3.1: Development of SCPZs Access Infrastructure & Support for AIP Management Governance

Under this activity, AfDB and partners will finance under the Agro-Processing Hubs (APHs) facility: 1) the construction of about 10 regional modules comprising of; administrative building, installation of ICT facilities such as fibre optics (50km length) and market platforms (hubs), financial centres, water supply plant for over 15,000 cubic meters/day; waste management plants with capacity of 3.21 MLD, 30 new boreholes and the rehabilitation of 8 old boreholes, 3 mini-dams and additional gravity irrigated areas spanning over 15,000 ha; provision of 243 kV transmission lines to, and around the IAIPs areas; 148 km new access roads that are resilient to extreme weather events, including the rehabilitation of 472 km of old roads. Under the Agricultural Transformation Centres (ATCs) facility, AfDB will finance: 2) construction of more than 40 ATCs) that are strategically located within the production areas of farming communities to serve as aggregation points to accumulate products from farmers and communities; and, 3) provision of cold stores, storage warehouses for fresh-farm produces from the farming communities.

Activity 2.1.1: Promoting CRA among smallholder farmers

Under this activity, the programme will focus on agricultural practices that enhance resilience to climate change in the three pilot countries. According to FAO[159] and USAID,[160] climate resilient practices can reduce the strength of climate impacts on agriculture productivity and generate additional benefits by increasing resilience to floods and droughts. Certain CRA practices such as improved nutrient management, and improved genetic resources, have been shown to improve soil quality and potentially double the yields per hectare as extensively discussed under sub-section 4.4. Also, when intercropped with agroforestry, per hectare yields increases considerably. For example, intercropping Okra with Cashew under drip irrigation can produced per hectare profit of about $13,177.68 as shown in the agroforestry model.

The new activity will therefore invest in the promotion and use of selected CRA practices such as improved nutrient management, and improved genetic resources ***including the deployment of climate-resilient rice, maize, coffee, potato, mango and cashew varieties, including seed production and multiplication,*** in collaboration with the National Food Crop Research Institutes in the respective countries. These national research Centres are mandated to produced new seed varieties adapted to local climate conditions. In most cases, they have shorter growing period and have been shown to use less water especially during periods of water. See section on crop water requirements for more details.

Activity 2.1.2: Promoting Agro-forestry practices among smallholder farmers

Similarly, agro-forestry practices is widely seen as an alternative and more sustainable source of income and many other benefits for small holders as it offers compelling synergies between

[159] FAO. (2012). Identifying opportunities for climate-smart agriculture investments in Africa. Rome: Food and Agriculture Organization of the United Nations - Economics & Policy Innovations for Climate-Smart Agriculture.

[160] USAID (2017). Cost and Benefit Analysis for Climate-Smart Agricultural (CSA) Practices in the Coastal Savannah Agro-Ecological Zone (AEZ) of Ghana. USAID Working Paper, September 2017.

Table 1: **Projected Precipitation Trends for Boke Catchments (2011–2040)**

adaptation and mitigation. According to Mbow et al., (2014),[161] agroforestry improves soil fertility, creates micro-climates, provides ecosystem services, as well as reduces the intensity of human impacts on natural forests. In general, agroforestry improves the economic and resource sustainability of agriculture while sequestering greenhouse gases. For Torquebiau (2013),[162]agro-forestry provides a particular set of innovative practices that are designed to enhance productivity in a way that often contributes to climate change mitigation through enhanced carbon sequestration, and that can also strengthen the system's ability to cope with adverse impacts of changing climate conditions. The emphasis is on using improved crop and pasture land management alongside intercropping with trees and crops, with an aim of better management of forest goods and services.[163] From the energy point of view, agroforestry reduces pressure on harvesting wood from natural tree covers through increasing wood supply on farm (Iiyama et al. 2014)[164].

For this programme, four agroforestry species will be introduced to be intercropped with other cash crops cultivated in the programme. These includes Cashew, Mango (Kent or Keitt mango), Arabica Coffee and Eucalyptus to serve as windbreakers in farms. The financial and economic profitability of these agroforestry trees has been carried out using Cost-Benefit Analysis (CBA) with all positive IRR and NPV values as presented under section 8.3.2. Equally, their abatement potentials are high are illustrated in the following table below. A total of 40,000 ha will be used for agroforestry (Table 51).

Table 51. Financial and economic benefits of agro-forestry practices

	Agroforestry Hectares (Ha)				Total
	Cashew	Mango	**Coffee	Woodlot	
Total Ha	15,000	15,000	-	10,000	40,000.0
*Trees per hectare	625.0	666.0	1,000.0	1,100.0	
Total trees	9,375,000.0	9,990,000.0	0.0	11,000,000.0	**30,365,000.0**
Carbon Stored per Ha (Tonnes)*	2.8	2.8	3.9	11.3	
Total Carbon Sequestered	42,000.0	42,000.0	0.0	113,000.0	197,000.0

Activity 2.2.1: Capacity building of value chains agents/communities'& development of agricultural processing support infrastructure

Under this activity, the following training and capacity building exercise will be conducted. 1) Capacity building and training of relevant staff of the Executing Entities (EEs), the Project

[161]Mbow, C., Smith, P., Skole, D., Duguma, L., Bustamante, M. (2014). Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability, 6, 8-14.

[162]Torquebiau, E. (2013). Agroforestry and climate change. FAO webinar. http://www.fao.org/climatechange/36110-0dff1bd456fb39dbcf4d3b211af5684e2.pdf

[163] Rizvi, A. R., Baig, S., Barrow, E., Kumar, C. (2015). Synergies between Climate Mitigation and Adaptation in Forest Landscape Restoration.

[164]Iiyama, M., Neufeldt, H., Dobie, P., Njenga, M., Ndegwa, G., Jamnadass, R., 2014. The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. Current Opinion in Environmental Sustainability 6, 138-147.

Implementing Units (PIUs), the Agro-industrial Parks (AIPs), value chain actors and ESCOs. This will include; O&M learning and training, management, business planning, stakeholder engagement, contract negotiation, PPP arrangements, governance, project performance monitoring, reporting and evaluation (M&E), investment mobilization and support, and investment promotion among others. 2) Training and capacity building of value chain actors in the use of good Agricultural Practices' in product quality, standardization and conformity requirements, as well as developing linkages and responding to commodity demand in terms of quality and quantity. 3) Training of young potential entrepreneurs including women to seize business opportunities along the value chains. 4) Massive sensitization and training of private sector investors, Ministries, Departments and Agencies (MDAs) on governance systems reforms such as land reforms and export promotion initiatives.

Activity 2.2.2: Establishment of climate information and early warning systems in SCPZs
This activity will help to enhance climate information services by promoting the generation of, access to and use of seasonal and sub-seasonal weather forecast and agricultural relevant weather products in the SCPZs. Collection of climate data and transmission of climate information at community-level will be promoted. The activity will improve climate-smart agro-advisory services, such as, planting time, good farm management practices, irrigation schedules, use of farm manure and choice of inorganic fertilizers, suitable crop types and varieties to be planted, weeding regimes, the available seed suppliers, crop pests and diseases prevention and control measures. This activity will provide technical assistance on preparatory mechanism including analysis of vulnerability, gathering of data, decisions on contingency plan and/or adaptation measures, analysis of gender and socioeconomic inequalities; seasonal information prior to major rainfall season including information on irrigation requirements during growing season; improved dissemination technique; Capacity building - adaptation and contingency & anticipatory plans.
Specifically, the project intervention under this activity include:

(a) Expansion of agrometeorological and rain gauge stations network within the SCPZs– Observations of physical and biological variables, such as, precipitation, solar radiation, sunshine and cloudiness, air and soil temperature, air pressure, wind speed and direction, air humidity and soil moisture, are essential. These variables are critical meteorological considerations needed to assess the performance of a plant or animal because their growth is largely influenced by the combined effect of genetic characteristics (nature) and their response to environment (nurture). The GCF intervention will establish and expand observing network with at least ten (10) automated agrometeorological and fifty (50) self-recording rain gauge stations in each of the zones. The local weather stations will help farmers manage their crops more efficiently as it will provide essential weather and climate data to make better irrigation decisions, protect crops from damage and observe wind conditions before spraying, among others. Alongside, the local weather information will guide decision-making in the operations of IAIPs, RTCs, ACs and market. The activity will help to identify the most suitable locations of additional and to analyze the best sites for agrometeorological and gauge stations, their densities, and proper distribution inside the individual zone. The World Meteorological Organization guidelines45 will be strictly followed to ensure best practices and standards. The sub-activity will also procure and maintain two (2) four-wheel project vehicles per region (i.e., a total of sixteen (16) project vehicles). One of the project vehicles will be fitted with a calibration unit to monitor the operation and conduct regular maintenance of all equipment and facilities installed across the region. The additional stations will ensure a rich blend of station observations with satellite- and model-based data and that weather information is forecast more accurately and more effectively in the zones.

(b) Deploying technologies to strengthen climate information services and early warning systems in SCPZs and Business Model Innovation for Togo, Guinea, & Senegal - This sub-activity will promote rural economic empowerment in the SCPZs through digital and financial inclusion. A cost-effective reseller model will be used to deploy and expand climate-smart agro-advisory services to targeted users within the SCPZs. These services will be deployed in collaboration with local partners including the National Meteorological Services (NMSs) and mobile network operators (MNO) in the 4 proposed countries. The local partners, representatives, agents and assigns will be carefully selected and taken through rigorous training to be able to deliver clients satisfaction with the highest standard (Figure 64).

Figure 64. A typical partners onboarding process in specific project site

Automated solutions will be used to profile and disseminate critical information to a base target of 20,000 beneficiary farmers in the inception year of set-up in each of the 4 proposed countries. The project approach will be to grow this beneficiary farmers by an average of 50% annually in subsequent years. In addition, the business model innovation will create about 30 direct jobs in the first 2 years of implementation in each of the proposed countries. There will also be the opportunity to create additional short-term jobs for about 60 young people to be engaged as field enumerators for the initial profiling of the 20,000 beneficiary farmers.

The Tech Services to be provided in this phase is illustrated in Figure 65, consist of rainfall forecast, climate-smart agro-advisory contents, market prices, digital tools to support end-to-end digitization, and digital literacy skills:

Figure 65. Illustration of Tech Services to be provided

Digital Tech Services in Critical Information Delivery includes: (a) Seasonal Rainfall forecasts; (b) Onset and end of the rainy season; (c) Climate Smart Agronomic Advisory; (d) Creating Market linkages through Market Price Advisory from all the districts/provinces/counties of all the 4 proposed countries of deployment; and (e) Farmer crop/livestock/fishery/poultry protocol advisories that is intended to enable farmers understand and apply received critical information in the best possible channels as well as health, nutrition and financial inclusive services.

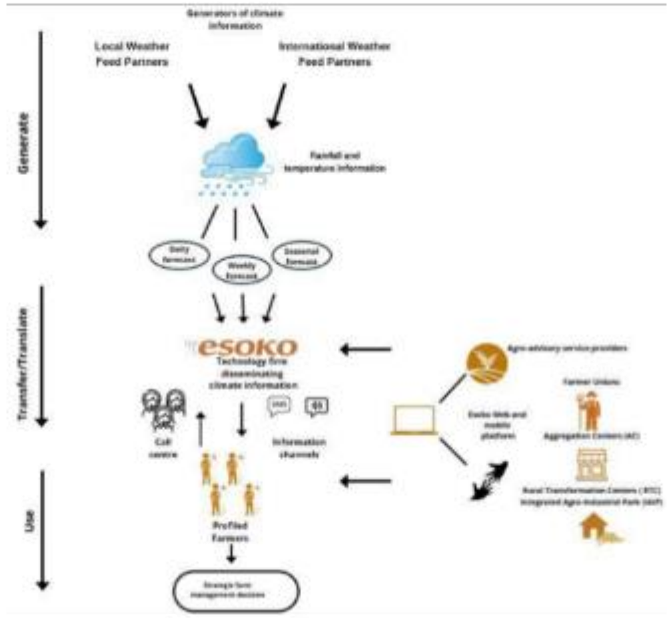

Figure 66. Automated system for the dissemination of Climate and Weather-related Agriculture Advisories

The automated system for the dissemination of climate and weather-related agriculture advisories (Figure 66) will achieve the following objectives:

i. Develop a user-friendly web-based platform that will, among other things, automatically compile and send agricultural and farm advisories related to weather and climate in the form of SMSs to farmers, extension workers and other stakeholders. The web-based platform will allow for user editing and review before disseminating the advisories
ii. Develop an android for accessing short and medium-range weather forecast and information, seasonal forecast, as well as area and farming systems-specific agriculture related advisories. The app will further provide access and links to relevant literature, audio, and video clips
iii. Re-align, re-format and code (programme) existing advisories for crop and livestock that are related to weather and climate within the proposed system
iv. Develop a feedback mechanism within the system/web-based platform which allows farmers and extension officers to provide feedback on the information content, its relevance and usefulness, as well as how easy/difficult it is to understand
v. Train agricultural extension officers (AEOs) in the system administration of the web-based platform and mobile application
vi. Set-up and train all SCPZs stakeholders (Famer Unions, Aggregation Centers, Rural Transformation Centers, Integrated Agro-Industrial Parks) on the usage of the platforms as collaborators on which solution best applies to their operations.
vii. Train AEOs in the system administration of the web-based platform and mobile application
viii. Set-up and train all SCPZs stakeholders (Famer Unions, Aggregation Centers, Rural Transformation Centers, Integrated Agro-Industrial Parks) on the usage of the platforms as collaborators on which solution best applies to their operations.

(c) Capacity building and awareness raising – This sub-activity will focus on awareness and training on how to use and maintain the observing networks. The activity will conduct

stakeholders' engagement meeting with prospective farmers, aggregators, Famer Unions (FUs), Famer Based Organizations (FBOs), and other interested bodies with the focus on creating awareness on the importance of the installed agrometeorological and gauge stations and the need to be responsible for the security of the networks. Farmers and other interested stakeholders will take ownership of the self-recording rain stations. Furthermore, selected volunteers will be engaged in training on how to maintain the rain gauge stations in order to ensure accurate rainfall measurements. Bi-annual exercise on calibration will be organized to re-calibrate the weather sensors to ensure measurement accuracy.

Currently, in the selected SCPZ countries, various fragmented initiatives are being implemented to build the resilience of smallholders and rural communities to climate change. However, achieving this is not easy and may not be possible unless the existing infrastructural, technological, financial, social and institutional barriers are addressed. Unless these barriers are overcome, implementing agriculture in the normal "business as usual" way in the context of climatic stress, are clearly inadequate and only add to the numerous challenges such as increasing emissions of GHG from agriculture, land use and forestry, food insecurity, malnutrition and heightened conflicts over resources use.

Barriers to be addressed by the programme includes:

1) **Absence of infrastructural development including ready markets for agricultural production**. A lack of market is related to lack of appropriate storage facilities for farm produce in the villages. This weakens the price negotiating power of small-scale farmers who may not be able to store their produce. Low prices may result into farmers being unable to honour their current loans and hence unable to contract future loans. Lack of markets is also associated with poor physical infrastructure such as roads in the villages. The programme will create the market for the increased production of agricultural products through investing in the agro-processing centres (agro-parks). The physical infrastructure includes roads, electricity, ICT, water supply and sanitation.

2) **Technological barriers**. In all three pilot countries, climate change is projected to lead to increases in average temperatures whereas; precipitation is projected to increase or decrease over the coming decades. A gain or a decrease over the coming decades, could determine if certain crops or farm practices remain viable, and if reduced water availability might require a shift to more drought resistant crops or if farmers are required to shift investments into irrigation or other waste management technologies. The SCPZs programme will provide the necessary farming skills and technology innovations to farmers around the Agro-Parks to increase agricultural production such that they are able to realize the market opportunities brought to their farm gate by these agro-parks. In particular, the programme will introduce best practices in climate resilient agriculture and agroforestry management, drip irrigation technology, waste and soil fertility management, production and use of clean and renewable energy among others, which are critical to climate adaptation and mitigation under changing climatic conditions.

3) **Financial barriers**: Small scale farmers are considered poor. Every form of adaptation entails some direct or indirect financial cost. For resource poor farmers facing capital constraints, high transaction cost could mean little gains. Access to credit facilities among others could help defuse this barrier by providing smallholder farmers with the opportunity

to invest in alternative income generating activities such as dry season horticulture and market gardening that can increase their incomes by as much as 15% to 25%. It could also help producers' especially agricultural cooperative societies, farm-based associations (FBAs) and women-led agribusiness enterprises to overcome post-harvest losses due to non-availability of efficient food processing technologies and storage facilities. This maybe through investing in post-harvest lost facilities to process, dry, store and package staple food crops to enhance competitiveness.

4) **Social barriers**: Strong held beliefs, cultural practices and value systems of individuals and groups influence the way communities perceive climate change and their subsequent adaptation strategies. For example, culture practices in the programme areas are the reasons why women are more exposed to climate shocks than men. The programme will overcome this barrier through the integration of a gender action plan (GAP) that will empower women to take active leadership role in all aspects of the programme interventions.

A **Theory of Change** (ToC) diagram describing this new paradigm shift is presented in Figure 67. The ToC equally highlights the main risks that characterized the programme (climate threats, water scarcity and climate-induced risks, including those associated with increasing GHG emissions from agriculture, energy and land use change and forestry (LUCF) sectors). It equally highlights the main programme barriers (fragmentation of the agricultural value chain, including access to finance resources, unsustainable agricultural practices, infrastructure and technology deficits, and institutional constraints), and articulate the integrated activities that will be implemented to minimize the associated risks and barriers.

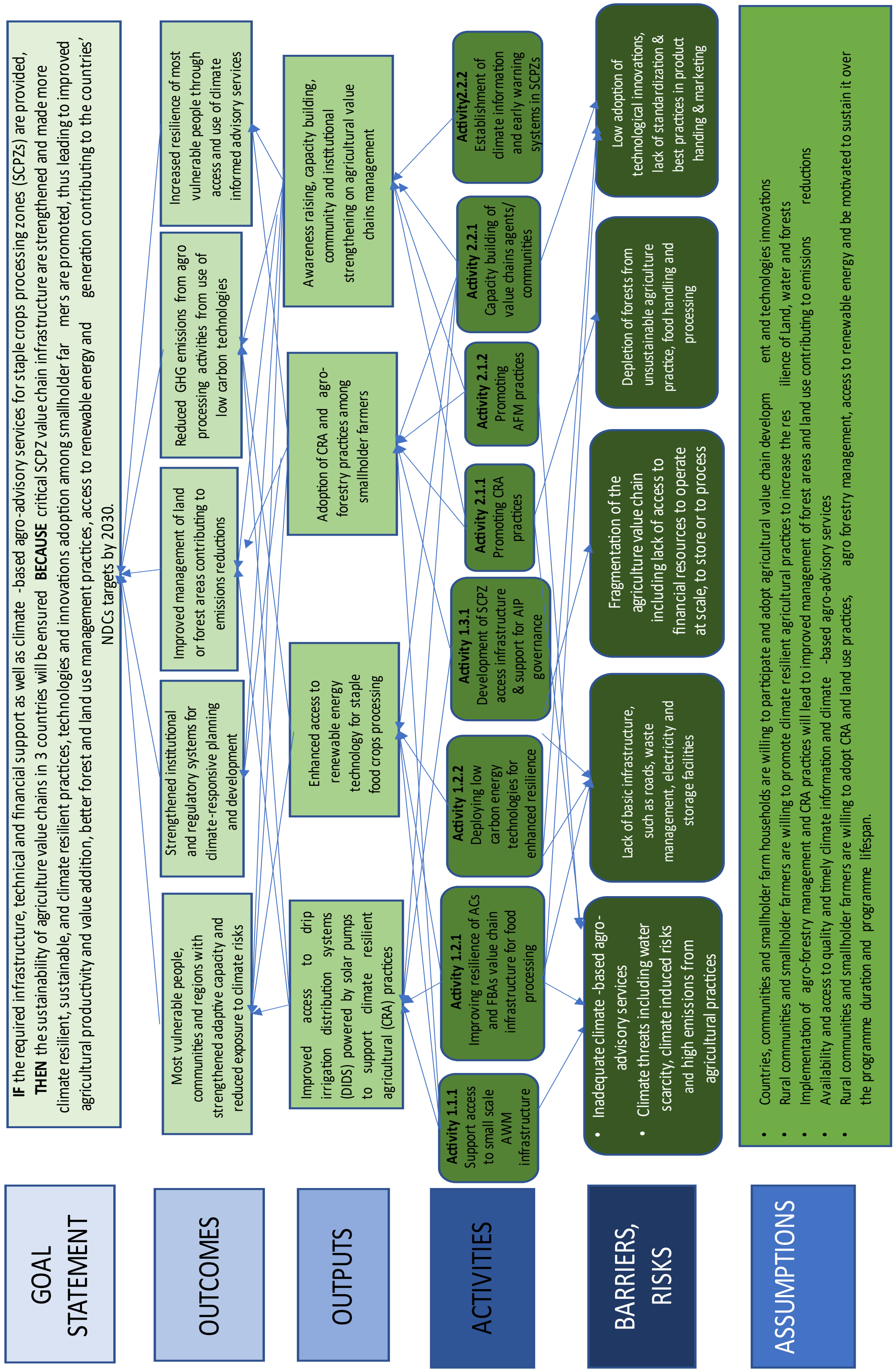

Figure 67. SCPZ Programme ToC

7.2. Cost of Financing the Additional Programme Interventions

Table 52 presents a detailed breakdown of the total cost estimates of financing the additional programme interventions, disaggregated by countries. As shown in the table, the total cost of the additional programme interventions is estimated at $102.79 million. By country's distributions, Togo will receive the budget of $38,898,617.38 million (37.86%), Senegal $33,333,722.23 (32.44%) and lastly, Guinea that receives close to $30,517,648.04 million or about 29.70% of the budget allocations. The distributional breakdown is highlighted in Figure 68.

Table 52. Distributional Breakdown of Budget by Countries

GCF Budget allocation per country	Amount per country	Percent (%)	GCF Financial Instruments	
			Loan	Grant
Togo	$38.898.617,38	37,86%	$9.999.987,18	$28.898.630,19
Senegal	$33.333.722,23	32,44%	$10.999.948,59	$22.333.773,65
Guinea	$30.517.648,04	29.70%	$5.999.896,21	$24.517.751,83
Cost of translation	$41.000,00			$41,000.00
Total	$102.790.987,65	**100,0%**	$26.999.831,98	$75.791.155,67

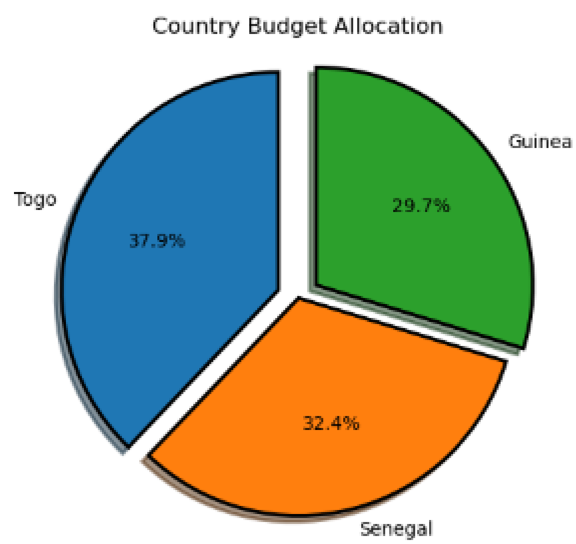

Figure 68. Additional Programme Budget Distribution by Countries

The justification of each country's budget allocations is based on a number of crucial factors such as: (i) the Biodigesters volume of each country computed using iTAP recommended Carbon and Finance analyses; (ii) Solar energy demand analysis for processing of staple food crops such as cereal, roots and tubers, legumes and nuts, including vegetables and fruits based on iTAP's recommended guidelines (see Appendix 3A of funding proposal);

and, (iii) total number of irrigated hectares powered by solar pumps based on energy demand analysis. The summary analysis describing the total Biodigesters volume (m3) for each country, the Solar (Watts) Capacity needed, and total additional irrigated land hectares are presented. Detailed basis for the costing is provided in Appendix 3A of the funding proposal.

As shown in Table 53 the additional activities and quantity description include: (i) Togo (9,447.1 m^3 of Biogas digester, 1,018,248.0 W or about 1.02 MW of Solar PV energy for pumping, 7.2 MW for lighting and processing, and a total of 25,428.0 ha of additional land area to be covered by solar irrigation, CRA (15,428 ha), and agro-forestry (10,000 ha) practices); (ii) Senegal (5,218.6 m^3 of Biogas digester, about 0.79 MW of Solar PV energy for pumping, 3.27 MW of Solar PV energy for processing and lighting, and solar irrigation, including over 31,940.0ha of land to be covered by solar irrigation, CRA (11,940 ha) and agro-forestry (20,000 ha) practices); and (iii) Guinea (9,911.21 m^3 of Biogas digester, about 0.78 MW of Solar PV energy for pumping, 4.25 MW of Solar PV energy for lighting and processing, and solar irrigation, including 21,810.0 ha of additional land to be covered by solar irrigation, CRA (11,810 ha) and agro-forestry (10,000 ha) practices.

Table 53. Description of Country's Activities and Quantities

GCF Financed Activities Disaggregated by Countries				
Togo	**Description**	**Budget**	**Loan**	**Grant**
Biodigester Volume in m3	9,447.1	$2,834,118.00	$696,788.61	$2,137,329.39
Solar PV -Pumping (Total Watts Capacity Needed)	1,018,248.0	$1,527,372.00	$375,515.56	$1,151,856.44
Solar PV-Lighting (Total Watts Capacity Needed)	7,166,527.4	$7,166,527.37	$1,802,170.45	$5,364,356.92
DIDS (Land Area in Ha)	15,428.0	$6,942,600.00	$1,706,888.92	$5,235,711.08
CRA (Land Area in Ha)	15,428.0	$11,278,617.50	$2,819,654.38	$8,458,963.13
Agroforestry (Land Area in Ha)	10,000.0	$5,000,000.00	$1,229,286.52	$3,770,713.48
CIEWS (Equipment)		$4,149,382.50	$1,456,633.96	$2,692,748.54
Sub-total for Togo		*$38,898,617.37*	*$10,086,938.41*	*$28,811,678.96*
Senegal	**Description**	**Budget**	**Loan**	**Grant**
Biodigester Volume in m3	5,218.6	*$1,565,577.00*	*$554,097.39*	*$1,011,479.61*
Solar PV -Pumping (Total Watts Capacity Needed)	788,040.0	*$1,182,060.00*	*$418,331.03*	*$763,728.97*

Solar PV-Lighting (Total Watts Capacity Needed)	3,273,085.2	*$3,273,085.23*	*$1,144,587.21*	*$2,128,498.02*
DIDS (Land Area in Ha)	11,940.0	*$5,373,000.00*	*$1,901,504.70*	*$3,471,495.30*
CRA (Land Area in Ha)	11,940.0	*$7,790,617.50*	*$2,726,716.13*	*$5,063,901.38*
Agroforestry (Land Area in Ha)	20,000.0	*$10,000,000.00*	*$3,539,000.00*	*$6,461,000.00*
CIEWS (Equipment)		*$4,149,382.50*	*$671,610.76*	*$3,477,771.74*
Sub-total for Senegal		*$33,333,722.23*	*$10,955,847.22*	*$22,377,875.01*
Guinea	**Description**	**Budget**	**Loan**	**Grant**
Biodigester Volume in m3	9,911.0	$2,973,302.58	$608,722.08	$2,364,580.92
Solar PV -Pumping (Total Watts Capacity Needed)	779,460.0	$1,169,190.00	$239,333.19	$929,856.81
Solar PV-Lighting (Total Watts Capacity Needed)	4,250,655.0	$4,250,655.04	$879,976.66	$3,370,678.38
DIDS (Land Area in Ha)	11,810.0	$5,314,500.00	$1,087,878.15	$4,226,621.85
CRA (Land Area in Ha)	11,810.0	$3,511,235.42	$702,247.08	$2,808,988.34
Agroforestry (Land Area in Ha)	10,000.0	$5,000,000.00	$1,023,500.00	$3,976,500.00
CIEWS (Equipment)		$8,298,765.00	$1,451,690.85	$6,847,074.15
Sub-total for Guinea		*$30,517,648.04*	*$5,993,348.02*	*$24,524,300.44*
Costs of ESS translation		$41,000.00		$41,000.00
		$41,000.00		*$41,000.00*
Grand Total all Countries		**$102.790.987,65**	**$26.999.831,98**	**$75.791.155,67**

7.3. Implementing Arrangements for the Additional Programme Interventions

The additional programme interventions will be implemented following the same management and coordination structured described under **section 4.2.3** (**Component 3**: **Programme Coordination and Management**) and extensively discussed in the programme operational manual. However, sub-projects under these new interventions, particularly: (1) small–scale agricultural water management (AWM) infrastructure such as (i) drip irrigation distribution systems (DIDS) equipped with solar pumps; (b) improving ACSs and FBAs value chains infrastructure; and (2) deployment of low-carbon energy technologies such as Biodigester and Solar PV for renewable energy generation and CRA and agro-forestry practices will be implemented in accordance with AfDB implementing arrangements (see full detailed description in the POM).

The first step of the process involves the Issuance of International Competitive Bidding (ICB), for the recruitment of national or international consultants that will: (i) visit each pilot country to agree on the detailed scope and timeline of activities, carry out a stock taking exercise on existing knowledge on target countries for the proposed interventions, and developed an inception report; (ii) liaised with each country's Programme Executing Agency (PEA) and Programme Implementing Unit (PIU), to update and modify the selection criteria used for the selection of programme beneficiaries, carry out detailed mapping exercise to select programme beneficiaries based on the selection criteria agreed upon, work with the PEAs and PIUs to finalize the constitution a programme committee for each activity, and developed a field finding report of mapping exercise; and (iii) Carry out a training of the programme beneficiaries in conjunction with line ministries, department and agencies (MDAs) involved in the programme, in collaboration with the PEAs, PIUs and other key stakeholders of the programme, organized a 'Training of Trainers' – (ToTs) workshop for selected programme beneficiaries to support with the upscaling of the activities throughout the programme and after, develop a workshop report that summarizes the key lessons from each training, develop a ToT manual covering each activity, and prepare a final report highlighting the main findings of the assignment (see POM for sample **Request for Expression of Interests (REOIs) to be issued under each sub-project activities).**

7.3.1. Selection of Sub-project Beneficiaries

The selection guidelines to be used in selecting sub-project beneficiaries are extensively discussed in the POM. However, as noted above, it will be subject to adjustments and modifications.

Activity 1.1.1: *Support access to small-scale agricultural water management (AWM) infrastructure*

- All activities related to drip irrigation will be carried out within the SCPZs designated programme areas in all three countries (39,178 ha out of the total 1.5 million ha designated for the programme).
- 80% preference for women and girls who are the most vulnerable groups in the society;
- Beneficiaries must be a formally registered ACS, FBA, women-led agribusiness enterprise (WABE), or smallholder farm household (SHFH) willing to work with the programme to implement climate resilient agricultural practices associated with on-farm surface water catchment;
- Preference for ACS, FBA, WAE, or SHFH that are willing to belong to a farmer water user group (FWUG) or farmer water user community (FWUC) to promote water harvesting through on-farm catchment (small ponds and reservoirs), for irrigational use, including necessary O&M;
- Preference for ACSs, FBAs, WABEs, and SHFHs that commit to contribute to necessary O&M of on-farm water catchment ponds and reservoirs;
- Preferences for ACSs, FBAs, WABEs, and SHFHs practicing any form of water coping strategy in agriculture such as water harvesting, use of boreholes, small reservoirs and dams;
- Preferences for ACSs, FBAs, WABEs, and SHFHs located in communities around the IAIPs more prone to climate hazards, risks and potential disasters. Here, community involvement would be crucial in the selection of programme beneficiaries;
- Preference for ACSs and FBAs that have women farmers as potential beneficiaries;

- Preferences for ACSs, FBAs, WABEs, and smallholder farmers that engaged in dry season farming as a coping strategy;
- Being in production of fresh agro produce within the last two years;
- Willing to participate in the programme and to accept technological innovations such drip irrigation, including necessary O&M;
- Willing to accept new fresh agro varieties that may be introduced by the programme; and,
- Committed to working with the IAIPs, PIUs and other regional agricultural institutions and line ministries.

Activities 1.2.1 and 1.2.2: *Providing solar and biogas energy for staple food crops processing*
The selection criteria for the eligible for solar PV and bio-digester includes those listed under activity 1.2.1 and *1.2.2* as well as the following additional criteria:

- The Design, Construction, Operational and Maintenance (DCOM) will be handled by Private Sector Energy Service companies (ESCOs), which will be selected through a public procurement process in collaboration with the Project Implementing Units (PIUs) in each country;
- ESCO must show through formal commitment the responsibility of handling the operational and maintenance (O&M) costs of the equipment throughout the project lifespan. ESCOs were contacted during a field mission in 2022 and were questioned about their interest in participating in the project. Most responded positively provided sufficient incentives were provided (refer to Chapter 6 of the Feasibility Study)
- Direct programme beneficiaries must be in production of at least 100 kg – 200 kg of manure daily;
- Has no objection for ACS, WAE or FBA to be used as a training and demonstration location for the duration of the project;
- Commitment to adopt climate resilient and good agricultural practices such as composting, mulching, organic agriculture, climate resilient varieties;
- Capacity to contribute funds either by having own funds or taking loans;
- Commitment to use bio-slurry as a fertilizer substitute.

Activity 1.3.1: *Development of SCPZs Access Infrastructure & Support for AIP Management Governance*[47]

- The agricultural potential of each region with respect to the targeted staple food crops for sustainable agricultural intensification.
- The existence of other ongoing activities in the regions complements the project.
- Proximity to local and international markets, transport networks and telecommunications.
- Stakeholders' consultations and viewpoints.
- Willingness of communities to participate in the project.
- Proximity to raw materials.
- Existing agro-processing infrastructures that are in place in each region.
- Energy and water requirements.
- Furthermore, consideration was given to identifying sites that have access to existing commercial and support services such as universities, research centres, technical vocational education and training centres; farmers’ cooperatives and unions; and financial institutions.
- A formally registered agricultural cooperative society (ACS), FBA or WABE with the Government for more than 1 year;

- A formally registered SHFH with a cooperative society, FBA or WABE
- Main focus of activities is along the agricultural value chains involving targeted crops under the programme;
- Currently practicing any form of climate resilient activities in its daily operations such as use of drought resistance and improved yield seeds, among others;
- Willing to accept new innovations that may be introduced by the programme such as clean and renewable energy sources; including necessary O&M
- Preference ACSs, FBAs that utilize diesel-based energy sources for agro-food crops processing;
- The size of the cooperative society or FBA must not be less than 20 members with at least 20 -30% of the members being women;
- Preference for ACSs and FBAs that have women farmers as potential beneficiaries;
- Has a strong business plan to develop a trading agribusiness with potential downstream value chain linkages;
- Should have strong commitment to implement climate change measures to reduce vulnerability to impacts of climate change, and reduce GHG emissions in its operations through prog renewable energy and improving energy efficiency uptake; and,
- The area under cooperative or FBA primarily grows any of the 18 staple food crops considered under the 'Feed Africa' Initiative such as rice, maize, potato, yam, cassava, mango, cashew, coffee, sorghum, millet, cowpea, wheat, soybean, livestock, poultry, and fish among others.

***Activities 2.1.1 and 2.1.2: Promote** CRA and Agro-forestry Practices among Smallholder Farmers*

- All activities related to CRA and agro-forestry management practices will be carried out within the SCPZs designated programme areas in all three countries (79,178 ha out of the total 1.5 million ha designated for the programme).
- A formally registered SHFHs with an ACS, or FBA for more than 1 year
- A formally registered ACS, WAE, FBA with the Government for more than 1 year;
- 80% preference for women and girls who are the most vulnerable groups in the society;
- The size of the ACS, WAE, or FBA must not be more than 15 members with at least 20 -30% of the members being women;
- Preference for ACSs and FBAs that have women farmers as potential beneficiaries;
- Preference for beneficiaries that are currently practicing any form of climate resilient activities in daily farming operations such as water harvesting, mixed agro-forestry practice, livestock rearing, use of drought resistance and improved yield seeds, crop rotation among others;
- Preference for beneficiaries that are willing to accept new technological innovations and new farming practices that may be introduced by the programme such DIDS powered by solar pumps; improved nutrient management, and improved genetic resources;
- Activities are mainly carried out along the agricultural value chains involving targeted crops under the programme;
- Willing to accept new innovations that may be introduced by the programme such as improved nutrient management, improved genetic resources, and the adoption of clean and renewable energy sources;
- Willing to accept new seed varieties and technologies that may be introduced by the project;

- Has a strong business plan to develop a trading agribusiness with potential downstream value chain linkages;
- Should have strong commitment to implement climate change measures to reduce vulnerability to impacts of climate change, and reduce GHG emissions in its operations through prog the adoption of good agricultural practices and technology and innovations uptake; and,
- The area under cooperative or FBA primarily grows any of the 18 staple food crops considered under the 'Feed Africa' Initiative such as rice, maize, potato, yam, cassava, mango, cashew, coffee, sorghum, millet, cowpea, wheat, soybean, livestock, poultry, and fish among others.

Activity 2.2.1: *Capacity building of value chains agents/communities'& development of agricultural processing support infrastructure*

The selection criteria for activity 2.2.1 includes:

- All program beneficiaries of activities 1.1.1 – 2.2.1;
- Preference for SHFHs, ACSs, WABEs, FBAs who are non-beneficiaries of the program, but located within the SCPZ program areas;
- Staff of the EEs, PIU, AIPs, and relevant staff of Ministries, Departments and Agencies (MDAs) working on the agro-industrial domain and other key sectors involved in agricultural value chain development (AVCD);
- Representatives of organised Civil Society Organizations (CSOs), Environmental Non-Governmental Organizations (NGOs), and the prospective private sector investors;
- Representative of Public and Private Financial Institutions (PFIs);
- Preference for young potential entrepreneurs, SMEs, MSMEs working on the agro-industrial domain; and,
- Relevant representatives of the donor community.

Activity 2.2.2: Establishment of climate information and early warning systems in SCPZs

For climate-resilient and sustainable farm practices within the SCPZs, this activity will help to enhance climate information services by promoting the generation of, access to and use of seasonal and sub-seasonal weather forecast and agricultural relevant weather products in the SCPZs.

- The intervention will expand automated agrometeorological and self-recording rain stations to improve collection of climate data and transmission of climate information at community-level
- The activity will use innovative tech services to improve on climate-smart agro-advisory services, such as, planting time, good farm management practices, irrigation schedules, use of farm manure and choice of inorganic fertilizers, suitable crop types and varieties to be planted, weeding regimes, the available seed suppliers, crop pests and diseases prevention and control measures.
- This activity will (i) provide technical assistance on preparatory mechanism including analysis of vulnerability, gathering of data, decisions on contingency plan and/or adaptation measures, analysis of gender and socioeconomic inequalities; (ii) produce seasonal information prior to major rainfall season including information on irrigation requirements during growing season; (iii) improve dissemination technique; and (iv) build capacity - adaptation and contingency & anticipatory plans

The technical approach to expand business in the 4 proposed project countries is summarized as follows:

- To deploy a Tech Team to support the local partner team to conduct an initial field survey for the set-up of the technology infrastructure, engagement with local MNOs for the platform integrations and configurations and licensing bodies within the countries of deployment.
- To deploy a Call Centre Team for the set-up of the Call Centre's
- Deploy a Business Development Team to train the local partner business team on the commercialization of the solutions in their respective countries and beyond.
- To engage Agricultural Experts in the proposed project countries to use the developed digital platforms to collect and design tailored climate smart advisory, weather alerts, market price information, health and financial inclusive information services
- To use appropriate digital channels to communicate the generated information and warnings to target beneficiaries including smallholder farmers for their innovative farm management decision making vis-a-vi market linkage
- To create a digital database of profiles of the initial 20,000 beneficiary farmers in selected value chains to roll out the services

8. SCPZs PROGRAMME SUSTAINABILITY

In general, there are several key factors to facilitate the viability of a development project. These factors correspond to the likelihood that the innovation introduced by the project is assimilated, rather than rejected, by the receiving environment, as well as the motivation and capacities (technical, economic and other) to see the perpetuation of activities necessary for the maintenance and development of achievements. The viability is linked in particular to the integration of the project into its environment and the sustainability of natural resources or the ecological conditions on which it depends (European Commission, 2001). The viability of a project must be continually reinforced throughout the project, but must also be considered since the design stage. It is therefore in this case a matter of caring about choosing objectives that are sustainable, cumulative, and able, if possible, to break the vicious circles and turn them into virtuous circles.

The durability/sustainability of project achievements should not be a goal to be considered just in the closing phase of the project, it must be defined since the design phase and even since the identification.
In what follows, we have deciphered the critical importance of some key factors that must be taken into account during the project planning phase, in order to ensure the sustainability of a Project. In particular, we quote among others:

Partnership and dialogue with the stakeholders: the extent to which the target and beneficiary groups of the project / program participate in its design and are involved. The project must gain their support for it to be viable once the funding ends.

Support Policy - the quality of the policy in place, and the extent to which the government (s) demonstrate (s) its / their support for the continuation of project activities. It is important to receive the full support of senior management.

Innovation and technology: ensuring that the technologies used by the project can continue to function in the long term (e.g., the local capacities of women and men in terms of operation and maintenance, etc.); in other words, a technology that uses local resources.

Environmental protection: the extent to which the project preserves or harms the environment, and therefore promotes or hinders the achievement of long-term benefits.

Socio-cultural aspects - It is a matter of knowing how the project will take into account local socio-cultural norms and attitudes; and what measures have been put in place to ensure that the beneficiary groups have adequate access to services and benefits arising from the project during and after the implementation.

Gender and minority/vulnerable groups analysis - It is a matter of knowing how the project will take into account the specific needs and interests of women and men; whether the project will provide women and men with sustainable and equitable access to the services and infrastructure put in place by the project; and whether it will contribute to reducing long-term gender inequalities.

Institutional and management capacities - the ability and commitment of the project/program planning/ management team, to continue to provide services beyond the funding period.

Economic and financial viability - the extent to which the project's additional benefits exceed costs and the project represents a viable long-term investment.

As mentioned above, it is important to integrate these factors to ensure the survival of the program. This means that they must be taken into account in the planning of this programme if we decide that the strengthening of the agricultural value chains in the SCPZs flagship programme does not remain a purely hypothetical question.

The acceptance of a project/program in the community can be difficult or even impossible if these considerations are lacking in decision making processes. Today, the sustainability of a program/project involves three (3) indissociable objectives: respect for the physical environment, improved social equity and improved economic efficiency. In addition, a sustainable development program/project is a program/ project that must nevertheless aim at a continuous improvement of the living conditions of all the actors involved in the project.

***Commercial sustainability of** climate information services and early warning systems in SCPZs and Business Model Innovation*

Once deployed, the project aims to be the go-to for market linkages and financial inclusive service in the agricultural for beneficiary farmers and other actors/stakeholders in the value chain. The project will enable service providers to grow by helping farmers to grow their yield and with their businesses. The range of productivity tools to be deployed is expected to increase the beneficiary farmers’ revenues by at least 20%. Such opportunity highlights the responsibility to sustain the tech innovations and gives back to the farmers within the proposed project countries the kind of support they need to leap out of the base of the pyramid.

To ensure the expansion program becomes financially sustainable and scale up the services, a Business-To-Business-To-Customer model will be implemented where existing businesses and organizations already providing services to or targeting farmers as a business, are made to bundle Esoko information services with their service offerings.

Aggregators, Famer Unions (FUs), Famer Based Organizations (FBOs), Input dealers, Financial Service providers, Offtakers, Nucleus Farmers etc benefiting from the platform services will eventually pay for the bundle services rendered to the beneficiary smallholder farmers. The bundled services will include inputs, climate smart agronomic advisories, weather alerts, market linkage advisories, financial services etc.

Smallholder farmers will pay for the bundle services they receive by cash or in-kind with their produce to the Aggregators, Offtakers, FUs, FBOs. For the tracking of filed activities to the last mile, the Aggregators, FUs, FBOs, RTCs, IAIPs, Nucleus Farmers will use their trained field agents using the web and mobile application developed by Esoko called Insyt to gain visibility and create digital footprint of all farming activity of their beneficiary farmers. With this data collected there the opportunity for farmer certification through traceability of farming practices and trainings by quality standard bodies and the also for the creation of creditworthiness and transparency of farmer transactions for the beneficiary farmers to access financial support.

Revenues will be generated through three (3) main streams as outlined in Figure 69.

Figure 69. Business Model

The implementation approach of the SCPZs program itself ensures to a certain extent the durability and sustainability of achievements due to the strong empowerment of communities, due to the endogenous nature of the solutions that make the best use of local resources and skills. In reality, in spite of the good basis of community empowerment, it is necessary to continue the accompaniment of the actors so as not to take the risk of jeopardizing the essential achievements. In Table 54, we present an evaluation of the sustainability of the achievements of the SCPZs flagship programme.

Table 54. Program Sustainability Assessment

Sustainability Factors Consideration	Programme Integration
(i) Partnership and dialogue with stakeholders	All stakeholders are involved in the implementation of the SCPZs programme and its sub-projects. The populations (ultimate beneficiaries) are the privileged targets whose concerns in terms of priority projects should be taken into account, through the consultations meetings with these populations during the infrastructures identification and evaluation missions. This ensures the appropriation of the Program's achievements by the beneficiaries
(ii) Political support	The program is coherent with national and African policies and priorities on Agricultural transformation in Africa. It contributes to the adoption of national and regional frameworks for agricultural transformation and priority investment in this key sector. The Governments concerned expressed a strong political will and commitment to the preparation of the Agropoles through in-kind contributions and regulatory framework strengthening. As a result, they will provide their support and allocate the necessary human and material resources during and after the implementation of the program.
(iii) Appropriate Technologies	The activities will be carried out by national staff with support from experienced and knowledgeable consultants. It is therefore expected that the results will be most effective at reasonable costs, taking into account the local conditions and capacities of all the players concerned. In particular, the introduction of biogas technology to utilize the huge agro-industrial and food waste, as well as ruminant waste, will have long lasting effects in the surrounding communities of the pilot countries.
(vi) Resettlement Plans	Resettlement plans have been factored into the programme to carter for all displaced persons. Thus, the programme is adequately design to protect the environment.
(iv) Socio-cultural aspects	The program takes into account local know-how and traditional knowledge in social context integration, local governance of agricultural value chains resources, resettlement plans, and land tenure conflicts, among others. This will enable the program's and sub-projects benefits to be sustainably anchored in the local context.
(v) Gender and social equity	The information and awareness-raising meetings are dedicated to awareness raising on the need for the concerted, coordinated and integrated approach to agricultural value chains management. A particular focus is on gender and social equity issues, which will contribute to mitigating the long-term gender linked inequalities.
(vii) Institutional and management capacities	The AfDB including other donors, as well as the relevant government departments have the capacities and expertise to implement the Program. However, there is a strong capacity building component (Component 2) planned for all involved stakeholders in the program.
(viii) Economic and financial viability	The additional benefits of the project far exceed its cost. By the funding leverage effect that it produces, the SCPZs programme represents a viable long-term investment for the pilot countries and the programme investors.

9. ECONOMIC AND FINANCIAL VIABILITY OF THE PROGRAMME

9.1. Baseline Programme

9.1.1. Distribution of Programme Cost by Components

In Table 55, we present the distribution of the baseline programme cost by components while the distributional by components weights is presented in Figure 70. As shown, the total cost of the baseline project is valued at US$ 253.26 million while the greatest budget allocation going to component 1 (Figure 70). By countries, Senegal ranks highest with a total budget allocation ($80.0 million), followed by Togo ($68.72) and lastly by Guinea ($16.71). By yearly distribution (Table 56), the bulk of the total programme funds will be mostly expended in Year 2 of the program ($71.97), followed by year 1 ($38.94).

Table 55. Estimated costs of SCPZs Programme (Baseline Components)

AE's Financed Activities	Total Amount	AE	GCs
Component 1	$107.928.537,89	$107.928.537,89	
Component 2	$36.898.080,90	$36.898.080,90	
Component 3	$24.085.918,16	$4.599.909,16	$19.486.009,00
	$168.912.536,95	*$149.426.527,95*	*$19.486.009,00*

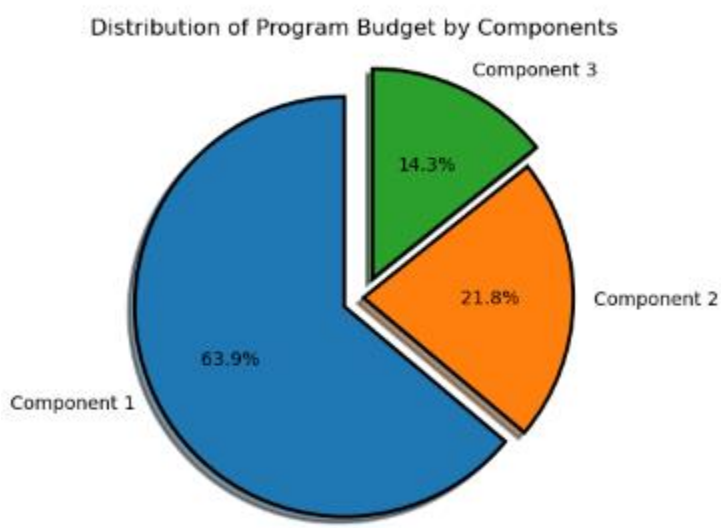

Figure 70. Distribution of Program Budget by Components

Table 56. Estimated costs Per Country (US Millions)

AE's Total Budget Disbursement Schedule by Country Disaggregated by Components in Million USD						
Country	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Togo						
Component 1	$6.128.369,49	$17.009.502,13	$21.105.794,33	$1.617.421,43	$0,00	$45.861.087,38
Component 2	$5.647.165,52	$4.096.782,69	$2.495.977,48	$482.165,68	$483.006,52	$13.205.097,91

Component 3	$3.377.205,94	$1.622.469,44	$1.578.141,23	$1.477.604,82	$1.484.810,44	$9.540.231,86
Sub-total Togo	***$15.152.740,95***	***$22.728.754,26***	***$25.179.913,04***	***$3.577.191,93***	***$1.967.816,96***	***$68.606.417,15***
Senegal						
Component 1	$9.977.664,17	$29.977.272,11	$5.190.884,93	$3.782.571,50	$3.225.297,00	$52.153.689,70
Component 2	$4.568.472,03	$12.781.246,59	$1.427.437,32	$995.290,37	$652.732,10	$20.425.178,40
Component 3	$2.594.272,41	$2.042.471,17	$2.071.894,92	$2.102.007,38	$2.123.166,03	$10.933.811,90
Sub-total Senegal	***$17.140.408,60***	***$44.800.989,87***	***$8.690.217,16***	***$6.879.869,24***	***$6.001.195,13***	***$83.512.680,00***
Guinea						
Component 1	$3.320.970,40	$2.966.622,40	$3.626.168,00	$0,00	$0,00	$9.913.760,80
Component 2	$2.146.996,71	$777.828,28	$266.995,04	$37.815,29	$38.169,28	$3.267.804,60
Component 3	$1.175.856,00	$695.980,00	$712.612,80	$483.752,00	$543.673,60	$3.611.874,40
Sub-total Guinea	***$6.643.823,11***	***$4.440.430,68***	***$4.605.775,84***	***$521.567,29***	***$581.842,88***	***$16.793.439,80***
Grand Total Program Budget	$38.936.972,66	$71.970.174,81	$38.475.906,04	$10.978.628,46	$8.550.854,98	$168.912.536,95

9.2. Additional Programme Interventions

9.2.1. Distribution of Additional Programme Interventions Cost by Components

In Table 57, we present the distribution of the program costs of the new interventions proposed in the program. As observed, the total estimated cost for the new interventions is valued at $102. 79 million. By distribution, the bulk of the entire budget is allotted to component 1 ($141.89 million), Component 2 containing the most of the climate resilience technologies activities has allocation of $92.85 million. By countries, the total budget allocation is as follows; Togo ($38.90million), Senegal ($33.33 million), and lastly Guinea ($30.52) as shown in Figure 71 below.

Table 57. Estimate Costs of Additional Programme Interventions

Components	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*	*Total*
Component 1						
Activity 1.1.1	$8.603.488,80	$6.452.616,60	$3.226.308,30	$2.150.872,20	$1.075.436,10	$21.508.722,00
Activity 1.2.1	$5.876.107,06	$4.407.080,29	$2.203.540,15	$1.469.026,76	$734.513,38	$14.690.267,64
Activity 1.2.2	$2.949.199,20	$2.211.899,40	$1.105.949,70	$737.299,80	$368.649,90	$7.372.998,00
Activity 1.3.1	$21.351.008,90	$44.979.503,79	$25.093.940,01	$3.961.586,03	$2.932.167,06	$98.318.205,78
Total Component 1	**$38.779.803,96**	**$58.051.100,08**	**$31.629.738,15**	**$8.318.784,79**	**$5.110.766,44**	**$141.890.193,42**
Component 2						
Activity 2.1.1	$9.032.188,17	$6.774.141,13	$3.387.070,56	$2.258.047,04	$1.129.023,52	$22.580.470,42
Activity 2.1.2	$8.000.000,00	$6.000.000,00	$3.000.000,00	$2.000.000,00	$1.000.000,00	$20.000.000,00

Activity 2.2.1	$7.312.292,34	$15.404.577,96	$8.594.171,18	$1.356.763,76	$1.004.208,41	$33.672.013,66
Activity 2.2.2	$6.639.012,00	$4.979.259,00	$2.489.629,50	$1.659.753,00	$829.876,50	$16.597.530,00
Total Component 2	$30.983.492,51	$33.157.978,09	$17.470.871,25	$7.274.563,80	$3.963.108,43	$92.850.014,08
Component 3						
Activity 3.1.1	$8.059.135,84	$16.891.556,42	$9.423.752,33	$1.487.729,93	$1.101.142,99	$36.963.317,51
Total Component 3	$8.059.135,84	$16.891.556,42	$9.423.752,33	$1.487.729,93	$1.101.142,99	$36.963.317,51
Grand Total	$77.822.432,31	$108.100.634,59	$58.524.361,73	$17.081.078,52	$10.175.017,86	$271.703.525,01

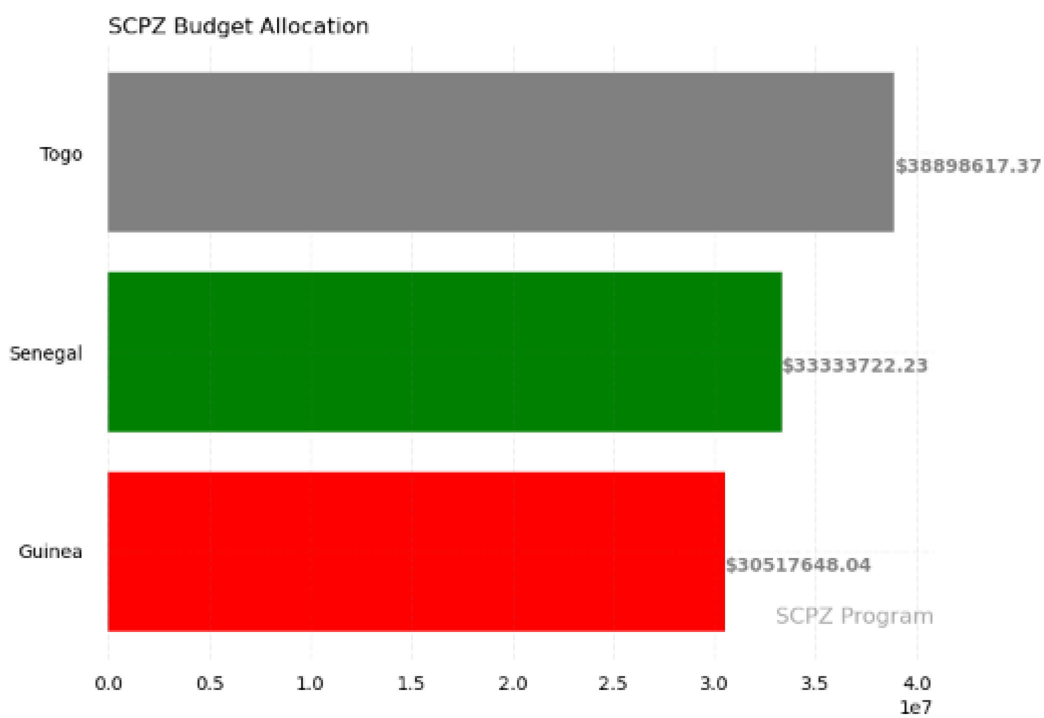

Figure 71. Budget Distributions by Countries (New Program Interventions)

9.3. Economic and Financial Analysis of the Programme

The first phase of the SCPZs program involves three countries, which quite variable inter-country and intra-country socioeconomic, political and agro-climatic characteristics. Thus, the economic conditions will vary between these different agro-climatic zones. Hence, we don’t expect financial model convergence in such instances. For simplicity purposes, we have presented only the results of the cost/benefit analysis of the program. Further details are provided in each country pre-feasibility studies. We begin firstly, with the baseline program economic and financial analysis and next, we move to the new interventions proposed to improve the climate resilience of the program.

9.3.1. Baseline Interventions

(1) Togo

The project is designed to generate a minimum of eight (8) types of benefits: (i) increased value added of cashew nuts by boosting their productivity from about 36.8 kg/tree to about 73.5 kg/tree, representing a yield improvement from 368 kg/hectare to 735 kg/hectare; for an area of 3,027 hectares (including new trees covering 1,500 hectares), production is likely to reach 2,229 tonnes/year; (ii) processing of cashew nuts into higher value-added products such as almonds, cashew nut juice and biogas; (iii) additional farm products from sesame and soybean; (iv) enhancement of most of the agricultural production benefitting from the facilities and climate regulation function of forest cover created by cashew trees, particularly for rice and maize; (v) improvement of the people's welfare by preventing drought and hunger, boosting food security, reducing labour insecurity for families and in particular for women and vulnerable groups, improving the people's life expectancy, increasing their income to allow them to have access to health care and education, etc.; (vi) improvement of animal production and livestock breeding owing to the quality and abundance of pasture and water; (vii) effects of carbon sequestration (carbon credit); and (viii) creation of temporary and permanent jobs resulting from the benefits generated by the project.

Financial Analysis: A significant part of the impacts listed above are not subject to commercial transactions, or are not even tangible and, therefore, do not lend themselves to financial performance analysis, based on existing markets. Under these conditions, it was not deemed relevant to include them in a quantitative analysis, based on the production model or income-generating-activity approach. Nonetheless, it was possible to carry out a FARMOD analysis based on the following five (5) models: (i) cashew nut production; (ii) rice production resulting from the development of the Agro-park; (iii) maize production; and, (iv) soybean production. In light of the above, the financial analysis related to the dividends from agricultural production was conducted for the cashew nut production and processing models, as well as for the crops mentioned above. The operation cycle is 25 years.

The financial analysis led to the following results: (i) a financial impact of about CFAF 4.45 billion per year as of the fourth year of operation projected over 25 years, in line with similar operations, depending on the lifespan of the investments; this means that the financial dividends from the project over the operating period exceed the cost of investment needed for its financing; (ii) a cost/benefit ratio of **1.48**, meaning that the benefits are higher than the cost of investments; (iii) an internal rate of return of **23.84%**, which is higher than the capital opportunity cost (capital cost of financial resources for investments under the project) estimated at **12%**. Based on these results, it can be concluded that Togo's PTAT has a rate-of-return profile that offers a financial justification for the cost of the project's investments.

Economic Analysis: The economic analysis was conducted using the reference price method, namely prices under economic efficiency conditions, in accordance with the "Pareto" optimum criterion. It was also conducted based on a comparison between the "without project" and the "with project" scenarios of the production models discussed in the financial analysis. In this model, cashew nuts were considered a tradeable commodity, meaning that they could be traded outside the country (FOB delivery at the port and CIF delivery at the Hamburg Port). Under these conditions, the reference price of cashew kernels (economic price) is evaluated based on the ex-ante balance of this crop to obtain the export-parity farm gate price. Labour was estimated at 65% of its financial value of CFAF 1,000/day, considering the inelasticity of demand for labour in the country as a whole and in the project area in particular. Based on realistically defined assumptions, the project's economic rate of return is estimated at **23.91%,** with a cost/benefit ratio of **2.14.** Consequently, the overall rate of return of the project may be deemed satisfactory in light of these results.

Sensitivity Analysis: The sensitivity tests conducted based on a reduction in production prices helped to measure the stability of the financial and economic performance indicators. The tests show that prices will have to be reduced to 27.20% (profitability threshold) to offset the additional financial and economic benefits generated at the financial and economic levels respectively, with the IRR and ERR equivalent to the opportunity cost of capital, or **12%**. This test shows that the project's rate of return is robust, although it was not performed on all endogenous values of the model. Nonetheless, the price variable is more significant, being the only variable that is not subject to the management, and hence operation, of the project. A summary of the sensitivity analysis is presented in the annex to the report.

(2) Guinea

The programme is designed to have direct spinoffs in terms of crops promoted and developed through private investments to establish agribusinesses, i.e., about 100 units per agro-industrial parkin Boké, with a total of 200 agribusinesses in under ten (10) years in these two regions. In addition to the spinoffs from private enterprises established in the Boké and Kankan agro-industrial parks, significant income will be earned by the beneficiaries of the agricultural production sites, also developed and from which enterprises will be supplied with raw materials concerning the crops and stock farming activities already mentioned in Section 2.2, i.e. cashew nuts, oil palms, sesame, soya, rice, fonio, groundnuts, maize, potatoes, yams, cassava, fruit (oranges, mangoes and pineapples), tomatoes, onions, okra and chillies, poultry, sheep, fishery products, non-wood forest products such as honey, leaves, wild seeds and fruit, oils and resins and infusions, etc.. However, the analysis does not take into account revenue generated at farm level given that this first phase of the programme only concerns agro-industrial parks. 3.1.2 In addition to these spinoffs, the programme is designed to generate other benefits such as: (i) the creation of temporary and permanent jobs as a result of the programme's achievements estimated at 500 per processing unit (i.e., 10,000, for the agro-industrial units alone).

Financial Analysis: Much of the above-mentioned spinoffs does not concern commercial transactions or is not even tangible and is not suitable for an analysis of financial performance on the basis of existing markets. Under these conditions, it was not considered relevant to factor it in to a quantitative analysis on the basis of a production or profitable business model approach. It was, however, possible, to carry out a cost/benefit analysis of different agro-industrial enterprise and agricultural production models (FARMOD). With regard to agro-industrial enterprises, a scenario is proposed on the basis of three (3) types of processing unit, i.e., small, medium and large enterprises with respective investments of USD 2,5 and 11 million each in accordance with the average investment profiles for this type of model. Under these conditions, annual turnover per enterprise is USD640,000, 1.6 million and 3.52 million respectively for small, medium and large-sized units from the 5th year over an operating period of about 20 years.

As regards agricultural crops on production sites for farmers and suppliers of agro-industrial park enterprises, FARMOD type production models and a cost-benefit model (input/output, with or without programme implementation) will be applied over a 20-year operating period. The financial analysis results were: (i) a financial impact of over USD109 million per year from the 5th year of operation over a 20-year period in accordance with similar types of operation, depending on the investment life cycle. This implies that the financial impacts of the programme over the operational period exceed the cost of investments required to finance it; (ii) **a cost/benefit ratio of 2.27**, where the benefits are higher than the cost of investments; (iii) an internal rate of return of **24.21 %,** which is higher than the opportunity cost of capital (the cost of tying up financial resources for investments under the programme), estimated at **12 %**. On the basis of these results, it may be concluded that the programme has a rate of return profile that financially justifies the cost of its investments.

Economic Analysis: The economic analysis was carried out using the reference price method, i.e. prices under conditions of economic efficiency in accordance with the Pareto optimum. It was also carried out by comparing the 'no programme' and 'with programme implementation' situations of production models used in the financial analysis. In this model, tradeable goods are those likely to be the subject of commercial transactions outside the country (FOB port CIF to port of Marseille). Under these conditions, the reference prices for these products (economic prices) are estimated on the basis of the ex-ante equilibrium of these crops that will give the export parity price at farm gate. Labour was economically valued at 65 % of its financial value of USD3/day to factor in the inelasticity of demand for labour in the country in general and in the programme area, in particular. On the basis of realistically defined scenarios, the programme's economic rate of return (ERR) was estimated at **26.97%**, with a cost-benefit ratio of **2.38**. As a result, the Programme's overall rate of return may be considered to be satisfactory in light of these results.

9.3.2. Additional Programme Interventions

The new programme interventions proposed are designed to generate a minimum of four (4) types of benefits: 1) a direct reduction of at least 512,752 tCO_2e from Solar PV, feedstock bio-digestion and Biogas replacement of diesel and about 197,000 tCO_2e indirectly from the adoption of CRA and agroforestry practices annually; 2) a direct reduction of at least 12,223,843 tCO_2e from Solar PV, feedstock bio-digestion and Biogas replacement of diesel and about 3,940,000tCO_2e indirectly from the adoption of CRA and agroforestry practices during project lifespan; 3) about 10.49 million males and females directly and indirectly benefiting from the adoption of climate resilient livelihood options including over 39,178 ha of land made more resilient to climate change; 6) construction 10 regional modules (APHs) and over 40 agricultural transformation centres (ATCs), including over 148 km new access roads resilient to extreme weather events as well as the rehabilitation of 472 km of roads to be climate-resilient; 7) improved water availability and efficient water supply for crop production and processing by providing; (i) Over 15,000 cubic meters/day from efficient and portable water supply systems, 8 new climate resilient boreholes and rehabilitation of 30 old boreholes, and 3 mini-dams with reduced sedimentation, flood control mechanisms, and reduced maintenance requirements and economic life; and (ii)14.69 MW solar for processing, drying, storage and pumping to improve irrigation efficiency up to 90%, labour, energy and water savings of up to 30%, and reduction in post-harvest losses of about 20% especially for market gardening and cereal crops; 8) over 15% increase in agricultural profit for growing horticulture practices especially in the dry season benefiting at least 2 million women directly and over 20 million indirectly; 9) Deployment of technologies to strengthen climate information services and early warning systems in all the SCPZs

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In the new financial model constructed, emission reductions are expected from electricity generation (with solar power and biogas to electricity), sustainable land use (from resilient agriculture interventions and agro-forestry practices) and from the reduction of biogas (methane) discharged in the atmosphere. Emissions reduction is estimated based on the following total effort (for a budget of $174.01 million):

- Improved cropping activities: **39,178.3** Ha (considering an average cost of $4,702 for 15 years, calculated as the average of all intervention options, a one-time capital cost and O&M costs for 15 years).
- Solar irrigation and lighting and processing: ~14.69 MW of capacity
- Biogas (for electricity: 17.2% of the budget): 10.24 MW of capacity.
- Agro-forestry practices (for carbon sequestration: 20.37% of the budget): 40,000Ha

Table 58. Avoided Carbon Emission from Major Activities of the New Program Interventions

GHG Accounting SCPZ			
Color code:	**Technology**		
red cells: Assumptions	Solar PV for irrigation (MW):	2.59	
black cells: Calculations	Solar PV for lighting and processing (MW)	14.69	
	Volume Digesters (m3)	24,576.66	
Assumptions			
Emission factor (tCO2/MWh) for Diesel	0.64		
Yearly irrigation hours (h)	1825		
Yearly hours for lighting and processing (h)	4380		

Yearly hours running Diesel equivallent biogas plants	4380			
Efficiency of solar PV systems	0.8			
Ratio tCH4/tCO2 eq avoided	25			
Country digesters ratio compared to overall programme	100%			
Energy Balance		**Annual**		
Annual solar energy generation for irrigation (MWh)		3,775		
Annual Solar energy Generation for lighting and processing (MWh)		51,475		
Annual Energy generation from biogas plants (MWh)		44,867		
Emissions Baseline				
Baseline 100% Diesel for solar irrigation and lighting (tCO2eq)		35,360		
Baseline methane discharge from bio-waste (tCO2eq)		477,392		
Baseline Diesel equivallent for biogas generators		-		
Baseline non sequestration by agro forestry (6 Years maturity)		197,000		
Baseline non sequestration by crops		-		
Baseline emissions including CRA and Agroforestry (tCO2eq)		**709,752**		
Abatement (Energy & Waste)		**Annual**	**2030 NDC (Ten Years)**	**Lifetime (25 Years)**
Abatement attributed to solar irrigation systems (tCO2eq)		2,416	19,328.98	60,403.07
Abatement attributed to solar lighting and processing systems (tCO2eq)		32,944	263,550.44	823,595.12
Abatement attributed to the proportion of bio-waste digested (tCO2eq)		424,879	3,399,030.94	10,621,971.68
Abatement attibuted to avoided diesel using biogas for electricity (tCO2eq)		28,715	229,719.56	717,873.61
Agroforestry abatement (Total Ha: 40,000)				
Baseline non sequestration by agro forestry (5 Years maturity)		197,000.00	985,000.00	3,940,000.00

Ex ante estimates abatement by roads construction and rehabilitation (tCo2eq)	-58894.4			
Total Estimated Emission Reductions		685,954	4,837,736	16,104,949
Total funding (USD)	**$271,703,525.01**			
GCF (USD)	**$102,790,988.06**			
Estimated cost per tCO2e	**$16.87**			
Estimated GCF cost per tCO2e	**$6.38**			

Source: Economic and Financial Model (Appendix 3 of Funding Proposal).

The ERRs for the use of renewable energy (Solar PV and Biogas) and CRA practices are presented in Table 59, and Table 60. For detailed calculations and methodologies used, see the Financial and Economic Models (FEMs).

For the comparative analysis of electricity consumption, solar, biomass to electricity, diesel power generators and electricity purchased from the grid are considered. To allow for easy comparison, a capacity of 1 kW is considered for both solar power and diesel generators. The financial assessment was carried out using an interest rate of 1.25%, 2.50%, 3.92% and 7.10%. The analysis reveals the following key findings:

- Investments in solar PV and biogas for electricity generation are not financially viable if an interest rate of 7.1% is assumed. Diesel generators are the most economical option, followed by purchasing electricity from the grid. This indicates that new donor support for investments in solar power and biogas is essential to facilitate the uptake of renewable energy in the SCPZs countries, both for irrigation and for food processing, and for increasing access to electricity. This is because of the higher capital cost for solar PV and biogas, and the incidence of fuel costs for diesel generators. With a high interest (or discount) rate the initial capital cost of solar PV and biogas has strong impact on the financial viability of these investments. The high cost of fuel, despite representing a much higher total disbursement of funding over time, has a small impact on the profitability of the investment, since this expenditure depreciates quickly. Of course, the results may change if we were to consider an escalation of diesel prices in the future, but the results already show strong rationale for donor funding to support the use of solar PV for irrigation or in staple food processing activities.

- With an interest rate of 1.25% instead, approximating a scenario where support is provided to support the uptake of renewable energy, the financial viability of solar PV and biogas greatly improves and bridges closer to that of diesel energy. The LCOE is still slightly, but the discounted cash flow is better than the one for diesel (especially for solar PV). As a result, with a lower interest rate for solar PV, the balance hedges towards renewable energy more markedly, especially when considering externalities (or the avoided externalities of renewable energy).

- Compared to diesel power generation, using solar power saves US$ 6,308.93 in fuel expenditure and contributes to avoiding 64.1 tons of CO2 over a period of 25 years for 1 kW of capacity, the assumed lifetime of the investment. The avoided energy cost is considerable, and indicates the potential to increase disposable income for farmers, creating a synergy with investments in CRA. In fact, lower energy costs would increase the capacity of farmers to pay back loans and to re-invest this avoided cost in CRA interventions. Overall, their economic resilience to climate change impacts would increase. Similarly, compared to diesel power generation, using biogas energy saves US$ 7,059.8 in fuel expenditure and contributes to avoiding 64.1 tons of CO2 over a period of 25 years for 1 kW of capacity.

- Investing in solar energy and biogas reduces the risk of capacity outages and makes the SCPZs countries power generation more resilient to climate change impacts (hence not only increasing economic resilience), both of which contributes to reducing the economic risk for farmers in the long run. In addition, by reducing the reliance on fossil fuels and global oil prices, using solar power leads to more stable and predictable electricity costs in the longer run.

- In addition to the economic and environmental benefits described above, renewable energy is more labour intensive and would hence generate more jobs in production, construction and operations and maintenance. On the other hand, it is currently unknown the extent to which the required labour force would be sourced locally (most likely for operation and maintenance).

Table 59. Financial return parameters for Solar PV

IRR (2XX0-2X25)	13.0%	
IRR with externalities (2XX0-2X25)	3.1%	
NPV (2XX0-2X25)	Cost of Capital Imp Rate	$69,965,516.97
	Social Discount	$2,250,661.48
	ESCO Discount Rate	-$9,333,029.77
NPV with externalities (2XX0-2X25)	Cost of Capital Imp Rate	$11,214,993.28
	Social Discount	-$18,031,634.83
	ESCO Discount Rate	-$22,127,451.05

Table 60. Financial return parameters for Biogas

IRR (20X0-25)	7.6%
IRR with externalities (20X0-25)	1.8%

NPV (20X0-25)	Cost of Capital Imp Rate	$32,967,343.70
	Social Discount	-$8,240,148.36
	ESCO Discount Rate	-$14,830,546.06
NPV with externalities (20X0-25)	Cost of Capital Imp Rate	$4,430,541.88
	Social Discount	-$18,091,837.06
	ESCO Discount Rate	-$21,045,160.70

Climate Resilient Agriculture (CRA)

In order to assess the potential impact of donor support for the implementation of climate resilience agriculture interventions in the SCPZs countries, we have built on previous experience and the literature, and have carried out the following analysis using Cost-Benefit Analysis (CBA). It has been used to assess the net benefits generated by CRA practices compared to the current baseline (Table 61). Hence:

- We have considered major cash crops, cereal, fruits and vegetables, legumes and nuts, and roots and tubers and an area of 1 hectare for implementation (as well as for cost and revenue calculation).
- We have assumed, in a baseline scenario, that yield will progressively decline year after years, reaching a reduction of 20% by 2035. The timeline of the analysis is 2019 – 2035.
- We have analysed five climate resilience agriculture (CRA) interventions: (1) improved nutrient management, and (2) improved genetic resources
- We have created a project financing model to estimate the internal rate of return (IRR), net present value (NPV) and debt coverage ratio (DCR) for each of the 5 interventions analysed. Currently the increase in productivity of crops is calibrated based on the NPVs obtained from the USAID (2017) study and the AFAWA funded project (FP0114).
- For the project financing model, we use a tenor of 5 years, grace period of 3 years, and interest rate of 1.25%. All assumptions (including yield, market prices, and costs of each intervention) are presented in the Excel files attached and can be easily adjusted for replication elsewhere.

Results from the CBA show that the IRR is positive for all interventions with improved nutrient management being the most profitable intervention. These results indicate that there is strong potential for avoiding climate impacts when using CRA interventions, and that these are also economic viable investments for farmers especially smallholder farmers. If support were to be provided to increase access to financing, the risk of a loan being repaid would be low, given the strong upside of productivity and production, and hence revenues. The payback time generally ranges between 1 and 3 years with the DCR looking positive almost immediately for most crops.

Table 61. Economic Rate of Return (ERR) of CRA Practices

CRA practice	Probability Distribution Average		Payback Period
	NPV (10%) in US$	IRR (%)	(Years)
Minimum tillage	($18,384.70)	-1.3	3
Improved agronomic practices, *e.g. crop rotation*	$13,354.10	19.1	1
Integrated nutrient management, *e.g. efficient fertilizer application, split application, timing*	$51,807.30	243.7	1
Improved genetic resources, *e.g. hybrid seeds to improve yield without changing production practices*	$17,667.90	21.4	2
Mixed cropping o make efficient use of inputs	$21,989.40	22.3	1

Drip Irrigation Technology (DIT)

To assess the financial and economic viability of drip supported irrigation technology within the programme context, a drip irrigation investment manual has been prepared (see Appendix 1). This can be contextualised for use in many parts in Africa to help inform irrigation water management policies. Particularly, the investment guide seeks to provide potential farm investors, smallholder farmers, cooperative societies; farmers-based associations and practitioners among others, with an overall guide on drip irrigation systems, particularly in terms of water requirements and irrigated plot sizes (i.e., 100m ^{2} and 500 m ^{2}). It also seeks to equip various farmers based associations, cooperative societies, farm investors and practitioners with the minimum investment and operating costs needed for operationalizing drip irrigation technology under different sampled plot sizes. Finally, the guide provides an economic and financial profitability of drip irrigation under different plot sizes and irrigation systems, which can be easily replicated or out-scaled in different socioeconomic context.

The initial investment for drip irrigation technology is based on a budget of $1,500 per hectare (covering climate resilient activities for women engaged in off season farming including purchase of drip irrigation kits).

The underlying assumptions used are;

- A sample plot with a total surface area of 2,278 m^2 including 1,400 m ^{2} of vegetable plots and 200 m ^{2} reserved for nursery.
- The suggested irrigation system used is composed of drip irrigation kits (iDE[165] technology) adapted to the water requirements of vegetable crops in most parts of the Sahel and SSA (Togo, Senegal and Guinea). These include: (1) water tanks; (2) two kits of 500 m2 for a total of 1000 m2; (3) four kits of 100 m2 for a total of 400 m2; and, (4) a water tower of up to 5,000 litres of capacity, which must be supplied by a regular water supply such as a borehole initially expected to have a discharge potential of at least 5 m^3 h^{-1}
- The following vegetable crops are irrigated during the dry season (onion, tomato, local eggplant, cabbage, pepper, carrot, lettuce, cucumber and okra), all widely cultivated by small farm households in the three pilot countries.
- Variable costs include; drip irrigation kits, solar powered pumps with capacity of 66 kW/ha, water storage tank and small reservoir of with capacity of 5 m3, small agricultural tool kids,

[165] International Development Enterprises

labour (plot installation), cost of site clearing and preparations, fencing of plot, seeds costs, fertilizer, pesticides and disease control, permanent labor (daily labor and follow-up during harvesting), cost of transportation and procurement of supplies for marketing, and a seasonal interest rate of 6% on total variable cost.

- Fixed cost includes interest payment on part of variable costs incurred (6%), and non-fixed cost includes a flexible maximal annual depreciation charge of 5% and total intermediate consumption by households.

Based on this, a cost-benefit analysis (CBA) was carried out to assess the profitability of investing in drip irrigation technology under the programme (2021 - 2030). The cash flow outlay generated by the investment (see Annex 3 B) was used to calculate the Extended Internal Rate of Return (XIRR) and the Net Present Value (NPV) under different Discount Rates. The results are presented in the Table 62 below. As observed, results from the CBA indicate a moderate XIRR of 68% for the investment with an XNPV values of **$89,542.21** assuming a 0.75% interest rate from the GCF (cost of borrowing from GCF). However, when the interest rates are alternated (i.e., using 12% social discount rate and 20% ESCO Discount rate (private sector), the XNPV values drops to $43,842.62 and $27,354.17 respectively, with a payback period of approximately 3.72 years or 44.7 months for the initial investment or $1,500. Even at different discount rates applied for the investment, the results indicate that there is strong potential for investing in drip irrigation technology in the programme in combination with other CRA interventions, and that these are also economically viable investments for farmers especially smallholders' farmers. If support were to be provided to increase access to financing, drip irrigation offers the greatest opportunity for smallholder farmers in these countries. With evidences of recurrent drought and increasing demand for agricultural water, supporting smallholder farmers to invest in drip irrigation technology offers the most promising climate resilient pathway to development. With a minimal investment capital of only $1,500, in five years, women in agriculture in the three pilot countries can earned up to $20,000.0 as shown in the Figure 72.

Table 62. Economic Rate of Return (ERR), DIDS

XIRR (20XX-20XX+5)	68%
XNPV (20XX-20XX+5) **at Discount (0.75% implicit for cost of capital)**	$89,542.21
XNPV (20XX-20XX+5) **at Social Discount**	$43,842.62
XNPV (20XX-20XX+5) **at ESCO Discount**	$27,354.17
Payback Period (Years)	3.72

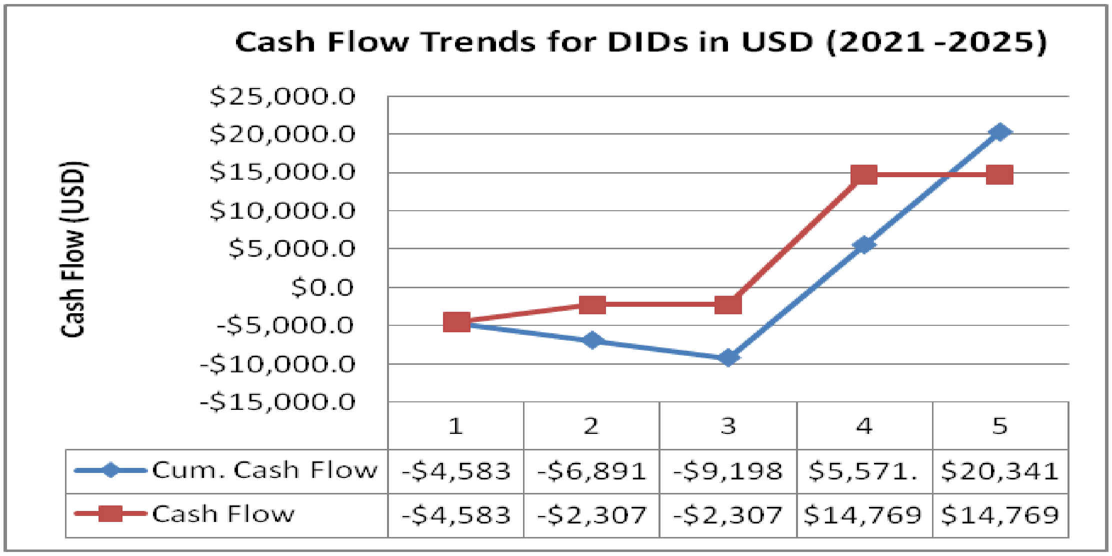


Figure 72. Growth in Cash Flows from Dry Season Vegetable Cultivations using DIDS

Agroforestry Management Practices.

According to Godsey (2006)[166], agroforestry budgeting is a two-step process. The steps are to develop enterprise budgets and combine the enterprise budgets into a cashflow plan. An enterprise budget is a complete, detailed listing of all the costs and revenues expected for each single enterprise, such as cashew, mango, corn, livestock or nut and timber trees. A cashflow plan combines the details from the different enterprise budgets in the agroforestry practice and adds a time dimension. The enterprise budget provides a framework for reporting and monitoring the profitability of each enterprise, and the cashflow plan provides the information necessary to assess and forecast the economic feasibility of the agroforestry practice over time.

The development of an enterprise budget is a three-step process. The first step is to list all possible sources of revenue for an enterprise. For the tree component of an agroforestry practice, it is important to list not only the sources, but also list the timing of those revenues (when fruits are produced if cultivated for their economic potentials as fruit trees). The second step is to list, in detail, all possible sources of variable costs. Variable costs are those costs attributed to the productive use of resources. Variable costs can be grouped into cash and non-cash costs. Variable cash costs include payments for establishment, maintenance, harvesting and marketing. Variable non-cash costs do not require a cash outlay, but reflect opportunity costs. Opportunity cost is simply the value of the next best alternative that is not chosen. For example, labor supplied by family members may not require a cash outlay, but could still be considered in the economic analysis.

The third and final step to preparing an enterprise budget and to list all fixed costs. Fixed costs are typically those costs that are attributed to resource ownership. In other words, fixed costs occur regardless of any productive activity being attempted. Fixed cash costs usually include property taxes, insurance, interest on intermediate or long-term debt, and lease agreements. Fixed

[166]Godsey, D.L. (2006). Economic Budgeting for Agroforestry Practices, www.centerforagroforestry.org/pubs/economichandbook.pdf.

non-cash costs are important when developing an investment analysis, because these costs have significant influence on taxes. However, these costs are difficult to determine. Depreciation and land costs are the two main areas of fixed non-cash costs. Fixed costs may not change as often as the revenues and variable costs. In fact, any changes may be predictable, such as a 2 percent increase in property taxes every year. When reporting fixed costs, be sure and note the source, the amount and the estimated changes that will occur in the original amount.

Summary steps for developing an agroforestry enterprise budget

- List all possible sources of revenue;
- List all possible sources of variable costs (both cash and non-cash);
- List all possible sources of fixed costs (both cash and non-cash).

The economic and financial analysis for agroforestry is based on a per hectare budget of $1,500 each for Cashew, Mango (Kent or Keitt) Arabica Coffee. Based on this, a simple economic budgeting for the three agroforestry practices were carried out. Cashew and Mango (Togo, Senegal, and Guinea). All prices used in the calculations were based on field information gathered from all three countries and calibration using studies so far carried out in these countries.

Cashew - Togo, Senegal and Guinea

Key Assumptions.

- The plantation lifespan is for 25 years
- Yield starts at year 3 and increases at a rate of 3% starting from year 4 to 10. but productivity starts declining after 25 years of producing
- An average of 4.5kg of raw nuts is produced per Cashew tree and 1 ha has approximately 625 Cashew trees.
- Minimum government farm gate price per/kg ranges from 450 - 550 XAF in West Africa.
- Can be intercropped with cabbage, or okra from year 3 especially under irrigation
- Minimum expected yield per hectare is about 2,812.5 kg/ha
- An initial budget of $1,500 per ha is assumed also covering drip irrigation and CRA for vegetable farming.
- Variable costs for per ha production include: site preparations cost (land clearing for liming), digging of holes and fencing the farm); costs of fertilizer (Lime, gypsum and N-P-K); planting cost (seedlings -Grafted scion, cost of transplant, labour cost for planting, and replanting- 1/50th of a hectare each year for first three years); maintenance cost (fertilization (November & December, application of Pesticides/Fungicides, Herbicides, Weed Control (May to September), training (first 4 years) August – September, labour cost for maintenance, and initial investment in irrigation). In economic prices, the variable cost per hectare under irrigated farming conditions is **about** $2,550.05 before yield starts at year 4. (Appendix 3B).
- Fixed and non-fixed costs include: interest payment on part of variable costs incurred (6%) and depreciation charges (5% on depreciable assets), which is about **$276** per/ha.

Developing a Cashew cash flow plan: All figures for the economic budgeting where calibrated based on the following source references[167], [168], [169]. Based on this, the per hectare net profit and cash flow streams for Cashew orchards were also computed for the lifespan of the investment using CBA (Annex 3B). Though the first two years recorded net losses, as soon as the Cashew orchard starts producing in year 3, net profit or income starts flowing in steadily. As observed in the Table 63, overall, investing in Cashew is highly profitable and a viable business in West Africa. The Extended Internal Rate of Return (XIRR) is 66 % with a Net Present Value (XNPV) of $52,484.88 per hectare at 0.75% implicit for cost of capital. When a Social Discount value 12% is considered, the XNPV falls to $14,958.98 and further down to $7,770.72 (at ESCO Discount Rate of 20%) and with a payback period of 3.78 years. Also note that, these values can be increased if intercropped with more profitable seasonal CRA practices such as tomato farming and carrots (the choice is up to the farmers, however, advisory services will be provided to guide these SHFHs)

Table 63. Economic Rate of Return (ERR), Cashew

XIRR(20XX-20XX+5)	66%
XNPV (20XX-20XX+5)at Discount (0.75% implicit for cost of capital)	$52,482.99
XNPV (20XX-20XX+5)at Social Discount	$14,958.98
XNPV (20XX-20XX+5)at ESCO Discount	$7,770.72
Payback Period (Years)	3.78

[167] FAO: FAOSTAT (1991 – 2019): Producer Prices. www.fao.org/faostat/en/#data/PP.
[168] https://www.cbi.eu/sites/default/files/vca-cashew-west-africa_0.pdf.
[169] https://www.researchgate.net/publication/271743844_Cashew_from_seed_to_market_A_review.

10. EXPECTED PROGRAMME EFFECTS

Besides the economic and financial viability of the program, there are other unquantifiable benefits (positive and negative) that the programme will have in these countries. For instance, environmental and social aspects like resettlement of displace peoples, cross cutting issues such as gender considerations among others.

10.1. Togo

10.1.1. Environmental and Social Aspects

Environment

In accordance with the requirements of the Integrated Safeguards System (ISS), the project was classified in Category 1, considering the scope of its environmental and social impacts. A strategic environmental and social assessment (SESA) was conducted to ensure that the incidence of the future activities carried out in the project area are already taken into account and possible mitigation measures have been identified. The SESA was approved by the Togo National Environmental Management Agency (ANGE) on 23 February 2018. A summary of the study was published on the AfDB website on 27 February 2018. The SESA will be implemented taking into account the AfDB and BOAD safeguards policies and will be in conformity with the environmental laws of the Republic of Togo for each activity to be developed on the site. In that regard, environmental and social impact assessments (ESIAs), resettlement action plans (RAPs) and pest and pesticide management plans (PPMPs) are being prepared to study in more detail the impact of the Agro-park infrastructure, the infrastructure of the production area (dams, rural roads, irrigated areas, developed lowlands and social infrastructure), and the electricity and telecommunication line.

Positive Environmental Impacts

From an environmental standpoint, the project will contribute to: (i) improved control of water resources in the three agricultural zones (water-fed, lowlands and irrigated) and of their availability throughout the year (thanks to mini-dams, among other things); (ii) flood risk management (effects on flooding); (iii) creation of wet zones conducive to the development of biodiversity; (iv) restoration of the plant cover of the hills located near the facilities and protection of the natural habitats and banks of the water courses on which dams are built; and (v) development of the biomass through the production of steam or any other type of energy from agricultural by-products (cashew nut shells, etc.).

Negative Environmental Impacts
The SESA revealed the most significant negative impacts that might be generated during construction and operation of the project, namely: (i) loss of biodiversity; (ii) ecological fragmentation; (iii) disruption of fish habitats; (iv) degradation of air quality; (v) greenhouse gas emissions; (vi) water pollution; (vii) soil pollution through the contamination of chemical inputs; and (viii) production of solid waste and waste water. Several mitigation measures have been proposed to contain the negative impacts, including standard measures to be implemented during construction of infrastructure (watering, compensatory reforestation, awareness-raising, waste

management plan, etc.) and specific measures to be taken during the operation phase. The SESA has established appropriate lists of mitigation measures as well as occupational health and safety measures for each product line. For each specific impact assessment to come, a detailed Environmental and Social Management Plan (ESMP) will be prepared based on these indications. A social and environmental management plan (ESMP) will also be developed to promote the provision of resources and the establishment of a framework conducive to the identification, management and monitoring of the project's impacts, while observing the Bank's safeguards measures.

10.1.2. Social Aspects

Positive Social Impacts and Enhancement Measures

At the local level, the beneficial effects of the PTA relate to: (i) development of intensive agricultural activities in the project area; (ii) creation of direct and indirect jobs, especially for young people; (iii) technical education for farmers through training and internships; (iv) development of the primary sector (livestock farming, agriculture, fishery, etc.); (v) opening-up of the main production centres; (vi) strengthening of means of transport (production roads) and means of storage (stores); (vii) increase in gross income per farmer; and (viii) increase in the people's purchasing power as a result of improved nutritional intake and living conditions of households. At the national level, the project will help to boost food production, especially rice production, and reduce rice imports. Enhancement measures have been built into the PTA. The project will support the construction of social infrastructure to improve the people's living conditions through: (i) the conduct of comprehensive studies on the establishment and rehabilitation of mini-drinking water supply (DWS) systems; (ii) long-term electrification of village centres; (iii) implementation of various activities to build the capacities and facilities of the 10 village centres; and (v) installation of 5,000 improved fireplaces, and reforestation.

Negative Social Impacts

The major social, economic, security and health impacts are as follows: (i) physical or economic displacements; (ii) loss of tangible and intangible cultural heritage, (iii) nuisances such as noise and dust during construction work; (iv) increase in the incidence of endemic, parasitic, water-borne and sexually transmitted diseases; (v) increased risks of accident during construction works: (vi) social disturbances and conflicts due to a population influx and deepening of social disparities; and (vii) increased competition for the use of resources. Just like for the environmental impacts, mitigation measures have been proposed to manage the negative social impacts. These measures involve compensation for the affected population, education on health, security and work schedules, supply of individual protective equipment (IPE), arrangement of work schedules and detour routes, etc. These measures will be included and explained in detail in the Environmental and Social Management Plan (ESMP) of upcoming impact assessments. The Environmental and Social Management Master Plan (ESMMP) includes strategic measures for the management of social and environmental impacts.

10.1.3. Cross-cutting Aspects

Environmental and Social Management Master Plan

SESA provides for strategic environmental and social measures to create a framework for identifying, managing and monitoring project impacts. These measures concern: (i) strengthening the political, institutional, environmental and social framework (implementing texts dealing with the SESA); (ii) sound knowledge of the area (baseline situation); (iii) management of natural resources; (iv) surveillance, monitoring and evaluation; and (v) training of actors involved in environmental and social management and education of the people. The implementation of these measures will be supported by the APRODAT and the relevant State entities. Implementation of the ESMMP will be under the responsibility of the APRODAT, which will recruit an Environmental Expert and a Social Development Expert. The implementation of the ESMMP will be monitored by various technical services under the coordination of the ANGE. The total cost of the environmental and social strategic measures is **CFAF 486,000,000,** which has already been taken into account.

Involuntary Resettlement

Resettlement action plans are being prepared for the Agro-park and rural infrastructure. Based on the estimate of land area that will be affected and the value of the land in the area, a provision of **CFAF 800 million** has been set aside to compensate affected persons. A resettlement master plan will also be prepared as part of the project. Although it is not a tool proposed by the Bank's ISS, the resettlement policy framework (RPF) is required as a precaution, to specify the procedure by which land that is not currently affected by the project will be developed subsequently.

Climate Change

Togo and the Kara region are facing severe deforestation related to tree-cutting for farming and alternative income-generation needs. The rate of deforestation is about 15,000 hectares/year, compared with a reforestation rate barely exceeding 3,000 hectares/year. This situation exacerbates the problem of climate change by depleting carbon stock. The PTA also has the potential to contribute to greenhouse gas emissions, owing to tree-cutting for the farmland development, rice production and building of dams. The PTA economic model will help to strengthen climate resilience through less-carbon-emitting activities throughout the agricultural production chains. These activities will involve: promotion of diversified agro-ecological systems and application of green technologies for waste management, as well as production of renewable energy that helps to reduce greenhouse gas emissions. The potential impacts are the following: (i) reduction of deforestation; (ii) increase in farmers' incomes; (iii) enhanced food and nutrition security in the communities; (iv) soil productivity; (v) waste management through organic composting; (vi) employment of women and young people; (vii) use of improved, drought-resistant grains and seeds; and (viii) improved management of water resources.

Gender

According to the 2010 general population census, the Togolese population comprised 48.6% men and 51.4% women, while the rural population, which lives essentially on agriculture, comprises 48.8% men and 51.2% women. The project area is one of the poorest, with a fairly visible impact on women and children. Women are involved in most of the product lines: rice, soybean, sesame, maize. Land insecurity, access to improved seeds, equipment and markets to sell their crops are major problems for women in the area. The following measures and actions will be taken to boost the role of women and maximize their contribution to the project: (i) grouping of women farmers by food product line (rice, maize, soybean and sesame); (ii) allocation of at least 30% of developed land to groups of women farmers; (iii) allocation of a 30% quota, at least, for women industrial promoters in the CTA; (iv) facilitation of women's access to modern agricultural production and processing equipment: inputs (seeds, fertilizers and phytosanitary products), processing materials and equipment (rice parboiling, maize husking); (v) building of the entrepreneurial capacities of women's groups in the production, storage, processing, packaging and marketing of agricultural products; (vi) building of women's capacities in business plan preparation, marketing and networking for the market and access to financing; (vii) facilitation of access to basic services, such as water and electricity; and (viii) facilitation of the process of obtaining civil status documents, such as identification and nationality cards. The budget to be allocated for specific gender promotion and women's empowerment activities is **UA 7.2 million**. The project is classified under category 2, according to the Gender Marker System.

10.2. Senegal

10.2.1. Environmental and Social Aspects

In accordance with the requirements of the Bank's Integrated Safeguards System (ISS), the project was classified as Category 1 due to its nature and potential impacts related to the proximity of sites with ecosystems environmentally and socially sensitive (classified forests, rivers, settlements) and the fact that the project may trigger the 5 Operational Safeguards. Indeed, the project proposes to set up a central module and 3 regional modules with infrastructure for processing agricultural products and departmental platforms with collection and packaging infrastructure. The sites of the regions of Ziguinchor, Sedhiou and Kolda are identified for the implementation of these modules. In this regard, a Social and Strategic Environmental Assessment (EESS) was prepared with the support of the AfDB, and the final report approved by the Department of Environment and Classified Establishments (DEEC). The summary and the EESS were published on the AfDB website on 01 August 2019, 120 days before the project was submitted to the Council. However, because of the categorization of the project, an Environmental and Social Impact Assessment (ESIA) with Environmental and Social Management Plans (ESMP) are required. The project is likely to cause physical and economic displacement, the development of a Resettlement Action Plan (RAP) in accordance with the National Compensation Grid is required to ensure the rights of the people affected by the project.

10.2.2. Economic Aspects

At the economic level, the project should double or even triple the household income from the exploitation of the main targeted sectors (mango, cashew, maize, banana and forest products). The evaluation mission will be an opportunity to refine the calculation assumptions and to make a complete economic and financial analysis, based on the information provided by the feasibility studies. At the social level, the project area corresponds to the natural region of Casamance, which has a population of about 1,872,668 million inhabitants in 2017, and covers the regions of Ziguinchor, Kolda and Sedhiou. However, approximately 14,500 people will be directly affected by the project, while the number of indirect beneficiaries is estimated at 350,000 people (51% of whom are women). The project will target the private sector likely to invest in the project. the processing of agricultural products and the provision of related services (supplies of inputs and services), but also to all the actors in the targeted sectors, including farmers. The development of the infrastructures of the agropoles will be based on labour-intensive and targeted at the poor. Support for decent jobs with a minimum of social security will be provided for enterprises at the core level.

10.2.3. Cross-cutting Aspects

Fragility Aspects

At the level of fragility, the conflict in the natural region of Casamance deepened the social divide dug by years of crisis and rekindled identity / ethnic tensions and land conflicts. Despite a return to calm, rising growth rates, the construction of infrastructure and state efforts for peace, the local population suffers from a certain impoverishment and the social fabric remains fragile. The result is the need to continue efforts for sustainable reconciliation, a return to social cohesion, and inclusive growth as a guarantee of stability and prosperity for all. Thus, efforts must take into account the regional, rural and gender (youth and women) dimension of fragility and consider concerted economic, humanitarian and social responses.

Climate Change

This project offers the opportunity to meet the challenges of climate change (CC) and ensure economic growth and development of the agricultural sector. It will contribute to the implementation at the regional level (Ziguinchor, Kolda and Sedhiou) of the country's Nationally Determined Contribution (NDC) submitted to the UNFCCC, for which the government has identified activities likely to contribute to the fight against CC at the agricultural sector level: improvement and adaptation of crop and forest products; the promotion of agricultural insurance, the promotion of climate information and the scaling up of the concerted management of natural resources. The project may be vulnerable to climate risk (Category 2). It will require a review of CC risks and accommodations. Practical risk management and adaptation options should be incorporated into project design and implementation plans.

Gender

The project runs in a social environment where gender inequalities are still alive and accentuated by the migration of men. This situation reinforces the triple role of women with its corollaries of work overload and poverty. Thus, the project will take into account the specific needs of women and men as well as young people of both sexes. The aim is to reduce the inequalities of access for women and men of all social categories to the opportunities offered by the Agropole. Thus, the actions to be carried out are: (i) equity in the implementation of activities the project (selection of projects, training, etc.), (ii) taking into account the specific needs of women and girls in the choice of infrastructures to be financed (childcare centres, showers and separate toilets, secure, equipped with water, etc.), (iii) support to women's and youth groups, (iv) recruitment of an expert in strengthening gender-specific organizations in the PIU. Thus, the project would be classified in category 2 according to the Bank's gender marker system.

Nutrition

The Rural Survey of Food Security and Nutrition (ERASAN 2014), shows that households in rural areas with food insecurity account for 30% of the total (153,728 households), 12% of which are in a severe situation, and 18% in a moderate situation. The rate of food insecurity is higher for female-headed households at 40.4 percent compared to 29.4 percent for men-headed households. The regions of Ziguinchor (63%), Sédhiou (52%) and Kolda (52%) have the highest rates of households in food insecurity which justifies the establishment of the agropolis. The Project will ensure that modules and platforms take into account the provision of medical services. Criteria for the selection of agricultural households will guarantee access to the agropolis by vulnerable populations. Specific IEC nutrition activities will be undertaken at the community level, with relays, on topics such as dietary diversification, improved infant and infant feeding practices, malnutrition screening and hygiene/sanitation.

10.3. Guinea

10.3.1. Environmental and Social Aspects

Environment

The PDZTA has been classified in Category 1 and, at this stage of its formulation process, is the subject of a Strategic Environmental and Social Assessment. Category 1 programmes are likely to have significant or irreversible environmental and/or social impacts or severely impact the environmental or social impacts considered by the Bank or borrowing country to be sensitive. Boké Department is located in the administrative region of Boké which, itself, is located in **Maritime or Lower Guinea**. With the presence of the Atlantic coast, Lower Guinea is the alluvial basin for major coastal rivers such as the Kogon, Fatala, Konkouré and Kolente Rivers. The area is also covered by mangrove swamps (Rizophora racemose and Avicennianitida). This natural region of Lower Guinea is also home to the country's main mining centres: the Guinean Bauxite Company (CBG) in Boké, ACG in Fria and the Kindia Bauxite Company (Débélé), etc. With regard to potential sites mainly for the PDZA-BK's anchor programmes, in particular the irrigation schemes in Boké Prefecture, the Denken plains covering an area of almost 600 ha located in Kolaboui rural municipality and the Kapatchez plains covering about 9,200 ha located in Kamsar rural community provide significant development opportunities. In the **Boké Administrative Region,** there are also the 9500-hectare Mankountan Plain, the 4,000-hectare Monchon Plain and the 6,000-hectare Koba Plain. Kankan Department, the programme's target area, is located in Upper Guinea. This natural region covers the entire north-east and centre of Guinea's territory. It is a region of plains and savannah, located between 200 and 400 metres of altitude. The Niger River and its tributaries have cut moist terraced flatlands into it.

In relation to the programme, large sedimentary plains in Upper Guinea border the main water courses and cover vast areas**:** the Niger plains in Faranah, Kouroussa, Siguiri, the Milo plains, the Fié plains and the Banié–Tinkisso plains. In Kankan prefecture, the following sites have significant irrigation potential: the Bafèle plain with about 11,000 ha of irrigable land located in Moribaya rural municipality and the Samanka plain with 800 ha located in TintiOulen rural municipality.

10.3.2. Cross-cutting Aspects

Climate Change

Guinea, at the gateway to the Sahel, is highly exposed to climate change. According to 2,100 climate projections, temperatures will rise throughout the country and, more specifically: (i) in Middle and Upper Guinea (north-east and north-west areas of the country), by about 0.4 to 3.3°C, with a sensitivity of 2.5°C; (ii) in Lower Guinea and Forest Guinea (south-west and south-east areas of the country), from 0.3 to 2.7°C with a sensitivity of 2.5°C. This rising temperature will be accompanied by changes in the distribution and volume of rainfall. These changes could reach 36.4 % of the present norm from 2050 and 40.4 % in 2100. Forest resources are among the most vulnerable resources to climate change because of the impact of human activities on forest ecosystems (carbonisation, excessive tree felling, nomadic pastoralism, agricultural clearing, mining and uncontrolled food gathering, etc.).

In terms of greenhouse gas emissions, Guinea remains a very low emitting country, with GHG emission per capita of 2.1 tCO_2e/inhab. in 1994 and less than 0.1% of global emissions. They have, however, increased fairly rapidly. Between 1994 and 2015, these emissions rose 21.5 times, that is, an average annual increase of almost 10 %. This means they doubled almost every 7.2 years. Guinea's objective in this area is to reduce its greenhouse gas emissions by 13% by 2030, compared to the 1994 level. In the forestry sector, this commitment concerns the stabilisation by 2030 of the mangrove areas, the reforestation of 10,000 hectares per year and the preservation of classified forests and protected areas.

Gender

On average, Guinean agriculture contributes an average of 17.5% to 23% to GDP and occupies 50% of the work force 75% of which is in rural areas (RGPH3, 2014). It is largely dominated by family-type farms. Over half of those in work (52.6%) are employed in the 'agriculture, livestock, forestry and fisheries' sector, 50.9% of whom are male and 53.5% female. Women play a major role in the agricultural economy throughout the agricultural chain from production and processing to marketing. However, despite their impact in the agricultural production chain, they still face many difficulties, including:

- Access to resources and factors of production, in particular land, inputs and fertilisers. Because of customs and traditions women are not usually the owners of farmed land;
- In decision-making and conflict management in the agricultural sector, women have less influence;
- In terms of financial resources: the lack of resources is a real problem both in the agricultural sector and in other areas (education, health etc.); and
- Concerning training: this remains a real concern, especially regarding capacity building, entrepreneurship, management… The literacy level of some women is also a handicap.

In order to alleviate these difficulties, the Special Agro-Industrial Processing Zones Development Programme proposes the following gender promotion and women's empowerment actions throughout its implementation: i) entrepreneurship, job creation for women and young people and access to markets; ii) agricultural production capacity building; iii) skill building in agricultural production and processing, starting and managing a business, marketing and market access; iv) sensitisation campaigns on behavioural changes regarding birth control and reproductive health, balanced nutrition, gender and the prevention of gender-based violence, the prevention of early marriages, HIV/AIDS, lifestyle management and environmental sanitation.

According to the Gender Classification System, the programme is classified in Category 2. The detailed gender analysis and gender action plan are presented in the Technical Annex on gender.

The budget allocated to gender promotion and women's empowerment actions is UA 2.883 million.

Involuntary Resettlement

Operational Safeguard 2 (OS 2): Involuntary resettlement: land acquisition, population displacement and compensation: the risk of physical displacement or resettlement of the population is minimal as well as the loss of major assets during the programme's implementation. However, the issues of land tenure and nomadic livestock breeding are two key challenges that should be taken into consideration. In the event of the physical displacement or resettlement of population, Resettlement Action Plans (RAP) will be prepared and implemented in accordance with the Bank's procedures and in compliance with OS2.

11. PROGRAMME RISKS MITIGATION MEASURES

Table 64 below outlines the lists of major risks associated with the programme in each specific country. It also indicates the precautions to be taken to control each risk as well as the severity of the risk if the precaution is not taken.

Table 64. Summary of the Programme Risks

Togo		
Risk 1: Land security measures are insufficient to attract the private sector and protect small farmers	Moderate	Mitigation 1: The SESA has identified mitigation measures in the project, including the implementing decrees of the new Land Code and the establishment of single window for land tenure in Kara
Risk 2: The significant benefits expected from the project could be monopolised by a minority	High	Mitigation 2: SESA (including RAP, and ESIMP, PDC), and Saemaul Foundation participatory and gender sensitive approach and nutrition of the will have positive effects for the people
Risk 3: Climate change and harmful practices of the people could degrade natural resources (NR)	Moderate	Mitigation 3: CRA practices and the development of alternative livelihoods should sustainably enhance the project effects
Risk 4: Lack of interest by the private sector could limit investments planned in the Agro-park	Moderate	Mitigation 4: (i) Meetings were held with the private sector (including Kalyan Group, key investor) and their needs taken into account; (ii) the Project will finance infrastructure for the development of agro-parks and production areas; (iii) support for the implementation of NP reforms is planned (land security, standardization and quality control, PPP, etc.); and (ii) technical assistance (including legal, technical, management, PPP etc.) will be made available to APRODAT
Risk 5: Delays in project implementation due to poor knowledge of AfDB procedures by APRODAT	High	Mitigation 5: Substantial institutional support (see action plans) for APRODAT is envisaged under the project
Risk 6: The significant benefits expected from the project could be monopolised by a minority	Moderate	Mitigation 6: The SESA provides for the implementation of actions (Population Resettlement Action Plan, ESIMP and PDC) that will have positive impacts on the people
Senegal		
Risk 1: Private Sector (PS) Lack of Interest Could Limit Investment	High	Mitigation 1: (i) The PS will be consulted during the evaluation and thereafter;(ii) the PIU and the SCE will put in place the required facilities (infrastructure, one-off facilities, etc.), and;(iii) credit facilities will be put in place
Risk 2: Climate change-CC and harmful population practices can degrade natural resources (RN)	Moderate	Mitigation 2: Integrated NR management, increased agricultural productivity, and access to markets and agricultural insurance will need to mitigate the effects of CC and harmful practices

12. PROGRAMME LOGICAL FRAMEWORK MODEL

The logical framework (Hereinafter, the logical framework model) represents the set of interrelated concepts that describe an operational matrix way the most important aspects of the formulation. It ensures that the program has as many components as necessary to achieve the overall goal. It provides to the different program partners the means to achieve a common understanding of said components and to agree on their content.

12.1. Baseline Components

(1) Togo:

Table 65. *Results-based Logical Framework of Togo*

NAME: Togo Agro-food Processing Zone Project (PTA-Togo)

GOAL: Contribute to inclusive agricultural growth, which will create wealth and jobs, and to the reduction of food imports through increased private investment in priority value chains, including agricultural processing and the supply of inputs and agricultural service.

	RESULTS CHAIN	PERFORMANCE INDICATORS Indicators (including SCI)	Baseline situation	Target	MEANS OF VERIFICATION	RISKS AND MITIGATION MEASURES
IMPACT	1. Contribute to reducing the volume of food imports per capita	1. Value of food imports in USD / per capita	21.3 (2014)	16 (2030)	National Statistics, Statistics of the United Nations System	
	2. Contribute to reducing the poverty rate (especially in rural areas)	2. % of population living below the poverty line (less than USD 1.90/Day)	49.1% (2015)	25% (2030)		
		2.1 Increase in household food security levels 2.2 Decrease in % of children affected by chronic malnutrition (including girls)	32.1% (Kara region)	28.9% (2025)	Demographic and Health Survey 2013-2014 (Baseline situation)	
OUTCOMES	1. The share of locally processed agricultural products has increased	1.1 Share of agricultural production of the project region processed in situ	19%	36%	Baseline Survey and End-of-Project Reports	<u>Risk 1:</u> Land security is not enough to attract the private sector and protect farmers <u>Mitigation 1:</u> SESA has identified mitigation measures, including decrees to implement the Land Code and establishment of the Kara one-stop-shop <u>Risk 2</u>: Inadequate attention to the needs of women and youth <u>Mitigation 2</u>: The Foundation's SESA (including RAP, ESIMP and PDC), and gender and nutrition-sensitive participatory approach will have positive effects on the population <u>Risk 3:</u> Climate change and harmful population practices could degrade natural resources (NR) <u>Mitigation 3</u>: Integrated NR management and the development of alternative livelihoods should scale up the project impacts.
		1.2 Private investments catalysed in agribusiness in the Kara region (USD million)	0	>100	National statistics	
	2. The living conditions of rural inhabitants of the project area have improved	2.1 Rate of household access to basic social services in the project-affected villages has improved: (i) Electricity; (ii) all-weather roads (within 5 km)	(i) 16%; (ii) 11%	(i) 43%; (ii) 22%		
		2.2 Number of direct and indirect jobs created / enhanced (of which 50% are held by women)	0	39,000		
		2.3 Crop yields of crops t/ha: (i) Irrigated rice (double-cropping); (ii) lowland rice; (iii) rain-fed rice; (iv) Corn; (v) soybeans; (vi) sesame; (vi) cashew nuts;	(i) 2; (ii) 1.5; (iii) 1; (iv) 1.2; (v) 0.5 ; (vi) 1; (vii) 0.5	(i) 10 ; (ii) 4; (iii) 2; (iv) 3; (v) 1; (vi) 1; (vii) 1	Demographic and Health Survey in Togo 2013-2014	
		2.4 % of children aged 6-23 months with a minimum acceptable diet	10.5% (Kara region)	20%		
OUTPUTS	**A / Support Policies, Governance and Incentives** 1. Support to improve the institutional framework of the ZTA	1.1 Land Code implementing regulations are enacted 1.2 SSEA-related implementing legislation is enacted 1.2 The national directorates of the Ministry of Industry in charge of food quality are equipped and trained	0 0 0	1 1 1	Baseline and Project Completion Surveys Reports	<u>Risk4:</u> Lack of private sector interest could limit investment in the Agro-park <u>Mitigation4:</u> (i) Meetings have been held with the private sector (including the Kalyan Group, a key investor), and their needs taken into account; (ii) The Project will finance infrastructure for the development of the Agro-park site and production areas; (ii) support for the implementation of PI reforms is planned (land, standards and quality control, PPPs, etc.); and (iii) Technical assistance (legal, technical, management, PPPs, etc.) will be made available to APRODAT.
	2. Establishment of the ZTA Governance System	2.1 APRODAT's capacities are built 2.2 The Agro-park management company is operational	0 0	1 1		
	3. Support to non-financial and financial institutions	3.1 The capacity of training, advisory support and certification structures is built 3.2 Percentage of partner FI portfolios invested in agriculture: (i) Banks; (ii) MFIs	0 (i) 0.3%; (ii) 10%)	1 (i) 3% ; (ii) 15%		
	B / Support infrast. for processing, production and access to agricultural inputs and services 4. Implementation of Agro-Park development infrastructure	4.1 Area of the Agro-park and developed (VRD+BC) 4.2 Annual capacity of Agro-park industrial units (x1000): (i) Rice; (ii) Corn; (iii) Soybean; (iv) Sesame; (v) Cashew nuts; (vi) Feed; (vii) Broiler chicken; (viii) Chicks	0 (i) 0 ; (ii) 0 ; (iii) 0 ; (iv) 0 ; (v) 0 ; (vi) 0 ; (vii) 0 ; (viii) 0	46 ha (i) 90T; (ii) 15T; (iii)10T; (iv) 10T; (v)10T; (vi)20T; (vii) 2000; (viii) 3000	Baseline data: year 2017	
	5. Infrastructure for production aggregation and access to agricultural inputs & services	5.1 No. of ATCs built and equipped 5.2 Total length of rehabilitated roads	0 0	10 100 Km	Project semi-annual activity reports	
	6. Establishment of agricultural production support infrastructure	6.1 Number of small dams built (capacity in m3) 6.2 Area covered by studies (i) Irrigation schemes; (ii) Lowlands developed (ha)	0 0	2 (Vol. >15 M.m3) (i) 1500 ha; (ii) 1500 ha		
	C / Capacity building of sector actors 7. Capacity building of priority value chain POs	7.1 No. of ATCs with capacity built 7.2 No. of key OPAs trained and supported 7.3 Number of farmers with access to services provided by ATCs (inputs, harvest management, e-farming, etc.)	0 0 0	10 50 10 000 (incl. 30% wom.) 10 000 (incl. 30% wom.)	Bank Supervision Reports	<u>Risk 5:</u> Project delays due to APRODAT's lack of control over the Bank's procedures) <u>Mitigation 5:</u> Substantial institutional support (see action plans) is planned for APRODAT within the framework of the project.
	8. Capacity building for communities	8.1 No of OPA support sub-projects completed (2 ATCs) 8.2 Number of improved stoves installed 8.3 Number of civil status documents established through the project	0 0 0	6 5000 50 000		
	9. Strengthening access to state services	9.1 Capacity building of state services in participatory approach, gender, health and nutrition, etc. 9.2 Capacity building for SESA implementation 9.3 Monitoring of ESIA, ESMP, RAP and PGPP (ANGE)	0 0 0	1 1 1		
	D / Coordination, management and monitoring and evaluation Steering and Coordination, Procurement, Financial Management Audit, Monitoring and Evaluation	Financial management /accounting/procurement procedures and systems prepared and implemented Number of PM Plans submitted on time and approved Annual audit report submitted on time Number of semi-annual progress reports submitted on time Project baseline and completion surveys conducted	0 0 0 0 0	1 5 5 10 2		
KEY ACTIVITIES	<u>Components:</u> (1) Support Policies, Governance and Incentives; (2) Support Infrastructure for Processing, Production and Access to Agricultural Inputs and Services (3) Capacity Building for Agro-industrial Sector Actors; (4) Coordination, Management and Monitoring and Evaluation	<u>Resources by component:</u> (1) Component A: UA 4.983 million (11%); (2) Component B: UA 30.339 million (67%); (3) Component C: UA 4.440 million (10%); (4) Component D: UA 5.304 million (12%)			<u>Sources of funding:</u> (i) ADF loan: UA 8.04 million, ADF Grant (with PPF): UA 4.635 million; (ii) TSF: UA 8.32 million; (iii) BOAD: UA 12.80 million; (iv) Saemaul Foundation: UA 3.52 million; (v) State: UA 7.74 million	

Table 66. Programme implementation timetable for Togo

Project Implementation Schedule

Year	2018				2019				2020				2021				2022				2023			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Preparatory activities																								
Project appraisal																								
Loan, grant negotiations and approval																								
Signing of loan/grant agreements and compliance with conditions precedent to first disbursement																								
Publication of General Procurement Notice																								
Finalisation of selection of key staff and project launch																								
I / Support policies, governance and incentives																								
Recruitment of the technical assistance firm at APRODAT and delivery of services: preparation of procedures manual, legal instruments, specifications of the management company. Technical Assistant to the Contracting Authority (ACA), training, etc.																								
Procurement of equipment and capacity building for: APRODAT, Quality Directorates in charge of quality (Min.industry), Agricultural Technical Services, Agro-Park Management Company, etc.																								
Recruitment of firms and feasibility study for two new ZTAs (OTI and Haut Mono)																								
Selection of and capacity building for non-financial and financial institutions (equipment and training): guarantee funds, IT equipment and agribusiness oriented training																								
II/ Support infrastructure for processing, production and facilitating access to agricultural inputs and services																								
(i) Architectural Studies and preliminary project design and bidding documents (APD/DCE) for the Agro-park, (ii) APD/DCE for small dams and irrigated areas; (iii) complete studies on dam B9; (iv) Access roads and Agricultural transformation Centres-ATC (10)																								
Development of the Agro-park including roads and sundry networks (drinking water, electricity, sanitation, roads, etc.), DWSS, WTP and BC. selection of service providers &works implementation																								
Rehabilitation of access roads (national budget)and construction of 10 ATCs (ADF/TSF) selection of service providers and works implementation																								
III/ Capacity building for actors in agricultural sectors																								
Capacity building for 10 ATC (sector structuring, technical and management training, support for input procurement/management, agricultural services including e-farmers platform, etc.)																								
Support for the implementation of priority sub-projects in the key sectors of 2 pilot ATCs (Sasakawa Globalization Foundation)																								
Capacity building for rural communities: local planning, environmental management, nutrition manufacture of improved stoves, civil status documents, etc.)																								
Capacity building for central and decentralise services (local development approach, action plans for protected areas and pesticides, ESMP/RAP, missions and training, etc.)																								
IV/ Project coordination and management																								
Implementation of the financial, administrative and accounting management system																								
Establishment of the baseline situation and implementation of the monitoring and evaluation system																								
Coordination and management, monitoring and evaluation and communication																								
Technical assistance to APRODAT (procedures manual, engineering, legal matters, etc.)																								
Annual audit reports																								
Mid-term review																								
Completion report																								

(2) Senegal:

Table 67. *Results-based Logical Framework of Senegal*

TITRE : **Projet de Zone de Transformation Agro-Industrielle du Sud (Agropole Sud), PZTA-Sud, Sénégal**						
BUT :**Contribuer à réduire la pauvreté et l'insécurité alimentaire en milieu rural, et à la réduction des importations alimentaires à travers notamment l'accroissement de l'investissement privé dans les filières prioritaires**						
	CHAINE DES RESULTATS	**INDICATEURS DE PERFORMANCE**			**MOYENS DE VERIFICATION**	**RISQUES ET MESURES D'ATTENUATION**
		Indicateurs (y compris les ISC)	**Situat. référence**	**Cible (*PSE)**		
IMPACT	1. Contribuer à accroitre la valeur ajoutée du secteur agro-industriel 2. Contribuer à réduire le taux de pauvreté (notamment en milieu rural)	1.0/Poids de l'industrie dans le PIB (%) 1.1/ **Valeur des produits alimentaires (i) importés ; et (ii) exportés (en $US per capita)** 2.0/**Taux de pauvreté national en milieu rural (modéré et sévère- seuil national de 1,25 $EU/jour)** 2.1**Prévalence de la malnutrition aigüe (% des enfants de moins de cinq ans, dont fille)**	20,6 (2017) 41,2% (2017) 9% (2017)	25% (2023) 33% (2023) 4,6% (2023)	Statistiques Nationales et du SNU Ref.	
EFFETS	1/. La part des productions agricoles transformées sur place s'est accrue 2/. Les conditions de vie des populations rurales de la zone de projet se sont améliorées	1.0.1/Niveau de transformation des produits agricoles: i) mangues;ii) noix de cajou; iii) maïs (dt % fortifié); iv) banane ; v) produits forestiers non ligneux 1.0.2/**Montant cumulé de l'Investissement privé (IP) catalysé par l'agro-industrie (en million $US)** 1.0.3/ Nombre de sous-projets financépar le secteur privé dans l'Agropole Sud 2.0.1/Niveau de revenus annuels des ménages ruraux ciblés de la zone de projet 2.0.2/Nombre d'emplois créés/ renforcés (dont 50% femmes et 60% jeunes): (i) directs et (ii) indirects	i) ; ii) 0 0 AC i) 0 ; ii) 0	i) ; ii) >200 19 AC i) 4500 ; ii) 14500	Rapports d'Enquêtes de référence et de fin de projet Situation réf. : Statistiques nationales Enquête démographique et de santé	Risque 1: Le manque d'intérêt du secteur privé (SP) pourrait limiter les investissements Mitigation 1: (i) Le SP sera consulté durant l'évaluation et par la suite ; (ii) la CEP et la SCEmettront en place les facilités requises (infrastructures, guiches uniques, etc.), et ; (iii)les facilités d'accès aux crédits seront mises en place Risque 2: Les changements climatiques-CC et pratiques néfastes des populations peuvent dégrader les ressources naturelles (RN) Mitigation 2 : La gestion intégrée des RN, l'accroissement de la productivité agricole, et l'accès aux marchés et à l'assurance agricole devront mitiger les effets du CC et accroitre les effets du projet.
CHAINE DES RESULTATS		**INDICATEURS DE PERFORMANCE**			**MOYENS DE VERIFICATION**	**RISQUES ET MESURES D'ATTENUATION**
		Indicateurs (y compris les ISC)	**Situat. référence**	**Cible**		

(3) Guinea

Table 68. Results-Based Logical Framework for Guinea

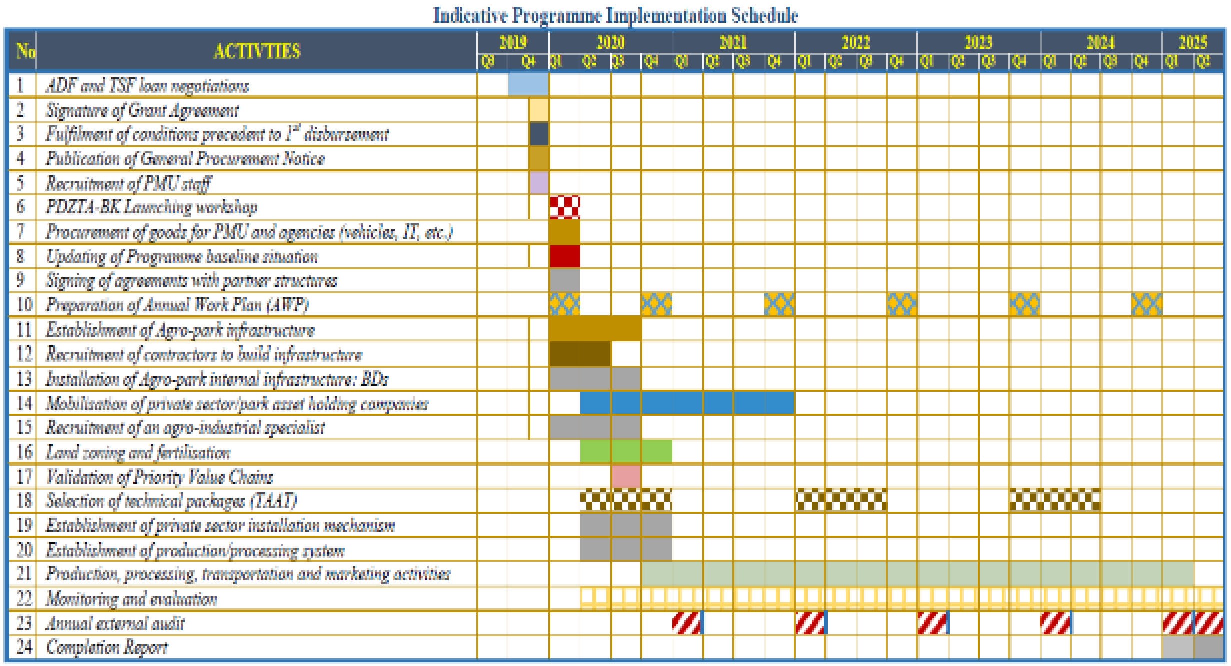
Results-Based Logical Framework

REPUBLIC OF GUINEA: BOKÉAND KANKAN SPECIAL AGRO-INDUSTRIAL PROCESSING ZONES DEVELOPMENT PROGRAMME (PDZTA-BK)
Programme Goal:Promote the inclusive transformation of wealth-generating and job-creating agriculture through the reduction of imports of agro-food products by increasing private investment in the priority value chains.

	RESULTS CHAIN	PERFORMANCE INDICATORS: Indicator (including CSIs)	PERFORMANCE INDICATORS: Baseline Situation	PERFORMANCE INDICATORS: Target	MEANS OF VERIFICATION	RISKS/ MITIGATION MEASURES
	LONG TERM		2015/2016	2025 ≤		
IMPACT	Impact 1 : Contribute to the reduction of agro-food imports	Value of agro-food imports	MUSD725	MUSD< 575	▪ Annual Report on Guinea's economic performances	
	Impact 2 : Contribute to the improvement of food and nutrition security	Severe/moderate prevalence of food insecurity	17.6%	< 15.0 %	▪ MICSsurvey ▪ Periodic report on Guinea's socio-economic performances	
		Chronic malnutrition prevalence rate (6-59 months)[1]	32.4 %	20.0%		
	MEDIUM TERM		2020	2025		
OUTCOMES	Outcome 1 : agricultural product processing time is improved	Average agricultural product processing rate	<3 %	≥ 12 %	▪ Ministry of Agriculture and Rural Development's Annual Report	**Risk:** Risk of weak private sector mobilisation / Political risk that could influence the choice of options and result in slippage on implementation **Mitigation Measure:** the programme was designed on the basis of a platform of exchange of information with the private sector whose concerns are taken into account in the programme's final formulation, a guarantee of SME involvement in, and ownership of, the programme. The political risk is mitigated by ongoing consultation with the Authorities, stakeholders and technical and financial partners to guide their choices in an objective manner and factor this constraint into the programme's planning.
	Outcome 2 : Level of private investment in agriculture has increased	Number of operational private small and medium-sized agricultural enterprises	<3	≥ 10	▪ Ministry of Agriculture's Monitoring Report	
	Outcome 3: the living conditions of people living in the PIA have improved	Number of direct and indirect jobs created benefiting men/women (M/F).	0/0	≥ 18,000 / > 7,000	▪ Guinean Employment Promotion Agency's (AGUIPE) Annual Report ▪ MICS Survey	
		% of children 6-23 months of age who receive a minimumacceptable dietin Boké / Kankan	0.5%/ 1.6%	10% / 12%		
	SHORT TERM		2019	≤ 2024		
OUTPUTS	**Output 1** :Good governance and incentive measures established	Number of agro-industrial hubs established and operational	0	2	▪ Programme Monitoring and Evaluation Reports	**Risks:** slow acceptance by certain stakeholders could delay the programme's implementation.
		Number of texts and codes prepared[2]	0	≥ 2		**Mitigation:** the programme was designed on the basis of systematic sensitisation and consultation to ensure its gradual ownership by all stakeholders
	Output 2 : Processing infrastructure completed	Service infrastructure in the Boké agro-industrial park (site development lot)	0	1	▪ Monitoring and Evaluation Reports	
		KW of transformers installed	0	155,705		
		Length of fibre optic installed (Km)	0	50		
	Output 3 : Programme steering, coordination, management and monitoring-evaluation carried out	Programme's physical implementation rate	0	≥ 95%	▪ Quarterly Status and Monitoring and Evaluation Reports and Annual Activity Reports ▪ Programme Mid-Term Review Report ▪ Programme Completion Report	
		Number of supervision missions	0	10		
		Mid-term report is approved	0	1		
		Completion Report is completed	0	1		
ACTIVITIES	COMPONENTS				INPUTS (million UAs)	
	Component 1: Support for Governance and Incentive Measures:		MUA **2.34**		ADF Loan:	2.99
	Component 2 : Development of Agricultural Processing Support Infrastructure		**MUA 6.50**		ADF Grant:	2.94
	Component 3 : Programme Management and Coordination:		**MUA 1.85**		TSF Loan:	3.69
					Government:	2.67
					TOTAL :	**12.29**

[1] The respective chronic malnutrition prevalence rates of 33.3% and 35.9% in the regions of Boké and Kankan will be reduced by at least 35%, i.e. ≤21.65 % in Boké and ≤ 23.34 % in Kankan.

Table 69. Indicative Programme Implementation Schedule



12.2. Additional Programme Interventions

12.2.1. GCF Impact Level: Paradigm shift potential

Table 70. GCF Impact Level: Paradigm shift potential

Assessment Dimension	Current state (baseline)		Potential target scenario (Description)	How the project/programme will contribute (Description)
	Description	Rating		
Scale	The Staple Crops Processing Zone (SCPZ) programme is designed to promote sustainable agricultural value chains in three African countries including Senegal, Guinea and Togo. These countries which rely heavily on agriculture, lie within the major climate 'hotspots,' and experience the deleterious impacts of climate change. Although there are	<u>Medium</u>	Paradigm shift will involve the inclusive adoption of climate resilient agro processing practices and shifting from fossil fuels to renewable technologies to improve resilience of agrosystems, agricultural assets and beneficiaries while contributing to reducing GHG emissions from the processing and agroforestry practices. With further support from Climate Information and Early Warning Systems, beneficiaries will be better prepared to react proactively to climate hazards rather than facing the consequences in the aftermath.	*Describe key applicable outputs and or resulting outcomes relevant to increasing (scaling up) quantifiable results within and beyond the scope of the intervention.* This programme will strengthen climate resilience and reduce GHG emissions within the agricultural value chain to help stimulate productivity and value addition, competitiveness, employment and incomes generation by facilitating access to technical assistance and concessional financial resources to communities within the three countries which rely heavily on agriculture

	various initiatives to help build the resilience of smallholder farmers and rural communities to climate change in the selected countries, these activities are fragmented. However, achieving this is not easy and may not be entirely possible unless key technical, financial, policy and regulatory obstacles that lead to fragmented and ineffective interventions in key sectors like agriculture, land use and forestry, water and energy are carefully addressed. Unless these obstacles are overcomed, implementing programmes in the normal "business as usual" way in the context of climatic stress, are clearly inadequate and only add to the numerous challenges such as increasing emissions of GHG from agriculture, land use and forestry, food insecurity, malnutrition and heightened conflicts over resources use			The Intervention is projected to deliver: • About 2.9 million direct beneficiaries and 10 million indirect beneficiaries of which 54% will be females. • Over 79,000 ha of land made more resilient to climate change. • A direct emission reduction of at least 16.14 million tCO_2eq by the end of the project lifetime from an integrated approach that combines (i) solar PV for irrigation, lighting and processing, (ii) replacement of fossil-based and biomass-based energy systems with solar and biogas technologies and (iii) agroforestry practices. • Contribute to achieving over 9% of conditional mitigation targets of Nationally Determined Contribution (NDCs) in the 3 countries. • Over 15% increase in agricultural profit for growing horticulture practices especially in the dry season benefiting at least 79,000 smallholder farmers, of which 50% will be females. • Over 20% increase in the yields of maize, soybean, rice, cassava, banana, sesame, horticulture,

				mango, cashew and coffee. Given the prominent importance of agriculture in these three countries and in other countries in Africa, successful implementation of this programme and lessons learnt from same will act as a blueprint to scale up the programme within the beneficiary countries and neighbouring countries as well.
Replicability	Given growing population and increasing economic activity, many countries have approached the AfDB to set up SPCZ in other RMCs to help them improve and optimise their agro processing capabilities therefore increasing food security and improving economic prospects. Moreover with current geopolitical instability and increasing price of basic commodities on the global market, the demand for modernized and climate resilient infrastructure is bound to increase globally	Medium	If successfully implemented, farming communities in the beneficiary countries will have enhanced climate resilience while being able to sustainably power their operations. Moreover, the project will bring along social co-benefits including positive health impacts and gender sensitive development impacts. Therefore, the solution could be replicated across the city, to other regions in the country, and even internationally.	*Describe key applicable outputs and resulting outcomes that will be replicated to other sectors, markets, geographical regions, or countries.* The programme will contribute through lessons learned which can then be adapted to other regions and countries where the farming and pastoral profile is different. The community driven approach as well as private sector engagement will also contribute in bettering the design and execution of similar projects in the future.
Sustainability	The governments of the three countries have committed to very ambitious NDCs whereby adaptation to climate particularly in the agricultural sector is strongly emphasized as is	Medium	The sustainability measures were already embedded in the design of the agricultural transformation centres and agro-industrial parks where shared facilities are provided to producers, processors, aggregators and distributors to operate in the same vicinity to reduce transaction costs and share business development services for	*Describe key applicable outputs and resulting outcomes that will be sustained beyond the project/programme period.* The project will support the private sector through concessional loans and grants for the deployment of low carbon technologies, and Climate information and Early

	the increased electrification of rural communities using renewable energy. This provides strong foundations for the ongoing management and development of greener agricultural infrastructure.		increased productivity, diversification and competitiveness. The PPP arrangements for the operation and management of the facilities for user fees will ensure that there is adequate revenue generated to maintain the facilities including the solar (lighting and irrigation) and biogas assets financed with GCF financing.	Warning systems. Moreover, GCF intervention will promote an inclusive approach and will strengthen institutional structures to promote accountability and good governance

12.2.2. GCF Outcome level: Reduced emissions and increased resilience

Table 71. GCF Outcome level: Reduced emissions and increased resilience

GCF Result Area	IRMF Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions / Note
				Mid-term	Final[170]	
Total GHG emission reduction	Core 1: GHG emissions reduced, avoided or removed/sequestered		0 Mt CO_2 eq.	Reduction of 2,057,861 tons of CO2eq (3rd year of project after	Reduction of 4,837,736 tons of CO2eq (5th Year of project implementation) and 16,140,949 tons of CO2eq during project lifespan	Implementation targets for solar PV and biodigesters are met as per project timelines.
MRA1 Energy generation and access	Core 1: GHG emissions reduced, avoided or removed/sequestered	Reports by an independent specialist as part of the yearly M&E report to be produced during project implementation. This can be cross checked against reports by project developers or against NDC/ biennial communications	0 Mt CO_2 eq.	Reduction of 2,057,861 tons of CO2eq (3rd year of project after	Reduction of 4,837,736 tons of CO2eq (5th Year of project implementation) after entire 10 MW of biogas systems and 14.69 MW of solar systems are in place across the 4 countries)	65% of Renewable Energy Capacity is installed and displacing Diesel and methane emissions from waste at year 3. 100% of Renewable Energy Capacity is installed and displacing Diesel and methane emissions from waste at Year 5.

[170] The final target means the target at the end of project/programme implementation period. However, for core indicator 1 (GHG emission reduction), please also provide the target value at the end of the total lifespan period which is defined as the maximum number of years over which the impacts of the investment are expected to be effective.

						16,140,949 tons of CO2eq avoided during project lifespan for all project activities
MRA4 Forestry and land use	Core 1: GHG emissions reduced, avoided or removed/sequestered	Reports by an independent local carbon verifier	0 Mt CO_2 eq.	0 Mt sequestrated at year 3 CO_2 eq.	197,000 tons of CO2eq sequestrated at year 5	GHG estimates are based on the 5-year GCF project duration. Additional GHGs will be reduced during the project´s lifetime (25 years) and equivalent to 3,940,000 tCO2 Annual emissions reduction from land use (Agroforestry): 197,000 tCO2eq
Total number of programme beneficiaries	Core 2: Direct and indirect beneficiaries reached			3.5 million by year 3, of which: Male= 1.6 million Female =1.8 million	10.49 million by year 5, of which: Male = 4.8 million Female = 5.68 million	Value chain actors, communities, and institutions etc., are willing to adopt climate resilient livelihood options & technological innovations, introduced by the programme.
ARA1 Most vulnerable people and communities	Core 2: Direct and indirect beneficiaries reached	At the Programme levels: Socioeconomic baseline surveys[171]& Programme progress/	0	3.5 million by year 3, of which: Male= 1.6 million Female =1.8 million	10.49 million by year 5, of which: Male = 4.8 million Female = 5.68 million With the following breakdown:	Value chain actors, communities, and institutions etc., are willing to adopt climate resilient livelihood options & technological innovations,

[171]This has been budgeted as part of the baseline investment in all three countries (1 at programme inception, 1 during mid year and the last one at year 5)

		completion reports submitted by MOTI, APRODAT, MDIPMI& ADAZZ At National levels: Labour force participation surveys (LFPSs), & Demographic and health surveys (DHSs)[172]. Annual M&E reports (refer to Annex 11) will include recording of data associated with beneficiaries derived from records established by project developers and cross checked with national statistical records undertaken during project implementation			Togo: 912,98 (direct beneficiaries) and 1,238,231 (indirect beneficiaries) Senegal: 918,375 (direct beneficiaries) and 4,925,721 (indirect beneficiaries) Guinea: 758,047 (direct beneficiaries) and 1,733,259 (indirect beneficiaries)	introduced by the programme. Training of beneficiaries will materialized in an increased uptake of climate resilient livelihood options. Uptake of climate resilient livelihood options will benefit various segment of the society, including but not limited to, family members and the growth of MSMEs. Programme funds are disbursed as planned.
	Supplementary 2.4: Beneficiaries (female/male) covered by new or improved early warning systems	Annual Performance Report Daily, weekly and seasonal publication and distribution of agriculture-specific weather forecasts	7,800 in Senegal 0 in Togo 0 in Guinea	20,000 more in each of the four SCPZs (80,000)	50,000 more in each of the four SCPZs (200,000)	Farmers are trained on how to use climate information. Farmers are trained on how to maintain simple rain gauge station There is adequate medium for communicating and disseminating climate-

[172] Usual reported on a yearly basis. However, the field statistics used for preparing the yearly reports are carried out quite frequently in most countries (quarterly or mid-year).

						base agro-advisory services
ARA2 Health, well-being, food and water security	Core 2: Direct and indirect beneficiaries reached			Beneficiaries are part of ARA1 estimates	Beneficiaries are part of ARA1 estimates	
	Supplementary 2.3: Beneficiaries (female/male) with more climate-resilient water security	Methodology to be based on the definition for water sources developed by the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) and carried out in the following ways: Socioeconomic baseline surveys administered to project beneficiaries & Programme progress/ completion reports submitted by , APRODAT, MDIPMI& ADAZZ At National levels: Regional level data collected by the Institute of *Statistics* and Economic and Demographic Studies (INSEED) - *Togo*; Agency of Statistics and Demography of Senegal (ANS D), &Statistical Office of Guinea	0 Information to be updated from socioeconomic baseline survey.	A total of 239,853 beneficiaries of which: Male= 110,332 Female = 129,521	A total of 599,631 beneficiaries by year 5, of which: Male = 275,830 Female = 323,801	Enabling environments are created for strengthening of safe water supply (e.g., farmers water user groups/committees, O&M training etc.) Access to reliable and safe water supply benefits different segments of the society especially beneficiaries household members.

[1] The final target means the target at the end of project/programme implementation period. However, for core indicator 1 (GHG emission reduction), please also provide the target value at the end of the total lifespan period

which is defined as the maximum number of years over which the impacts of the investment are expected to be effective.

[2]This has been budgeted as part of the baseline investment in all three countries (1 at programme inception, 1 during mid year and the last one at year 5)

[3] Usual reported on a yearly basis. However, the field statistics used for preparing the yearly reports are carried out quite frequently in most countries (quarterly or mid-year).

12.2.3. Programme specific indicators

Table 72. Programme specific indicators

Project/programme results (outcomes/ outputs)	Project/programme specific Indicator	Means of Verification (MoV)	Baseline	Target		Assumptions / Note
				Mid-term	Final	
		Sources of information and methods used to collect and report data/information to measure progress against targets	*The starting point or current value of the indicators before the implementation of the project*	*The estimated value of the indicator at the mid-point of the implementation*	*The estimated value of the indicator at the completion of the implementation*	*Externalities and factors outside project management's control that may impact on the Component* *Data sources and methodologies applied for estimating baseline and targets*
Output 1.1: Improved access to drip irrigation distribution systems (DIDS) powered by solar pumps to support climate resilient agricultural (CRA) practices	1.1.1Hectares of land under DIDS that contributes to climate resilient livelihood options	Agricultural baseline surveys, Annual agricultural statistics, Crops surveys, Project M&E reports, FAO Statistics. National reports on area of land contributing to climate resilient livelihood	0	27,400 additional ha by mid-term (3 years implementation) Togo: 10,800ha Senegal: 8,360 ha Guinea: 8,240ha	39,179.3 additional ha at end of year 5 Togo: 15,428ha Senegal: 11,941/ ha Guinea: 11,810ha	Programme beneficiaries are willing to form farmers water users groups/committees that will operate and maintain on-farm surface water catchments.
	1.1.2Expected Number of males and females benefiting from the		0	25,653 females & 21,853 males	42,756 females and 36,422 males	Small farmholders are willing to participate and adopt DIDS.

	adoption of DIDS for diversified, climate resilient livelihood activities	under SCPZ				
Output 1.2: Enhanced access to renewable energy technology for staple food crops processing	1.2.1. Annual Solar energy Generation for lighting and processing of food crops (MWh)	Report of Baseline survey on power generated annually for lighting and processing in the Agro-parks	0MWh	102,950 MWh of solar energy generation by mid-term. (40% of final target)	257,375 MWh of solar energy generation by end of year 5.	Based on 12 hours of solar energy generated daily for food crops processing with an efficiency of solar PV systems of 0.8
	1.2.2 Installed Capacity in MW Solar PV	Report of survey on renewable Energy penetration in the areas	0MW	9.1MW installed by mi term Togo: 4.44MW Senegal: 2 MW Guinea: 2.66MW	14.69 MW installed capacity by end of year 5 Togo: 7.17MW Senegal: 3.27 MW Guinea: 4.25MW	ESCOs are willing to Design Commission Operate and Maintain (DCOM): 2.59 MW installed capacity for solar irrigation & 14.69MW for solar processing
	1.2.3 Volume of biodigester installed	Report of Baseline survey on renewable Energy penetration in the areas	0MW	4.1 MW installed capacity by mid-term (40% of final target) Togo: 1.73MW Senegal: 0.92 MW Guinea: 9.38MW	10.24 MW installed capacity at end of year 5 Togo: 4.13MW Senegal: 2.18 MW Guinea: 3.94MW	ESCOs are willing to DCOM biogas Biodigester, and Biodigester are operated at 30% efficiency for 12 hours daily.
	1.2.4Expected increase in the number of ACSs, WABEs, & FBAs integrating	Report of survey on renewable Energy penetration in the areas	0	960 by mid-term Togo: 320 Senegal: 480	2,400 by year 5 Togo: 800 Senegal: 1,200	ACSs, WABEs, & FBAs are willing to adopt solar energy in agribusiness

	renewable energy in their agribusiness operations			Guinea: 160	Guinea: 400	operations, including necessary O&M
Output 2.1: Adoption of CRA and agro-forestry practices among smallholder farmers	*2.1.1 Number of climate resilient seed varieties released*	Socioeconomic baseline surveys, annual agricultural statistics, programme M&E reports, regional level agricultural data . produced by various regional offices of Statistics	0	9	18	SHFHs are willing to adopt new seed varieties introduced by the programme and are committed to learning about climate resilient practices. SHFHs are committed and willing to be trained in climate resilient livelihood options
	2.1.1 Number of SHFHs trained on climate resilient agricultural practices		0	52,291 SHFHs trained by mid-term of which, 54% are females	79,178 SHFHs trained by mid-term of which, 54% are females	
	2.1.3. Number of new CRA techniques and technologies introduced to improve staple food crops yields in the program areas		0	5	5	
Output 2.2: Awareness raising, capacity building, community and institutional strengthening on agricultural value chains management	*2.2.1a Expected number of people trained with increased awareness on agricultural value chain development approach*	*Programme M&E Reports, & Socioeconomic baseline surveys*	0	810,575 of which, 54% are females	1,350,958 of which, 54% are females	Target beneficiaries are committed and willing to participate in value chain development training.
	2.2.1b . Number of anchor training institutions equipped to implement the agricultural value chains development approach		0	200	250	

	2.2.2a Number of agrometeorological and rain gauge stations installed in each SCPZs	Purchase order and Delivery receipt for equipment Reports from National Met services in each country	4 in Senegal. 2 in Togo 2 in Guinea	5 agrometeorological and 25 rainfall stations added for each region per country	10 agrometeorological and 50 rainfall stations added in each region per country	Suitable sites are identified following the WMO guidance[173]
	2.2.2b Number of farmers benefiting from Climate-smart agro-advisory services and digital technology	Annual Performance Report Daily, weekly and seasonal publication and distribution of agriculture-specific weather forecasts	7,800 in Senegal 0 in Togo 0 in Guinea	80,000 farmers (20,000 farmers per SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	200,000 farmers (50,000 farmers per SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	Farmers are trained on how to use climate information There is adequate medium for communicating and disseminating climate-base agro-advisory services
	2.2.2.c Number of people trained on climate smart agro-advisory services and digital technology	Training reports and user manuals	7,800 in Senegal 0 in Togo 0 in Guinea	640,000 people (160,000 farmers per SCPZ; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	1,600,000 people (400,000 farmers per SCPZ; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	Farmers subscribe and are willing and ready to uptake climate-based advisory services in their agricultural activities
	2.2.2d Number of people made aware of the importance of observing networks	Reports on awareness-raising campaign	0	4000 people (1000 people in each of the four SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and	8000 people (2000 people in each of the four SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and	Quality and coverage of the awareness programme

173 World Meteorological Organization (WMO). 2010. Guide to Agricultural Meteorological Practices. WMO-No. 134. WMO, Geneva, Switzerland.

				Kara in Togo)	Kara in Togo)	
	2.2.2e Number of people trained on how to use and maintain observing networks	Training reports and user manuals	0	480 trainees (120 trainees in each of the four SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	960 trainees (240 trainees in each of the four SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	Number of people available and enrolled for the training
	2.2.2f Number of people trained on recalibration of meteorologica l sensors	Training reports and user manuals	0	640 trainees (160 trainees in each of the four SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	1280 trainees (320 trainees in each of the four SCPZs; South Agropole in Senegal, Boke and Kankan in Guinea, and Kara in Togo)	Number of people available and enrolled for the training
Project/programme co-benefit indicators						
Co-benefit 1	*Employment opportunities created through the project*	Annual Performance Report and national statistic records	0	158.360 Togo: 50,860 Senegal: 63,880 Guinea: 43,620	395,890 Togo: 127,140 Senegal: 159,700 Guinea: 109,050	For each beneficiary adopting CRA or AF techniques or accessing low carbon technologies , 5 jobs are created (79,178 x5) Farm holders are willing to adopt CRA and AF practices and adopt low carbon solutions
Co-benefit 2						
Co-benefit 3						

[1] World Meteorological Organization (WMO). 2010. Guide to Agricultural Meteorological Practices. WMO-No. 134. WMO, Geneva,

12.2.4 Programme activities and deliverables

Activities	Description	Sub-activities	Deliverables
Activity 1.1.1: Support access to small-scale agricultural water management (AWM) infrastructure	The activity is specifically designed to facilitate smallholder farmers' access to drip irrigation technology powered by solar pump. This will support horticulture, market gardening of fruits and vegetables including other SCPZ staple crops in ha of irrigable land. This will directly benefit more than 1.4million small holder farmers of which, 50% would be women.	• Issuance of International Competitive Bidding (ICB), short listing, and selection of firm for the training, supply and installation of DIDS in three pilot countries. • Mapping exercise and selection of DIDS sub-project beneficiaries including the identification of 31,179.27 ha of land in three pilot SCPZs countries. • Grant work plan for DIDS sub-project beneficiaries including management committees determined. • Capacity building and training of sub-project beneficiaries in the use of DIDS in three pilot countries. Distribution and installation of DIDS to selected sub-project beneficiaries in three pilot countries.	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Sub-project reports highlighting major gaps and opportunities for investing in drip irrigation technology in SCPZs pilots • Inception reports on detailed stakeholders communication strategies • Statistics on labour, energy and water use efficiency • Statistics on improvement in SCPZ crop yields • Well-documented country's statistics of DIDS • Additional Ha of land under irrigation • Reports on sub-project beneficiaries • Report on total number of men and women trained on drip irrigation technology. • Sub-project training manual on drip irrigation technology.
Activity 1.2.1: Improving resilience of agricultural cooperatives, FBAs value chains infrastructure for food processing	The activity involves the installation of 35.5MW of solar energy to support agricultural cooperative societies, women-led agric-business enterprises (WABEs), and FBAs to dry, process, and package staple food crops using clean energy.	• Issuance of ICB, short listing, and selection of Energy Service Companies (ESCOs) for design, construction, operation and maintenance supply of 14.69 MW of solar energy • Mapping exercise and selection of DIDS sub-project beneficiaries and including the identification of 31,179.27 ha of land • Grant work plan for DIDS sub-project beneficiaries	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Sub-project report highlighting major gaps and opportunities for investing in low-carbon energy technologies such as Solar PV in SCPZs pilots

		including management committees determined • Capacity building and training of sub-project beneficiaries in the use of DIDS Distribution and Installation of Solar PV equipment to sub-project beneficiaries	• Inception reports on detailed stakeholders communication strategies • Report on project beneficiaries • Catalogue of existing agricultural cooperative societies, women-led MSMEs, FBAs in the pilot countries. • Detailed report of sub-project feasibility studies highlighting major gaps and opportunities for improving the value chains infrastructure of cooperative societies, agric business ventures, women-led MSMEs and FBAs • Training report on total number of men and women trained in post-harvest losses and handling • Sub-project training manual on strengthening value chain infrastructure for agriculture cooperative societies, agric business ventures, women-led MSMEs and FBAs on post-harvest losses and handling. Statistics on new installed capacity of renewable energy.
Activity 1.2.2: Deploying low-carbon energy technologies for enhanced resilience	The focus of this activity is to specifically reduce GHG emissions in the agricultural value chains in the three SCPZs pilot countries. This is through the use of low carbon energy sources. This will involve the installation of ~10.24 MW of renewable energy from biogas generation or about 24,579 m^3 of biogas digester to treat livestock manure and produce biogas for heating or power generation. The energy provision will support the processing of produces, powering of cold storage facilities where applicable to ensure that farmers can offer their produce with the required market standards. Energy will also provide them with opportunities that will help them diversify their sources of income.	• Issuance of ICB, short listing, and selection of firm for the construction and installation of ~10.24MW of clean energy (Biogas digesters - 24,579 m^3). • Selection of eligible beneficiaries of bio-digesters (ESCOs). • Financial arrangements with ESCOS for Biogas grants and loans including work plan, as determined by management committees. • Capacity building and training in Biogas digesters, Bio-slurry, safety standards etc. Construction of bio-digesters by ESCOS and first year's	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Sub-project report highlighting major gaps and opportunities for investing in low-carbon energy technologies such as biogas technology in SCPZs pilot countries. • Mapping exercise report on direct sub-project beneficiaries including gaps and opportunities for

		operation and maintenance (O&M) by ESCOs	biogas investment in pilot countries. • Inception reports on detailed stakeholders communication strategies • Training report on total number of men and women trained in low-carbon energy technologies. Sub-project training manual on the adoption of low-carbon energy technologies for replication in other potential SCPZ countries.
Activity 2.1.1: Promote CRA among smallholder farmers	Specifically designed to promote the use of selected CRA practices in pilot countries, to strengthen climate resilience and reduce GHG emissions along the agricultural value chains. This is with the view to stimulate productivity and value addition, create competitiveness and employment while simultaneously generating incomes in three selected African countries	• Mapping exercise and selection of sub-project beneficiaries of AfDB-administered loans and grants to engage in CRA practices among smallholders' farm households, ACSs, women-led MSMEs and FBAs. • Work plan for sub-project grants and loans to promote CRA practices including CRA management committee determined. • Capacity building and training of sub-project beneficiaries in CRA practices. Implementation of CRA activities	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Sub-project report highlighting major gaps and opportunities for investing in CRA and agro-forestry practices in SCPZs pilots • Inception reports on detailed stakeholders communication strategies • Report on project beneficiaries • Additional Ha of land under CRA practices. • Training report on total number of men and women trained in CRA practices in the target countries. • Sub-project training manual on CRA practices for replication in other potential SCPZs countries. Report on additional number of farmers in pilot countries engaged in CRA practices.
Activity 2.1.2: Promote agro-forestry practices among smallholder farmers	Specifically designed to promote the use of agroforestry management practices to create sustainable income sources for farmers in the pilot countries. Additionally, the introduction of this climate resilient management practice will strengthen climate resilience and reduce GHG emissions through carbon sequestration from 40,000 ha of	• Mapping exercise and selection of sub-project beneficiaries of AfDB-administered loans and grants to engage in agro-forestry practices among smallholders' farm households, ACSs, women-led MSMEs and FBAs.	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Sub-project report highlighting major gaps and opportunities for

	woodlot, cashew nuts, mango and coffee orchards.	• Work plan for sub-project grants and loans to promote agro-forestry practices and agro-forestry management committees determined. • Capacity building and training of sub-project beneficiaries in CRA and agro-forestry practices. Implementation of CRA and agro-forestry activities	investing in agro-forestry practices in SCPZs pilots. • Inception reports on detailed stakeholders communication strategies • Report on project beneficiaries • Additional Ha of land under agro-forestry practices. • Training report on total number of men and women trained in agroforestry practices in the target countries. • Sub-project training manual on best practices in agroforestry management practices for replication in other potential SCPZs countries. Report on additional number of farmers in pilot countries engaged in agroforestry practices.
Activity 2.2.1: Capacity building of value chains agents/communities'& development of agricultural processing support infrastructure	This activity is targeted at awareness raising and capacity strengthening of value chain actors, communities and institutions on agricultural value chain development and climate resilient livelihood options.	• Capacity building and training of relevant staff of the Project Executing Agencies (PEAs), the Project Implementing Units (PIUs), and the Agro-industrial Parks (AIPs). • Training and capacity building of value chain actors in the use of 'Good Agricultural Practices' in product quality, standardization and conformity requirements, as well as developing linkages and responding to commodity demand in terms of quality and quantity. • Training of young potential entrepreneurs including women to seize business opportunities along the value chains. • Massive sensitization and training of private sector investors& MDAs on governance systems reforms such as land reforms and export promotion initiatives.	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Report on total number of men and women trained on agricultural value chain development and climate resilient livelihood options. • Socioeconomic baseline survey on number of value chain actors, community members and institutions trained and exposed to agricultural value chain development and climate resilient livelihood options. • Production of policy briefs on SCPZ management governance for circulation among policy makers. • Report on stakeholders'

			engagement plans for circulation. • Production of training manual on project performance monitoring, reporting and evaluation (M&E).
Activity 2.2.2: Strengthening climate information services and early warning systems in SCPZs	This activity will help to enhance climate information services by promoting the generation and access to seasonal and sub-seasonal weather forecast and agricultural relevant weather products in the SCPZs. This activity will focus on awareness and training on how to use and maintain the observing networks. The activity will conduct stakeholders' engagement meeting with prospective farmers, aggregators, Famer Unions (FUs), Famer Based Organizations (FBOs), and other interested bodies with the focus on creating awareness on the importance of the installed agrometeorological and gauge stations and the need to be responsible for the security of the networks. Farmers and other interested stakeholders will take ownership of the self-recording rain stations.	• Collection of climate data and transmission of climate information at community-level. • Improve climate-based agro-advisory services, such as, planting time, good farm management practices, irrigation schedules, use of farm manure and choice of inorganic fertilizers, suitable crop types and varieties to be planted, weeding regimes, the available seed suppliers, crop pests and diseases prevention and control measures. • Capacity building on preparatory mechanism including analysis of vulnerability, gathering of data, decisions on contingency plan and/or adaptation measures, analysis of gender and socioeconomic inequalities; seasonal information prior to major rainfall season including information on irrigation requirements during growing season • Improve dissemination technique • Capacity building - adaptation and contingency & anticipatory plans • Bi-annual exercise on calibration will be organized to re-calibrate the weather sensors to ensure measurement accuracy.	Each region (Agropole du Sud, Kankan, Boke, Kara) covered under the programme will have a dedicated report for the deliverables listed below: • Report on the generation of, access to and use of climate-based agro-advisory services • Number of people trained on preparatory mechanism • Coverage of climate information services

APPENDICES

Appendix 1: Drip Irrigation Investment Guide

Investing in Drip Irrigation Technology: A Technical Guide for Practitioners

1. Introduction

In the context of rainfall unpredictability and high climate variability, sustainable agricultural water management practices are fundamental to agricultural development across the West African arid environment (Zougmoré et al., 2016; FAO, 2012). The idea that expanding the use of efficient irrigation and agricultural water management technologies is essential to sustainably increasing yields in semi-arid zones is widely recognized (Venot et al., 2014). Unfortunately, the advocated and eagerly awaited revolution in the use of these technologies such as drip irrigation technology, has still been in its infancy in West Africa. As a result, hand buckets and watering cans are still common water lifting technologies for small-holder farming in West Africa, especially in Sahelian region of Mali, Niger, Senegal and Burkina Faso (Van Wesenbeeck et al., 2014;You et al., 2010; Pasternak et al., 2006).

Drip irrigation technology is a way of supplying water in frequent small amounts to the exact place where crop plants can use it, the root zone, through a system of plastic pipes supplied to smallholder farmers as kit packages. These kits work using low water pressure and can be effectively used for localized irrigation on small plots from a few square meters to up to 500 m² (20m X 25m). Drip irrigation kits consist of a water tank, main pipes (16 mm diameter) with valves and a filter, and a series of secondary pipes (1m density) fitted with drip emitters (1.2 mm diameter and 40cm density). The system requires a very simple and inexpensive maintenance consisting in a periodic cleaning of the filter component to prevent the drip emitters from the risk of choking. Technically, a water tank of 1000 liters (cf. photo) is emptied in approximately 15 mn over a plot size of 250 m^2, while the irrigation efficiency may reach 90%. Depending on crop type, root depths, soil type and weather conditions, water application may be different. For instance, with similar soil and rooting conditions, 250 m^2 lettuce in the Sudano-Sahelian weather conditions requires 600 liters of water per day (crop development stage), against 900 liters per day in the Sahel. The same figures stand at 750 and 1125 liters per day, respectively, for tomato. Compared to the other irrigation techniques (hand-bucket, watering can or sprinkler, etc.,), drip irrigation allows up to 30% water saving. It includes many other advantages such as: (1) increases in yield due to continuous and adequate water/fertilizer supply in function of the needs and depending strictly on the development stages; (2) decreases in labor and energy costs; and (3) significant decreases in disease attacks since water is not applied to the foliar system.

In the context of climate change, water stress, population growth and uncertain market and economic conditions in West Africa; studies on the economic and financial viability of drip irrigation technologies and out-scaling are essential to help inform irrigation water management policies in the region. Thus, the aim of the investment guide is threefold. First, it seeks to provide farm investors and practitioners with an overall guide on drip irrigation systems, particularly in terms of water requirements and irrigated plot sizes (i.e., 100m ^{2} and 500 m ^{2}). Secondly, the guide seeks to equip farm investors and practitioners with the minimum investment and operating costs needed for operationalizing drip irrigation technology for different sampled plot sizes. Thirdly and finally, the guide provides an economic and financial profitability of drip irrigation under different plot sizes and irrigation systems.

The rest of the drip irrigation investment guide is structured as follows. Section 2 describes a hypothetical sample plot with a total surface area of 2,278 m^2 including 1400 m^2 of vegetable plots and 200 m^2 reserved for nursery used as a pilot site for carrying out the economic and financial viability of drip irrigation technology. Note that the analysis could be extended to a plot size of any area. Section 3 presents the drip irrigation system technology used for the site while section 4 reports the annual gross operating incomes anticipated from the pilot site. In section 5, the economic and financial profitability of the investment is assessed throughout a series of analytical indicators such as the added value (AV), the gross operating surplus (GOS), the net operating surplus before taxes (NOS), the net profit and cash-flow. Section 6 concludes with some potential barriers that are likely to confront farm investors and practitioners when considering investing in drip irrigation technologies in the region.

2. Ground Plane and Technical Elements of the Pilot Site

Figure 1 shows the pilot site that was carefully selected for carrying out the economic and financial viability of drip irrigation technology application. It consists of a total surface area of 2,278 m^2 including 1,400 m ^{2} of vegetable plots and 200 m ^{2} reserved for nursery.The site offers the advantage to be completely flat with a slight slope of about 1%, favoring a good management of drainage. Moreover, the soil of the site does not appear to be initially compacted or poor in organic matters and micro-organisms. Nevertheless it will be necessary to resort to relevant appropriate cultivation technics (e.g., lime application, green fertilizers, manure and composts) to optimize the physical condition of the soil (structure, aeration, etc.) as well as its chemical status (pH, calcium, organic matter) which are indicators of the health of soil (Bio-Action, 2009).However, one has to emphasize that the first cycles of production as it's on this site, does not usually produce very satisfactory results because of the rate of mineralization generally low at the head of the production cycle, being characterized by a low population of micro-organisms and/or a lack of ventilation/drainage, etc.

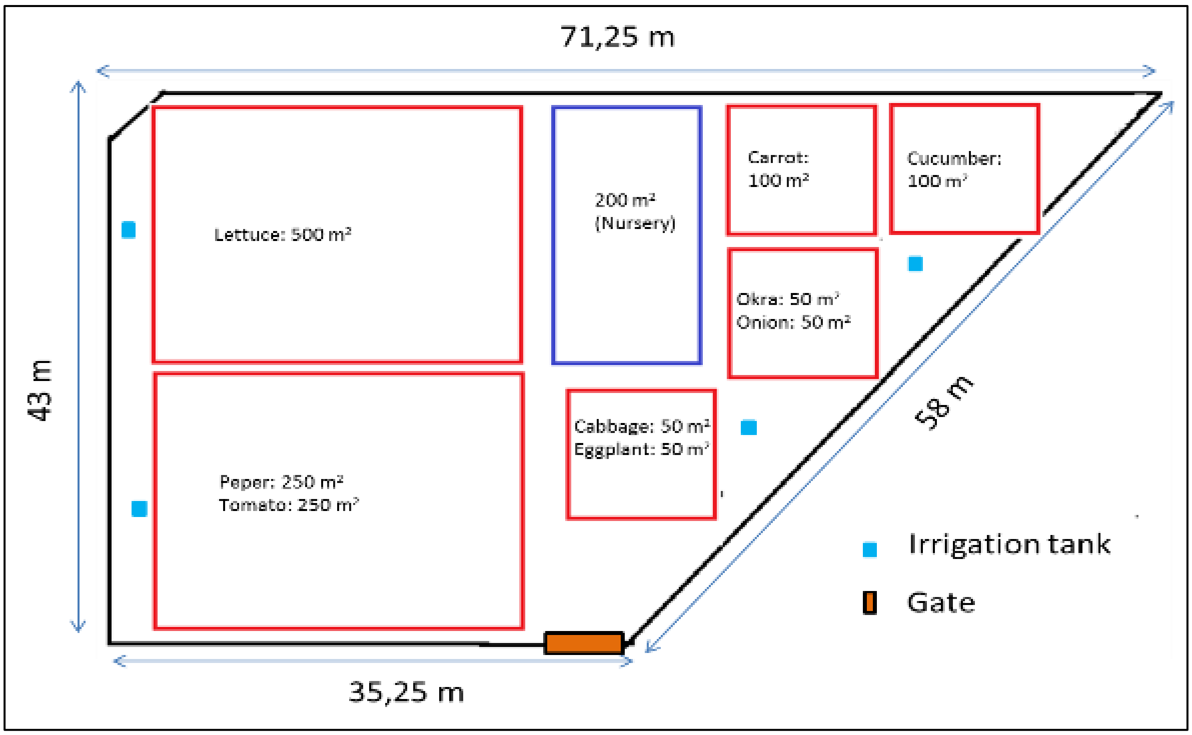
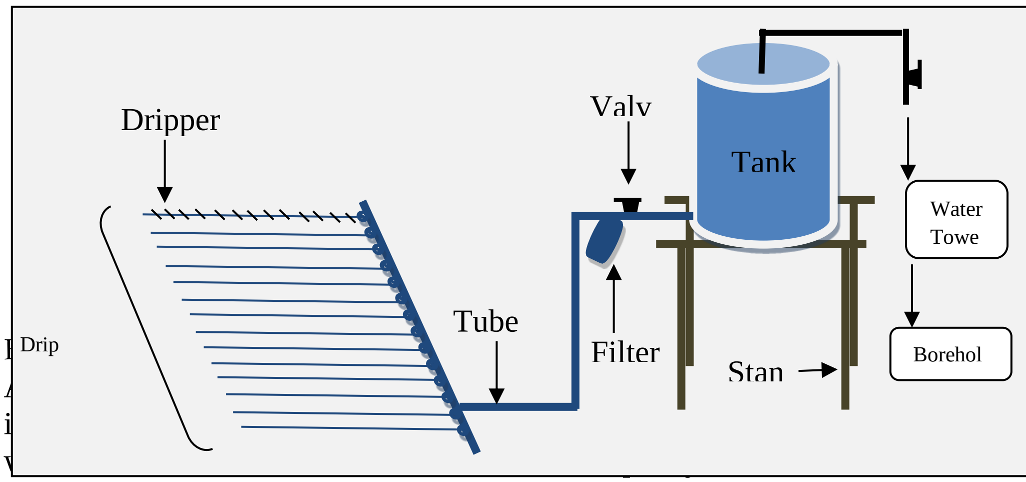


Figure 1: Ground plane.

3. Description of the Irrigation System

The suggested irrigation system for the site is composed of drip irrigation kits (iDE[174] technology) adapted to the water requirements of vegetable crops in the region as well as the characteristics (e.g. size of irrigated plots of 100m^2 and 500 m^2) . As described in Figure 1, the installation requires: (1) four water tanks; (2) two kits of 500 m2 for a total of 1000 m2; (3) four kits of 100 m2 for a total of 400 m2; and (4) a water tower of up to 5,000 liters of capacity, which must be supplied by a borehole initially expected to have a discharge potential of at least 5 m^3 h^{-1}.

The so-called kits are new generation kits (with 40 cm density of drippers, Figure 2) recently tested under the agro-climate conditions of the Sahel and showing a higher performance compared to the old technology with 1m density of drippers. The advantages of such an irrigation system are multiples: (1) significant decreases in crop water requirement of up to 30% since water is supplied directly to the root zone, with no erosion and no soil washing; (2) increases in yield production due to continuous and adequate water/fertilizer supply in function of the needs and depending strictly on the development stages; (3) decrease in labor and energy costs; (4) significant decrease in disease attacks since water is not applied to the foliar system.



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characteristics are largely sufficient to permanently supply the irrigation tanks and then meet the water requirement of the whole site. The discussions conducted with the technical partners (iDE) has pointed out the fact that an irrigation tank of 1,000 liters (used on the site) is emptied in approximately 15 mn for a plot of 250 m^2.The calculation of the daily water requirements was carried out for the selected crops taking into account their water consumption coefficients. Onion has been pointed out as the most demanding with up to 130 l m^2 d^{-1}, leading to a total irrigation time of up to 75 mn d^{-1} for a plot size of 500 m^2. Based on this investigation it was suggested an irrigation time of 30 mn twice a day (morning and evening) over a plot of 500 m^2. Table 1 shows a more detailed irrigation plan for the different plots implemented on the site.

Table 1. Detailed irrigation plan for Pilot Site.

Tank	Plot	Volume of water and irrigation time		Total number of filling	
		Morning	Evening	Morning	Evening
Tank 1	Plot 1 (250 m^2)	1 m^3 in 15 mn	1 m^3 in 15 mn	1	1
	Plot 2 (250 m^2)	1 m^3 in 15 mn	1 m^3 in 15 mn	1	1
Tank 2	Plot 3 (250 m^2)	1 m^3 in 15 mn	1 m^3 in 15 mn	1	1
	Plot 4 (250 m^2)	1 m^3 in 15 mn	1 m^3 in 15 mn	1	1
Tank 3	Plot 5 (100 m^2)	0.5 m^3 in 7 mn	0.5 m^3 in 7 mn	1/2	1/2

[174]International Development Enterprises

	Plot 6 (100 m^2)	0.5 m^3 in 7 mn	0.5 m^3 in 7 mn	1/2	1/2
Tank 4	Plot 7 (100 m^2)	0.5 m^3 in 7 mn	0.5 m^3 in 7 mn	1/2	1/2
	Plot 8 (100 m^2)	0.5 m^3 in 7 mn	0.5 m^3 in 7 mn	1/2	1/2

4. Initial Investment and Operating Costs

Table 2 provides detailed information on the approximate investment costs (e.g., site securing, irrigation systems, borehole and water tower) needed for the pilot site. The annual operating costs (e.g. seed, fertilization, diseases and pests' controls and labor) are as shown in Table 3, 4 and 5. Table 6 shows details of the annual depreciation charges. Other costs such as the annual intermediate consumption charges (including procurement of supplies for marketing or transportation) are presented in Table 7. The information as provided in the different table are required to proceed with the economic and profitability analysis of the investment decision taken-up later in section 5.

Table 2: Initial Investment costs.

Ref	Designation	Unit	Quantity	Unit Price	Total Price
1	Wire fence (securing the site)[175]	m	207.5	4,213	874,150
2	Irrigation kit 500 m2	500 m2	2	124,000	248,000
3	Irrigation kit 100 m2	100 m2	4	35,000	140,000
4	Stand (metallic scaffold for the irrigation tank)		4	20,000	80,000
5	Irrigation tank		4	80,000	320,000
6	Transportation and installation costs			100,000	100,000
7	Water tower (metallic scaffold + a reservoir of 5 m3 of capacity)		1	1,000,000	1,000,000
8	Borehole (drilling)			2,500,000	2,500,000
9	Electric water-pump and installation			1,000,000	1,000,000
10	Small agricultural tool kits			86,000	86,000
11	Labour (plot installation)			280,000	280,000
12	Unexpected costs			200,000	200,000
Total					6,828,150

Table 3: Annual Operating Costs.

Ref	Designation	Unit	Quantity	Unit Price	Total Price
1	Seed	season	2	33,600	67,200
2	Fertilization				179,000
3	Control of disease vectors and pests				39,000
4	Permanent labor (daily labor and follow-up)	month	12	50,000	600,000
5	Unexpected costs				100,000
Total					985,200

Table 4: Example of detailed seasonal costs for organic and mineral fertilizers

Ref	Designation	Unit	Quantity	Unit Price	Total Price
F1	Substantive manuring (150kg/100m2)	Cart	28	3000	84,000
F2	Mineral fertilization (10 to 25g/m2)	Kg	200	475	95,000
Total General					179,000

Table 5: Example of Detailed Seasonal Seed Costs

Ref	Designation	Unit	Quantity	Unit Price	Total Price
1	Yellow Pepper of Burkina Faso	50g	1	10000	10,000
2	Tropimech tomato / Petromech	100g	1	7700	7,700
3	Violet onion of Galmi	100g	1	6500	6,500
4	Okra Clemson	100g	1	1800	1,800
5	Carrot Tokita	80g	1	2500	2,500
6	Eggplant Black Beauty	100g	1	5100	5,100
7	Lettuce	100g	1	4500	4,500
8	Pepper Narvac	50g	1	7500	7,500
9	Cabbage SeminisOxylus 10g	10g	1	3000	3,000
Total General					33,600

Table 6: Maximal Annual Depreciation Charges.

[175] The wire fence is subject to an annual depreciation charge of about 87,415 over 10 years.

Ref	Designation	Investment	Number of depreciation years	Maximal annual depreciation charge
1	Wire fence (securing the site)	874,150	10	87,415
2	Irrigation kits	388,000	5	77,600
4	Stand (for irrigation tank)	80,000	10	8,000
5	Irrigation tank	320,000	10	32,000
6	Borehole	2,500,000	10	250,000
7	Water tower (metallic scaffold + a reservoir of 5 m3 of capacity)	1,000,000	10	100,000
9	Electric water-pump	1,000,000	5	200,000
10	Small agricultural tool kits	86,000	2	43,000
Total				798,015

Table 7: Intermediate Consumption.

Ref	Designation	Unit	Quantity	Unit Price	Total Price
1	Procurement of supplies for marketing				50,000
2	Services: Transportation and deliveries				100,000
Total					150,000

5. Annual Gross Operating Incomes

In order to assess the agricultural and economic potential of the site and therefore decide on the types of crops to put in place (as previously indicated in the ground plane in section 1) and beyond provide reliable input data for the economic and profitability analysis exercise, it was appropriate to pay visits to existing vegetable farming sites in Ouagadougou including immediate surroundings, especially production sites under drip irrigation systems. A drip irrigation site was visited in the locality of Koudougou, 100 km far from the Centre of Ouagadougou, while a site with traditional irrigation system (with the use of watering cans) was visited in Loumbila, 30 km far from the Centre of Ouagadougou. Focus groups-based interviews and discussions were to help compile very useful farm and market information as summarized in Table 8: main crop types, crop duration, yields, market prices, possible number of crop cycle during the year. These field information were analyzed and compared with the online resource titled "Analysis of vegetable sector in Burkina Faso" (http://www.fao.org/docs/up/easypol/887/analyse-filiere-maraichage_107fr.pdf) before being subsequently used for estimating the agricultural and economic potential of the project site in terms of expected yields per crop type depending on plot size with associated annual gross operating income (see Table 8).

Table 8: Gross Operating Income for the Selected Crops.

Crop	Crop duration (day)	Yield per hectare (ton)	Price per kg during the RS (FCFA)	Price per kg during the DS (FCFA)	Possible number of cycles over the RS or DS and under irrigation	Annual gross income per hectare under irrigation (FCFA)	Planned plot size (m^2)	Expected yield per plot (Kg)	Annual gross income per plot under irrigation (FCFA)
Onion	90-120	20	500	1000	2	30,000,000	50	70	150,000
Tomato	100-110	40	600	1200	3	108,000,000	250	700	2,700,000
Local Eggplant	130	40	300	600	2	36,000,000	50	140	180,000
Cabbage	80-90	40	200	400	4	48,000,000	50	140	240,000
pepper	180	30	800	1200	2	60,000,000	250	525	1,500,000
Carrot	90	40	300	600	3	54,000,000	100	280	540,000
Lettuce	45	*	**	***	7	63,700,000	500	****	3,185,000
Cucumber	60-70	45	300	500	4	72,000,000	100	315	720,000
Okra	110	15	600	600	3	27,000,000	50	52.5	135,000
Total							1400		9,350,000

* 104 lettuce seedlings per 15 m2

** 4 lettuce seedling for 500 fcfa leading to 6,066,667 fcfa per hectare with a coverage rate of 70%

*** 4 lettuce seedling for 1000 fcfa leading to 12,133,333 fcfa per hectare with a coverage rate of 70%

**** 2427 lettuce seedling

RS: Rainy Season and DS: Dry Season

Table 8 shows that the sale prices are almost double during the dry seasons. Lettuce has been pointed out as the crop with the shortest growing cycle with in total 7 possible number of cultivation over the year under adequate irrigation systems. With 3 possible growing cycles over the year, tomato has shown the highest annual income per hectare (108,000,000 FCFA/hectare) followed by cucumber (72,000,000 FCFA/hectare), lettuce (63,700,000 FCFA/hectare) and pepper (60,000,000 FCFA). This analysis has mainly supported the crop distribution as shown on the ground plane (cf. section 1): 250 m2 for tomato, 250 for pepper, 500 m2 for lettuce, etc. The highest plot size was attributed to lettuce since it's required almost no management in terms of diseases and pests' control. Overall, based on the implemented ground plane, lettuce is associated with the highest annual gross income (3,185,000 FCFA over 500 m2) followed by tomato (2,700,000 FCFA over 250 m2), pepper (1,500,000 FCFA over 250 m2), etc. (cf. Table 8). A total gross income of 9,350,000 FCFA (over 1400 m2) is then annually expected from the ground plane put in place. This amount may be optimized while going for a single crop cultivation (such as tomato), but does not meet the requirements for a sustainable agriculture.

6. Economic and Financial Profitability Analysis

The economic and financial profitability of the investment is assessed throughout a series of analytical indicators such as the added value (AV), the gross operating surplus (GOS), the net operating surplus before taxes (NOS), the net profit and cash-flow.

AV means the wealth created by the activity. It is obtained by subtracting from the total raw product (sum of the gross operating income per crop) the total intermediate consumption such as procurements of supplies for marketing or transportation and delivery services. The added value is given by the equation (1):

$$AV = \sum_i RP_i - \sum_k IC_k \qquad (1)$$

where RP_i is the row product or the gross income per sold vegetable *i*, $IC_k$is the expense associated with the intermediate consumption *k*.

GOS expresses the gain (or loss) of the economic agent once acquitted of all current operating expenses so it's the difference between the added value and the operating costs taking into account all goods and services that are destroyed or transformed during the production process or are incorporated into the product. The operating costs are mainly personnel costs (labor), seed costs, fertilization costs, costs for diseases and pests' controls and other unexpected costs. GOS is given by the equation (2):

$$GOS = AV - \sum_i OC_i \qquad (2)$$

where OC_i is the operating charge *i*.

NOS expresses the economic gain (or loss) given by the investments made so is the profit before the income tax expense is applied and is obtained by subtracting the depreciation of equipment and financials costs from the gross operating surplus. NOS is given by the equation (3):

$$NOS = GOS - \sum_i DC_i \qquad (3)$$

where DC_i is the depreciation charge *i*.

The net profit is calculated by deducting the income tax expense from the net operating surplus. These taxes are calculated on the profit generated by the business and represent 7% of profit before tax (NOS). The net profit is given by the equation (4):

$$Net\ profit = NOS - Income\ tax\ expense \qquad (4)$$

The cash flow is calculated as the sum of net income and amortization. It's primarily used to evaluate companies through the "discounted cash flow method DCF" and given by the equation (

$$Cash\ flow = Net\ profit + \sum_i DC_i$$

(5)

where DC_i is the depreciation charge i.

The above described analytical indicators were calculated and shown in Table 9 based on the data presented in the sections 3 and 4.

Table 9: Analysis of Profitability for Years of Exploitation

Analytical indicators	year1	year2	year3	year4	year5
Gross operating income	9,350,000	9,350,000	9,350,000	9,350,000	9,350,000
Total raw product (1)	**9,350,000**	**9,350,000**	**9,350,000**	**9,350,000**	**9,350,000**
Procurement of supplies for marketing	50,000	50,000	50,000	50,000	50,000
Services: transportation and deliveries	100,000	100,000	100,000	100,000	100,000
Total intermediate consumption (2)	**150,000**	**150,000**	**150,000**	**150,000**	**150,000**
Added value (3) = (1) - (2)	**9,200,000**	**9,200,000**	**9,200,000**	**9,200,000**	**9,200,000**
Seed costs	67,200	67,200	67,200	67,200	67,200
Fertilization costs	179,000	179,000	179,000	179,000	179,000
Costs for disease and pest control	39,000	39,000	39,000	39,000	39,000
Labor costs	600,000	600,000	600,000	600,000	600,000
Unexpected costs	100,000	100,000	100,000	100,000	100,000
Total operating charges (4)	**985,200**	**985,200**	**985,200**	**985,200**	**985,200**
Gross operating surplus GOS (5) = (3) - (4)	**8,214,800**	**8,214,800**	**8,214,800**	**8,214,800**	**8,214,800**
Depreciation charges	798,015	798,015	755,015	755,015	755,015
Charges after GOS (6)	**798,015**	**798,015**	**755,015**	**755,015**	**755,015**
Net operating surplus (7) = (5) - (6)	**7,416,785**	**7,416,785**	**7,459,785**	**7,459,785**	**7,459,785**
Income tax expense*	-	-	-	-	-
Net profit (9) = (7) - (8)	**7,416,785**	**7,416,785**	**7,459,785**	**7,459,785**	**7,459,785**
Cumulated net profit	**7,416,785**	**14,833,570**	**22,293,355**	**29,753,140**	**37,212,925**
Cash Flow (10) = (9) + (6)	**8,214,800**	**8,214,800**	**8,214,800**	**8,214,800**	**8,214,800**
Cumulated cash Flow	**8,214,800**	**16,429,600**	**24,644,400**	**32,859,200**	**41,074,000**

*Not applied.

Appendix 2: Renewable Water Resources (RWR)

(1) Togo

Food and Agriculture Organization of the United Nations

AQUASTAT
Global Water Information System

Country Fact Sheet
Togo

LAND AND POPULATION	Year	Value	Unit
Area			
Country total area	2016	5 679	1 000 ha
Cultivated area (arable land + permanent crops)	2016	2 820	1 000 ha
Population			
Total population	2015	7 305	1 000
Population density	2016	128.6	inhab/km²
Rural population	2015	4 439	1 000
Economically active population in agriculture	2014	1 458	1 000
As % of total economically active population	2014	50.87	%

RENEWABLE WATER RESOURCES (RWR)	Year	Value	Unit
Long-term average annual precipitation			
Depth		1 168	mm/year
Volume		66.33	km³/year
Long-term average annual RWR			
Internal (IRWR)		11.5	km³/year
External (ERWR)		3.2	km³/year
Total Actual (TRWR)		14.7	km³/year
Dependency ratio		21.77	%
TRWR per capita	2014	2 012	m³/year
Total dam capacity	2015	1.717	km³

WATER WITHDRAWAL	Year	Value	Unit
By sector			
Agricultural	2002	0.076	km³
Municipal	2005	0.1407	km³
Industrial	2005	0.0063	km³
Total	2002	0.169	km³
Total water withdrawal per capita	2002	32.87	m³
By source			
Surface water withdrawal		-	km³
Groundwater withdrawal		-	km³
Total freshwater withdrawal	2002	0.169	km³
Desalinated water produced		-	km³
Direct use of treated municipal wastewater		-	km³
Direct use of agricultural drainage water		-	km³
Pressure on water resources			
Total freshwater withdrawal as % of TRWR	2002	1.15	%
Agricultural water withdrawal as % of TRWR	2002	0.517	%

IRRIGATION AREAS	Year	Value	Unit
Area equipped for irrigation			
Full control irrigation	1996	2.3	1 000 ha
surface irrigation (1996) 2.3 1 000 ha			
sprinkler irrigation (1990) 0.55 1 000 ha			
localized irrigation (1990) 0.01 1 000 ha			
Equipped lowland areas	1996	5	1 000 ha
Spate irrigation		-	1 000 ha
Total area equipped for irrigation	1996	7.3	1 000 ha
As % of cultivated area	1996	0.298	%
Area actually irrigated	1996	6.247	1 000 ha
As % of area equipped for irrigation	1996	85.58	%

Notes: 1 km³ = 10^9 m³ = 1 000 million m³; 1 ha = 1 hectare = 10 000 m²

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Source: FAO (2019)

(2) Senegal

Food and Agriculture Organization of the United Nations

AQUASTAT
Global Water Information System

Country Fact Sheet
Senegal

LAND AND POPULATION	Year	Value	Unit
Area			
Country total area	2016	19 671	1 000 ha
Cultivated area (arable land + permanent crops)	2016	3 268	1 000 ha
Population			
Total population	2015	15 129	1 000
Population density	2016	76.91	inhab/km²
Rural population	2015	8 585	1 000
Economically active population in agriculture	2014	4 515	1 000
As % of total economically active population	2014	68.89	%

RENEWABLE WATER RESOURCES (RWR)	Year	Value	Unit
Long-term average annual precipitation			
Depth		686	mm/year
Volume		134.9	km³/year
Long-term average annual RWR			
Internal (IRWR)		25.8	km³/year
External (ERWR)		13.17	km³/year
Total Actual (TRWR)		38.97	km³/year
Dependency ratio		33.8	%
TRWR per capita	2014	2 576	m³/year
Total dam capacity	2015	0.25	km³

WATER WITHDRAWAL	Year	Value	Unit
By sector			
Agricultural	2002	2.065	km³
Municipal	2002	0.098	km³
Industrial	2002	0.058	km³
Total	2002	2.221	km³
Total water withdrawal per capita	2002	213.8	m³
By source			
Surface water withdrawal		-	km³
Groundwater withdrawal		-	km³
Total freshwater withdrawal	2002	2.221	km³
Desalinated water produced	2002	0.00005	km³
Direct use of treated municipal wastewater		-	km³
Direct use of agricultural drainage water		-	km³
Pressure on water resources			
Total freshwater withdrawal as % of TRWR	2002	5.699	%
Agricultural water withdrawal as % of TRWR	2002	5.299	%

IRRIGATION AREAS	Year	Value	Unit
Area equipped for irrigation			
Full control irrigation	2002	102.2	1 000 ha
surface irrigation (2002) 102.2 1 000 ha			
sprinkler irrigation 1 000 ha			
localized irrigation (1980) 0.4 1 000 ha			
Equipped lowland areas	2002	17.5	1 000 ha
Spate irrigation		-	1 000 ha
Total area equipped for irrigation	2002	119.7	1 000 ha
As % of cultivated area	2002	3.861	%
Area actually irrigated	1997	69	1 000 ha
As % of area equipped for irrigation	1997	96.64	%

Notes: 1 km³ = 10^9 m³ = 1 000 million m³; 1 ha = 1 hectare = 10 000 m²

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http://www.fao.org/nr/aquastat/

Source: FAO (2019)

(3) Guinea

Food and Agriculture Organization of the United Nations

AQUASTAT
Global Water Information System

Country Fact Sheet
Guinea

LAND AND POPULATION	Year	Value	Unit
Area			
Country total area	2016	24 586	1 000 ha
Cultivated area (arable land + permanent crops)	2016	3 800	1 000 ha
Population			
Total population	2015	12 609	1 000
Population density	2016	51.29	inhab/km²
Rural population	2015	8 020	1 000
Economically active population in agriculture	2014	4 572	1 000
As % of total economically active population	2014	77.99	%
RENEWABLE WATER RESOURCES (RWR)	**Year**	**Value**	**Unit**
Long-term average annual precipitation			
Depth		1 651	mm/year
Volume		405.9	km³/year
Long-term average annual RWR			
Internal (IRWR)		226	km³/year
External (ERWR)		0	km³/year
Total Actual (TRWR)		226	km³/year
Dependency ratio		0	%
TRWR per capita	2014	17 924	m³/year
Total dam capacity	2015	1.837	km³
WATER WITHDRAWAL	**Year**	**Value**	**Unit**
By sector			
Agricultural	2001	0.2929	km³
Municipal	2005	0.2248	km³
Industrial	2005	0.0562	km³
Total	2001	0.5533	km³
Total water withdrawal per capita	2001	60.71	m³
By source			
Surface water withdrawal	1987	0.666	km³
Groundwater withdrawal	1987	0.074	km³
Total freshwater withdrawal	2001	0.5533	km³
Desalinated water produced		-	km³
Direct use of treated municipal wastewater		-	km³
Direct use of agricultural drainage water		-	km³
Pressure on water resources			
Total freshwater withdrawal as % of TRWR	2001	0.2448	%
Agricultural water withdrawal as % of TRWR	2001	0.1296	%
IRRIGATION AREAS	**Year**	**Value**	**Unit**
Area equipped for irrigation			
Full control irrigation	2001	20.39	1 000 ha
surface irrigation (2001) 19.93 1 000 ha			
sprinkler irrigation (2001) 0.3 1 000 ha			
localized irrigation (2001) 0.16 1 000 ha			
Equipped lowland areas	2001	74.53	1 000 ha
Spate irrigation		-	1 000 ha
Total area equipped for irrigation	2001	94.92	1 000 ha
As % of cultivated area	2001	3.122	%
Area actually irrigated	2001	94.91	1 000 ha
As % of area equipped for irrigation	2001	99.99	%

Notes: 1 km³ = 10^9 m³ = 1 000 million m³; 1 ha = 1 hectare = 10 000 m²

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Source: FAO (2019)

Appendix 3: Survey on Willingness to Pay (French)

Numéro du questionnaire : |_ _ _|____|____|____|____|

Date de l'entretien : _ _/ _ _/2022

Etude de marché sur la volonté de payer pour la fourniture d'énergie renouvelable (PV solaire et digesteur de biogaz)

Pays : ____________________________ Région : ___________________________ Province : ____________________________ Département : ______________________

Numéro de téléphone : ______________________________

Contact email : ____________________________

CADRE D'ÉCHANTILLONNAGE

L'enquête auprès des ménages portera sur :

1. **Société coopérative agricole :** Définie comme une association commerciale dans laquelle les agriculteurs mettent leurs ressources en commun et, ce faisant, ils peuvent augmenter leurs revenus, réduire les coûts ou partager les risques, selon le type de coopérative.

2. ***Organisation paysanne*** ou « **OP** » désigne une organisation établie sur un territoire donné pour répondre aux besoins communs de ses membres (petits exploitants agricoles)

3. **Petits exploitants agricoles :** agriculteurs opérant sur moins de 2 hectares de terres cultivées. Agriculteurs opérant sous des contraintes structurelles telles que l'accès à des quantités sous-optimales de ressources, de technologie et de marchés ou avec une dotation en ressources limitée par rapport à celles des autres agriculteurs du secteur.

A. Caractéristiques générales du répondant

A.1- Âge (années) : /________/

A.2- Sexe : *Homme /___/ Femme / ___/*

A.3- *Diplôme d'études le plus élevé : (Combien d'années de scolarité ? /___ /)*

A.4- *Profession : /____ ______________________________ /   (S'il s'agit d'agriculture, quelles sont les principales activités exercées, la taille de l'exploitation agricole (taille de la parcelle en hectares) et le nombre de travailleurs employés, y compris la main-d'œuvre domestique ?)…………………………………. ……………………………..*

….

……

……………………………… ………………………………………………………………………

A.5- *Exercez -vous une autre profession ? Oui /____ / Non /____/*

Si oui, veuillez énumérer toutes les activités secondaires

…..………………………………………………………………………………………………………

……………………………

………………………………………………………………………………………..………………

…………………………………………………………………………………

A.6- *Quelles sont les principales sources de vos revenus (Veuillez cocher les options appropriées ci- dessous)*

i. *Activités agricoles (productions végétales et animales), ………………………*

ii. *Activités non agricoles (poisson, élevage d'escargots, cueillette forestière, etc.) … ………………………*

iii. *Revenus de transfert (cadeaux, envois de fonds, etc.)… ……………………………*

iv. *Autre activités commerciales …………………………………………………… …..*

v. *Activités rémunératrices (salaires, ouvriers, etc.)… ………………………*

vi. *Autres (précisez)…………………………*

A.7- *Pour chacune des activités génératrices de revenus énumérées ci-dessus, veuillez donner une estimation des derniers revenus annuel (avant cette enquête)*

i. *Activités agricoles (productions végétales et animales, ………………………*

ii. *Activités non agricoles (élevage de poissons et d'escargots, etc.)… ……………………*

iii. *Revenus de transfert (cadeaux, envois de fonds, etc.)… ……………………………*

iv. *Autre activités commerciales ………………………………………………… …..*

v. *Activités rémunératrices (salaires, ouvriers, etc.)… ………………………*

vi. *Autres (précisez)…………………………*

A.8- *Quelle est la source principale de votre éclairage ? (Veuillez cocher ci-dessous)*

Source principale d' éclairage (Cochez /__X_/)
1.Kérosène / ____/
2.Gaz / ____/
3.Services électriques locaux / ____/
4.Groupe électrogène /
5.Batteries / ____/
6.Torches / ____/
7.Bougies / ____/
8.Bois de chauffage / ____/
9.Biogaz / ____/
10.Pas d'éclairage / ____/
11.Autre (Précisez) / ________/

A.9- *Utilisez-vous accès a l' électricité? Oui /____/ Non /____/. Si oui, quelle est la facture mensuelle moyenne d'électricité ? Facture mensuelle moyenne d'électricité….…………………………… …..*

A.10- *A quelle fréquence payez-vous vos factures ? (Régulier………………… (Non Régulier…………………)*

A.11- *. Utilisez-vous un système d'irrigation goutte à goutte dans votre plantation ? Oui /____/ Non /____/*

Si ***non*** *souhaitez-vous en installer un* ***?*** *Oui /____/ Non /____/*

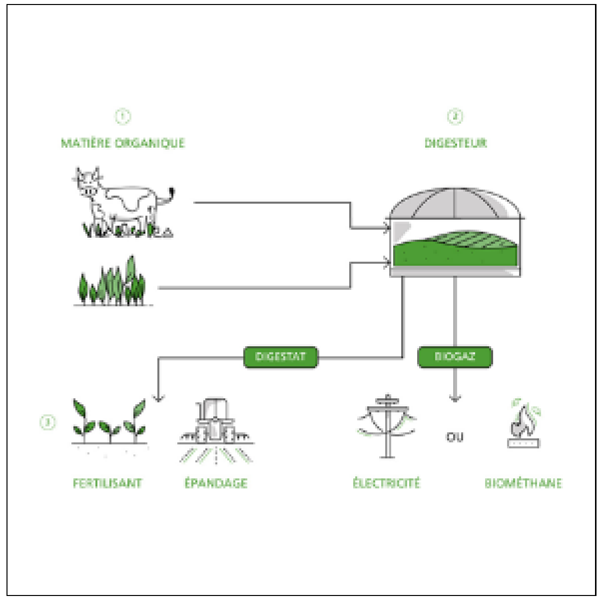
Si vous avez besoin d'un système d'irrigation goutte à goutte, pourquoi n'en avez-vous pas encore installé jusqu'à maintenant ?

…………………………………………………………………………………………………

……………………………………………………………………………………

A.12- *Connaissez-vous les sources d'énergie alternatives telles que les technologies solaires ou biogaz ? Oui /____/ Non /____/*

*Si **non,** les images ci-dessous donnent un aperçu de ce que les technologies solaires et biogaz*



*Si **oui** , utilisez-vous l'une des technologies ?*

Oui /____ / Non /____/

*Si la réponse est **Oui**, Quelle est l'utilisation spécifique et le coût des sources d'énergie alternatives ?*

…

……………………………………..…………………………………………………………………………

……….

*Si la réponse est **Non**, êtes-vous prêt à participer à un nouveau programme conçu par le gouvernement, la BAD et le Fonds vert pour le climat (FVC) pour introduire l'accès aux technologies d'énergie propre ci-dessus afin d'améliorer le changement de valeur agricole ?*

Oui, désireux de participer /____/ Non, non désireux de participer /____/

Si vous ne souhaitez pas participer, veuillez indiquer les raisons pour lesquelles vous ne souhaitez pas participer au programme.

….……

……………………………… ………………………………………………………………………………

A.13- *Si vous êtes prêt à participer, êtes-vous prêt à payer des frais supplémentaires sur vos factures d'électricité mensuelles pour participer au programme ?*

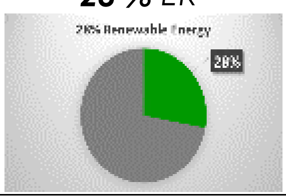
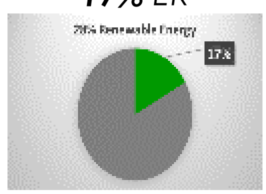
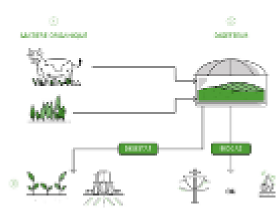
Oui /____/ Non /____/

A.14- *Les services seront fournis par une entreprise de services énergétiques (ESCO). Avez-vous une ESCO préférée que vous aimeriez être en charge de fournir ces services ? Oui /____/ Non /____/*

*(Si **oui** , veuillez indiquer l' entreprise spécifique)… ………………………………*

B. *Préférences*

A.15- *Lequel des nombreux attributs des deux technologies d'énergie renouvelable préféreriez-vous sous la forme d'une augmentation de 5 % de vos factures d'électricité mensuelles ?*

Ensemble de choix 1	***Variante A***	***Variante B***	***Niveau de statu quo***
% ÉNERGIES RENOUVELABLES (ER)	***28 %*** *ER* 	***17%*** *ER* 	***0%*** *ER* 
PRINCIPAL TYPE D'ÉNERGIE RENOUVELABLE			
AUGMENTATION EN % DE LA FACTURE ÉLECTRIQUE MENSUELLE Laquelle des alternatives	*Votre facture d'électricité mensuelle augmentera de 5 %*	*Votre facture d'électricité mensuelle augmentera de 5 %*	*Pas de changement*

préférez-vous ?

Remarques : Les agriculteurs ne doivent en choisir qu'un seul.