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Country Profile on Climate Change, Agricultural Trade and Food Security in ECOWAS - Sierra Leone Report

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African Climate Policy Centre

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LIST OF ABBREVIATIONS

ACPC	African Climate Policy Center
ACR	Agro-climatic Region
AGOA	African Growth Opportunity Act
ADB	African Development Bank
AfDB	African Development Bank
ASYCUDA	Automated System for Customs Data Management
AU-IBAR	African Union-Inter African Bureau for Animal Science
BRAC	Bangladesh Rural Advancement Committee
CAADP	Comprehensive Africa Agriculture Development Programme
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CNRM-CM3	National Meteorological Research Centre Climate Model 3
COP	Conference of Parties
CSA	Climate Smart Agriculture
CSIRO Mark 3	Climate model developed at the Australian Commonwealth Scientific and Industrial Research Organization
CSO	Central Statistics Office
DFID	Department for International Development
DRC	Domestic Resource Cost
DSSAT	Decision Support System for Agro-technology Transfer
ECHAM	Climate model developed by the Max Planck Institute for Meteorology
ECOWAS	Economic Community of West African States
EEZ	Exclusive Economic Zone
ENADIS	Epidemio-Surveillance Network for Animal Diseases in Sierra Leone
EPA	Economic Partnership Agreement
EPIC	Environmental Policy Integrated Climate Model
EU	European Union
EU-EBA	European Union- Everything but Arms
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FBC	Fourah Bay College
FCS	Food Consumption Score
GDP	Gross Domestic Product
GCM	General Circulation Model
GIZ	Gesellschaft fur International Zusammenarbeit
GHG	Green House Gase
GOSL	Government of Sierra Leone
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IMF	International Monetary Fund
IMPACT	International model for Policy Analysis of Agricultural Commodities and Trade
IPCC	Inter-governmental Panel on Climate Change
ISO	International Organization for Standardization

ISPM	International Sanitary and Phytosanitary Measures
ITCZ	Inter Tropical Convergence Zone
IVS	Inland Valley Swamp
LDC	Least Developed Country
MAFF	Ministry of Agriculture, Forestry and Fisheries
MAFFS	Ministry of Agriculture Forestry and Food Security
MFMR	Ministry of Fisheries and Marine Resources
MIROC	Model for Interdisciplinary Research on Climate
MLCPE	Ministry of Lands Country Planning and Environment
MWR	Ministry of Water Resources
NAP	National Action Programme
NAPA	National Adaptation Programme of Action
NARC	Njala Agricultural Research Station
NERICA	New Rice for Africa
NGO	Non-Governmental Organization
NSADP	National Sustainable Agricultural Development Plan
NRC	Nimba Research Consultancy
NSCC	National Secretariat for Climate Change
NU	Njala University
OIE	World Organization for Animal Health
PAMPEMSD	Policy Analysis MatrixProject Evaluation, Monitoring and Statistics Division
RARC	Rokupr Agricultural Research Station
SLARI	Sierra Leone Agricultural Research Institute
SLECAD	Sierra Leone Chamber for Agricultural Development
SLIEPA	Sierra Leone Investment and Export Promotion Agency
SLPMC	Sierra Leone Produce Marketing Company
SSL	STATISTICS Sierra Leone
UNDP	United Nations Development Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNECA	United Nations Economic Commission for Africa
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNU-INRA	United Nations University Institute for Natural Resources in Africa
WFP	World Food Programme
WMO	World Meteorological Organization
WTO	World Trade Organization

SUMMARY

Sierra Leone is highly vulnerable to climate change and there is urgent need to respond through appropriate adaptation, mitigation of Green House Gas emission and improved food security. There is however inadequate information on the potential adjustment in intra West African agricultural trade as a response to climate change. UNU-INRA is conducting a research project aimed at bridging this gap and as a first step embarked upon a mapping of information on climate, climate change, agricultural production, agricultural trade and food security. The overall objective of the mapping is to contribute to a regional assessment and modelling of climate change, agricultural trade and food security in ECOWAS. The specific objectives are to provide country specific data/information and sources on climate, climate change, soil, hydrology; agricultural land and production; agricultural trade and food security; challenges, opportunities, policies and institutional arrangements.

This mapping found that data on climate collected in meteorological stations across the country for over 30 years are available but there are gaps. Observed average annual temperature has been increasing since 1960 at an average of about 0.18 ^{0}C per decade. Average daily maximum temperature is projected to increase by 1-2.5% in 2050 compared to a 2000 baseline. Observed annual rainfall has been variable with extreme events in recent years. Projected rainfall is also variable (both increases and decreases).

Soil surveys have been conducted mainly at the reconnaissance level and 12 soil associations identified and detailed information on soil chemical and physical properties are available for selected soil profiles. There is variability in soil properties but in general, the soils are low activity clay soils of inherent poor fertility status. Summarized data on monthly water balance for 30 years for selected stations across the country are available. Sierra Leone has abundant water resources with 12 watershed basins and 9 major rivers. Data on monthly river flow and ground water are limited. Detailed information on soil water regimes for selected profiles is available.

Land suitable for cultivation on a sustainable basis is 53,620 km^2, 74.2 % of the total land area. Land degradation is perceived to be serious, but quantitative estimates are limited; data on soil nutrient mining and soil erosion are available. Land tenure and access, under communal ownership are key determinants of vulnerability of small scale farmers, in particular women, to climate change.

A wide range of annual and tree crops are cultivated in Sierra Leone, with rice being the major staple. The production of rice, cassava, sweet potato, cocoa, coffee and oil palm has been on the increase since 2001but on-farm yields of annual and perennial crops are low and well below their potentials. The FAO database contains long term data on crop yields, acreage harvested and production. Cattle, sheep, goats, poultry and swine are the major livestock raised; breeds are hardy but generally of low productivity. Data on livestock production is limited. There is locally and internationally (e.g. Seaaroundus database) available long term data on marine fisheries landings. Local records show that production declined between1983 and 1997 but has been rising since 2007.

There is locally available data, at selected district and farm level, on volume and value of domestic trade and market channels for major crops. Import value of rice increased and export value of cocoa and coffee increased between 2001 and 2011. Production trends and international market prices over 30 years are available from the FAO database. The UN COMTRADE database also provides information on national agricultural trade.

Information on costs, returns, margins, value chains and comparative advantage in the production of agricultural commodities are useful in the analysis of trade possibilities. Farm level studies indicate profitability of rice production systems and that labour accounts for a significant proportion of production costs. Small holder cocoa, coffee and oil palm production are also profitable. Value chains for rice, cassava and palm oil are underdeveloped being restricted mainly to the primary stages of production and marketing. There is comparative advantage in the local production of rice for import substitution and in the production of cocoa, and cassava for export. Food insecurity still exists for the most vulnerable and for certain periods of the year but the overall food security status of the population improved between 2003 and 2013, as indicated by food poverty levels and food consumption scores. The FAO food balance sheets provide information on food security parameters including domestic supply, domestic utilization and per capita supply of calories, proteins and fats for a wide range of crops, livestock and fisheries products for over 30 years.

For an optimistic Green House Gas Emission (GHG) scenario, downscaled General Circulation Models- CNRM-CM3 and CSIRO Mark 3 predict gains in rice yields of 5-25% by 2050 over a 2000 baseline especially in the north (Savannah zone). ECHAM 3 predicts the greatest decline in yields, but there are areas in Sierra Leone with no significant changes. Yield of groundnut is

predicted to decline by 5-25% in many parts of the country but CSIRO Mark 3 predicts yield increase of 5-25% in the coastal zone.

Fisheries landings are projected to decline by 14-53% by 2050 compared to a 2000 baseline level, depending on GHG emission scenario. Modelling the effects of climate change on livestock production in Sierra Leone has not been done but the impact is expected to be negative if appropriate adaptation measures are not put in place.

The extension services and farmers are aware of the impacts of climate change on the agriculture sector. Farmers have been adapting to the extent possible within their generally low capacity. The holistic Climate Smart Agriculture approach has recently been introduced into Sierra Leone and where farmers are already making use of components of CSA.

The National Adaptation Programme of Action, the National Communications to UNFCCC, the Agenda for Prosperity (Sierra Leone's third generation poverty reduction strategy paper), the draft climate change policy, and the National Sustainable Agricultural Development Plan directly deal with climate change in agriculture. The Land Policy has a statement on land related disasters such as droughts and floods.

Several sectors and subsectors dealing with agricultural production, trade and food security have challenges related to the biophysical and socioeconomic environments, knowledge gaps, service delivery and institutional capacities. Opportunities including large acreages of arable land, abundant water resources, availability of climate adaptation technologies, government policy reforms and world-wide recognition of the reality of climate change and its impact on agriculture exist. Policies, agreements and institutional arrangements that are in place respond to varying extents to the challenges and opportunities.

Locally available data/information in conjunction with those from international databases can be used to integrate Sierra Leone into the ECOWAS study. The capacities of institutions responsible for the collection, processing and dissemination of agricultural statistics require urgent strengthening.

1. INTRODUCTION

1.1 Background and Motivation

West Africa is being negatively impacted by climate change and Sierra Leone is rated as among the three most vulnerable countries in the world (Maplecroft 2014). There is therefore urgent need for developing and implementing measures that will improve adaptation to climate change, mitigate emissions of Green House Gases (GHGs) and improve food security.

In addition to modifications to production systems, adjustment in trade is one of the options for adaptation. Nelson *et al*. (2009) linked an agricultural-supply-demand projection model (IMPACT) to a biophysical crop model (DSSAT) on the impact of climate change on major crops for future climate scenarios as projected by General Circulation Models (GCMs). They predicted that climate change will result in price increases in developing countries for major crops such as rice, maize and soybean that will translate to higher feed and meat prices. The CSIRO Mark3 model predicted more exports from developed countries and more imports into developing countries. This would lead to deterioration in trade balances and adverse consequences on the poor who spend the largest proportion of their incomes on the purchase of food.

Information on the potential adjustment in intra West African agricultural trade as a response to climate change and ways in which national climate adaptation plans may influence agricultural trade regimes within ECOWAS and vice versa is inadequate (UNU-INRA 2014). Agricultural trade flows within and between countries are dependent upon factors such as climate, soil, hydrology, farming systems, agricultural land and production, food security status, macro-economy and sectoral policies.

The United Nations University Institute for Natural Resources in Africa (UNU-INRA) in collaboration with the African Climate Policy Center (ACPC) of the United Nations Economic Commission for Africa (UNECA) is implementing a research project to assess whether agricultural production systems and trade policies in ECOWAS can be adjusted to alleviate the impact of climate change on food security and promote sustainable development in the region. The first step involved mapping of country information on climate change, agricultural trade and food security and related issues to provide a road map for consolidating and harmonizing the

analytical methodologies of the research project which is the focus of this report.

1.2 Geographical, Environmental and Socioeconomic Profile

Sierra Leone is situated between latitude $6^0$55' N and $10^0$00' N and between longitude $10^0$16' W and $13^0$18' W on the West Coast of Africa and has an area of 72,300 km^2. The total area consists of 60,650 km^2 uplands and 11,650 km2 lowlands. Land suitable for cultivation is estimated at 5.36 million ha, (74% of the total land). It borders Guinea to the north and northeast, Liberia to the south and south-east and the Atlantic Ocean on the West.

It is made up of four major physiographic regions namely; peninsular mountains which are up to 900 m in elevation; a 40 km strip of coastal plain most of which is below 15 m; interior plain which is 100 km wide and 15 - 150 km elevation; interior plateau and hills of 150 - 600 m elevation (Odell *et al.* 1974). Only less than 5% of the country is estimated to be under mature forest, but 70% of the country was forested several decades ago (IFAD 2010). Logging and slash and burn agriculture have had serious negative impact on the vegetation. The current types are rain forests, semi deciduous forests, montane, mangrove, savannah, swamp forests and farm bush (the most dominant). Sierra Leone has 295,950 hectares (ha) of forestry, game reserves and national parks and 32,000 ha of community forests. The country has fauna and flora of international importance suitable for ecotourism and about 15,000 plant species have been identified (IFAD 2010).

Sierra Leone has a hot humid climate marked by distinct wet and dry seasons. The start of the seasons has been shifting over recent years a phenomenon linked to climate. The water resources are abundant, with average annual rainfall ranging from about 2000-5000 mm and nine major river systems draining into the Atlantic Ocean. The soils dominated by low activity clays, are highly leached, acidic and have widespread plant nutrient deficiencies. Maintenance or improvement of the integrity of these systems is vital for ensuring the ecosystem services on which the growing population depends.

The national census of 2004 put the population of Sierra Leone at 4,976,871 projected to rise to 6,348,350 by 2014 (Koroma *et al.* 2006). The population growth rate was estimated at 2.2% in 2010 (World Bank 2013a). Sierra Leone is in the group of Least Developed Countries (LDCs) having come out

of an eleven year civil war in 2002. Life expectancy at birth is estimated at only 47 years and adult male and female literacy are low at 52.7 and 30.1 years respectively (World Bank 2013a).

Trends in economic development indicators show a negative trade balance and the important contribution of agriculture to GDP to the economy (Table 1.1). The GDP grew at 4% per annum immediately after independence in 1961 and dropped in the 1970's and 1980's. Recent key indicators show that the economy is improving (GDP was 6% in 2011 and 15.2% in 2012) mainly due to the exploitation of iron ore deposits. GDP growth in 2013 was estimated at 13.3% (GOSL 2012a; 2013b).

Table 1.1: Economic development indicator trends ***(World Bank 2013b)***

	1980	**1990**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**1980-1989**	**1990-1991**	**2000-2010**
GDP Growth (%)	4.8	3.4	7.5	7.2	7.3	6.4	5.5	3.2	5.0	1.1	-4.3	9.2
Ext. Trade Balance Share of GDP (%)	-15.4	-1.3	-10.9	-12.9	-7.6	-7.0	-13.1	-13.1	-12.4	-3.1	-4.5	-13.9
Agric. Value Added Share of GDP (%)	33	46.9	44.9	51.6	51.1	49.9	50.2	52.3	49.0	40.0	47.9	49.9

Agriculture's contribution to GDP has been increasing steadily from 33% in 1980 to 40% in 2001 and about 47% in 2013 (Table 1.2). The crops sector contributes strongly (25-38%) to GDP. Sierra Leone is in its second year of implementing its Agenda for Prosperity (2013-2018), which is the country's third generation Poverty Reduction Strategy Paper (GOSL 2013b). The strategy has linkages to the continental Comprehensive Africa Agriculture Development Programme (CAADP) and the regional ECOWAS policies and strategies (CAADP 2003; ECOWAS 2005).

Table 1.2: Contribution of Agriculture Sub sectors and Forestry to GDP (%)*(STATISTICS Sierra Leone, personal communication, 2014)*

Sub sector	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Crops	25	29	28	30	32	32	31	32	38	34	34	31	29
Livestock	2	3	3	3	3	3	3	3	3	3	3	3	2
Forestry	6	5	5	4	4	4	4	3	7	7	7	8	7
Fishery	7	7	8	9	9	8	8	8	8	9	10	10	9
Total	**40**	**44**	**44**	**46**	**48**	**47**	**46**	**46**	**56**	**53**	**54**	**52**	**47**

1.3 Objectives

The overarching objective of the study was to contribute to a regional assessment and modelling of climate change, agricultural trade and food security in ECOWAS. The specific objectives were to assess the status, provide data/information, identify data sources and where possible specify the methods previously used for data collection with regards to: (i) climate, climate change, soil and hydrology, (ii) agricultural land and production, (iii) agricultural trade and food security, and (iv) challenges, opportunities, policy and institutional arrangements.

1.4 Methodology

The study involved a desk review and synthesis of data and information in published and unpublished reports, papers published in peer reviewed journals and conference proceedings. Interviews were held with key informants/stakeholders dealing with soils, crops, livestock, fisheries, lands, water resources, trade, food security, and climate change. A list of persons contacted in one form or the other are presented in Annex 1. Data was also accessed from international databases with emphasis on medium to long term data that can be used for climate-related modelling. The data was collected between April and July, 2014.

2. CLIMATE, CLIMATE CHANGE, SOILS AND HYDROLOGY

2.1 Climate and Climate Change

2.1.1 Past and Recent Climate

The climate of Sierra Leone is determined by the interactions of two air masses; the maritime (humid) air mass originating from the Atlantic Ocean and associated with the south-western winds commonly referred to as the south-west monsoon and the continental (dry) air mass originating from the African continent and associated with the north-eastern harmattan winds (trade winds). The seasonality of the climate is a result of the annual north-south migration of the Inter Tropical Convergence Zone (ITCZ), which is the narrow zone of discontinuity between these two air masses. Climate and weather of Sierra Leone have been described by several workers but Odell *et al.* (1974) and UNDP/FAO (1979a) are the most quoted reports dealing with agriculture and the environment.

The typical weather pattern of Sierra Leone is a rainy season (May - November) followed by a dry season (December - April). The weather patterns having been changing. The rainy season is characterized by a sequence of thunderstorms and squalls, then steady rains and again thunderstorms and squalls. Relative humidity is high (above 70%) throughout the period. The dry season is marked by dry weather with high humidity, followed by short periods of dry weather with low humidity (harmattan) and finally dry weather with high humidity. The rainy season is most pronounced in the coastal zone (3048-5080 mm) and least in the north of the country where rainfall ranges from less than 2032-2540 mm. The dry season is most severe in the north (less than 127 mm) of rainfall and least in the central eastern parts (254-381 mm or more). Rainfall data for 1961-2010 is available (GOSL 2012b) as reported in the Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC).

Comparison of average monthly rainfall for 1961-1990 with data for 2012 and 2013 show declines for Lungi in the Savannah woodland/coastal plain (Figure 2.1) and both increases and decreases for Bo in the transitional rainforest savannah woodland/rainforest depending on the month (Figure 2.2). There are also occurrences of ‘extreme events’ like the unusually heavy rainfall in March of 2013 in Bonthe in the Coastal plain/savannah

woodland/transitional rainforest savannah woodland and there tended to be more rainfall between May and December 2012 compared to 1961-1990 (Figure 2.3).

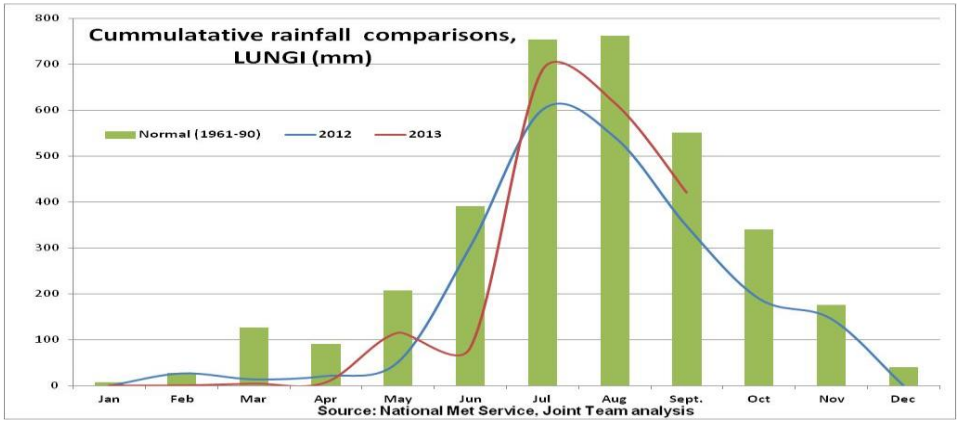

Figure 2.1: Comparison of Monthly rainfall at Lungi between 1961-1990, 2012 and 2013

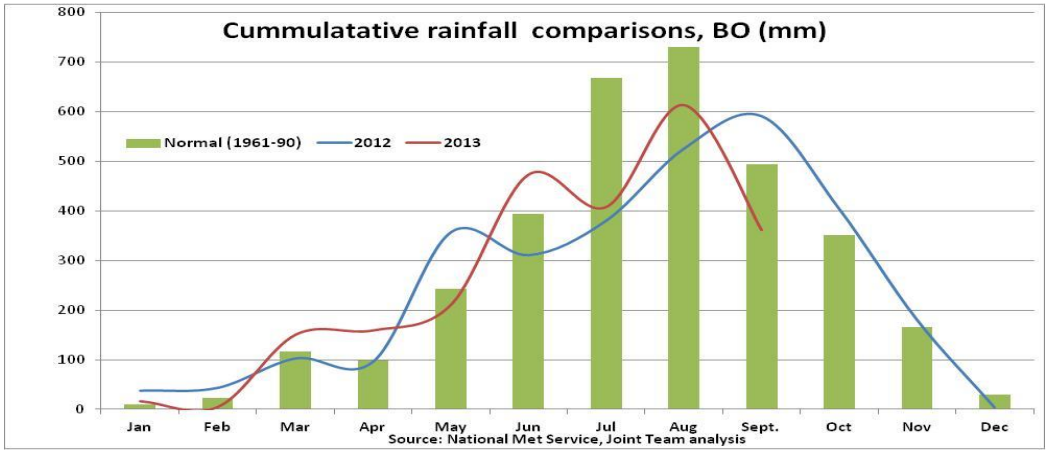

Figure 2.2: Comparison of Monthly rainfall at Bo between 1961-1990, 2012 and 2013

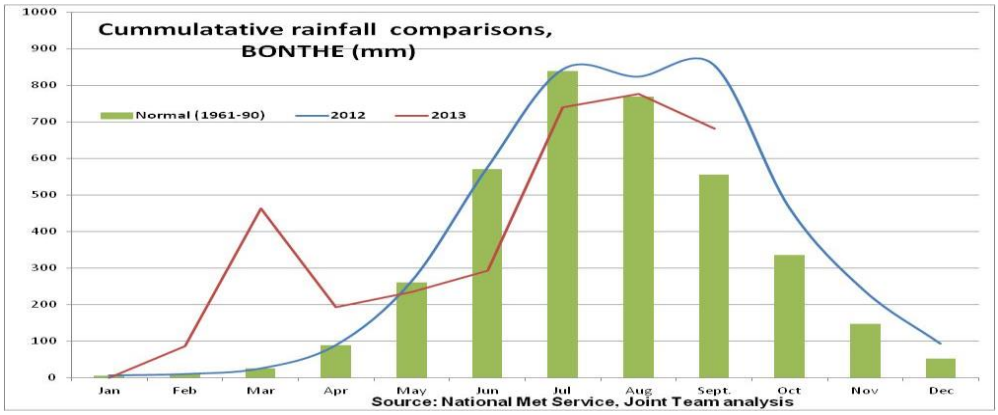

Figure 2.3: Comparison of Monthly rainfall at Bonthe between 1961-1990, 2012 and 2013

Data on annual and monthly mean temperatures is available but very little information is available on soil temperature. Data from limited observations have shown that there is little difference between soil temperature at 15 cm and 30 cm depths (Odell *et al.* 1974). Annual average temperature for the period 1961-1990 in Sierra Leone was 27 ^{0}C (GOSL 2008a). It has been increasing since 1960 at about an average of 0.18 ^{0}C per decade (Tarawalli 2012).This is higher than the rate of global warming between 1998 and 2012 of 0.05 ^{0}C - 0.15^{0}C per decade and between 1951 and 2012 of 0.08 ^{0}C - 0.14 ^{0}C per decade (IPCC 2013).

Relative humidity is usually very high with mean monthly values ranging from 90% along the coast to 70% in the northeast in August. In January, it ranges from 60% along the coast to 30% in the northeast then drops as low as 20% during the harmattan. Evapotranspiration is relatively low and is estimated at 930 mm on the coast in Freetown increasing northwards to 1877 mm in Musaia in the Koinadugu District (Odell *et al*. 1974). Data on rainfall, temperature (minimum and maximum), sunshine, relative humidity, evapotranspiration, vapour pressure, wind speed based on measurements from 10 meteorological stations across the country for periods ranging from 1926 to 2014 is available (Annex 2; Odell *et al.. 1974).*

2.1.2 Climate Change Projections

Outcomes for rainfall for an optimistic scenario, that is, a GHG emission scenario that assumes fast economic growth, a population that peaks mid-century and the development of new and efficient technologies, along with a balanced use of energy sources are varied (Johnson *et al.* 2013). The CNRM-CM3, CSIRO Mark3 and ECHAM5 General Circulation Models (GCMs) indicated rainfall varying from -50 to +50 mm by 2050 (compared to a 2000 baseline) in most areas, with an increase of 50-100 mm in 20% of the country, but the 3 models differed in terms of the specific regions that will experience this increase. MIROC 3.2 however indicated a severe reduction in rainfall in most parts of the country of 50 to -100 mm in the north and -200 to -400 mm in the south.

Increases of 1-1.5 ^{0}C in average daily maximum temperatures by 2050 were always predicted by CSIRO Mark3 and MIROC 3.2. CNRM-CM3 indicated increase of 2-2.5 ^{0}C throughout the country with the exception of a small area largely in the coastal zone and ECHAM 5 predicted similar increases that would be greater in the north and northeast compared to the rest of the country.

2.1.3 Agro-climatic Regions

The country has four main physiographic regions: the coastal plains, savannah woodland, transitional rainforest savannah woodland, rainforest (Table 2.1 and Fig. 2.4). These were used as basis for determining agro-climatic regions by combining physical characteristics with length of growing period (UNDP/FAO 1979b). Verheye (1997) criticized the zonation as being too broad and largely determined by vegetation and went on to propose nine zones (Fig. 2.5). More than one agro-climatic region may occur in an administrative district. However, it is difficult to relate Verheye's zonation with current cropping systems (Jalloh 2006). The UNDP/FAO agro-climatic zonation, the most widely used in Sierra Leone, was adopted for the agricultural sector review of Sierra Leone in 2004 and this mapping makes use of it.

Table 2.1: Characteristics of the agro-climatic regions *(UNDP/FAO 1979b; MAFFS/MFMR 2004b)*

Regions	Area (km^2)	Dominant land form	Altitude (m)	Average temperature (^0C)	Average annual rainfall (mm)	Average length of growing period (days)	Dominant vegetation
Coastal plain	11,016	Estuarine swamps, alluvial plains, beach ridges and coastal terraces	< 150	27.9	3000	260 ±10	Mangrove swamp and grassland
Savannah woodland	27,993	Drainage depressions, undulating plains, low plateau and hills.	150-300	28.2	2280	255 ±10	Lophira savannah, Savannah woodland, mixed tree savannah upland grassland and forest regrowth
Rainforest/ savannah	20,712	Plateau with undulating high lying plains, rolling hills	150-300	28.5	2730	270-300	Savannah woodland, montane grassland and forest regrowth
Rainforest	12,579	Plateau with undulating plain, rolling plains and hills	300-600	28.6	2660	314 ± 9	Forest and forest regrowth
Hills /mountain	14,723	Highly dissected hill ridges	>600				Montane grassland, upland grassland

Figure 2.4: Agro-climatic regions (1) ***(Reproduced from UNDP/FAO 1979b)***

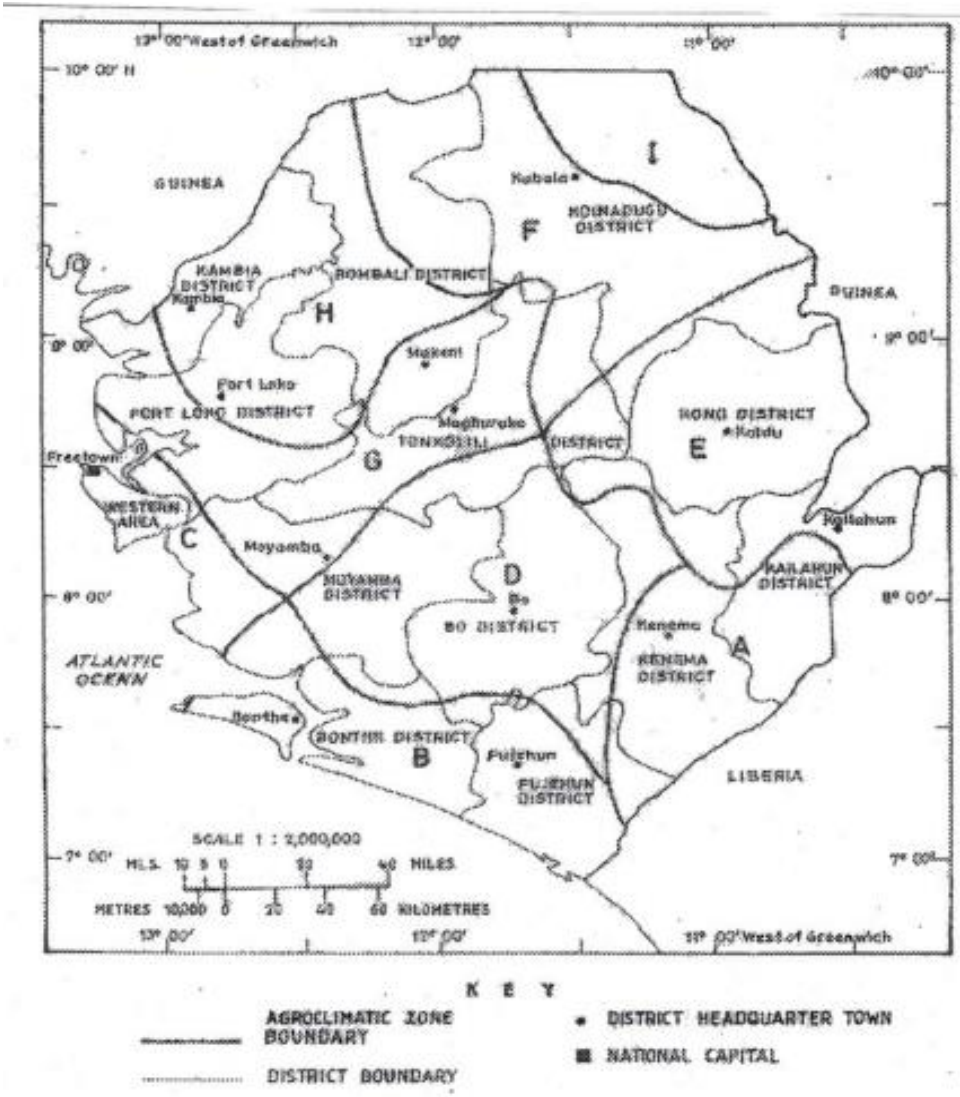

Figure 2.5: Agro-climatic regions (2) *(Reproduced from Verheye (1997)*

Notes for Figure 2.5:

- Zone A: representative station Daru; Length of GP > 300 days; start of GP in the third decade of February; rainfall in GP = 2500 – 3000 mm; length of humid period >240 days, dry season <70 days.
- Zone B: representative station Bonthe; start and length of GP: first decade of March and 270 – 300 days respectively; rainfall in GP > 3000 mm; length of humid period 230 days; dry season between 70 and 100 days

- Zone C: representative station Newton; start and length of GP: first decade of April and 230 – 270 days respectively, rainfall in GP > 3000 mm; length of humid period 230 - 270 days; dry season between 100 and 120 days
- Zone D: representative station Bo; start and length of GP: first decade of March and 270 – 300 days respectively, rainfall in GP 2750 - 3000 mm; length of humid period 240 days; dry season between 70 and 100 days.
- Zone E: representative station Yengema; start and length of GP: second decade of March and 270 – 300 days respectively, rainfall in GP 2500 - 2750 mm; length of humid period 230 days; dry season between 70 and 100 days.
- Zone F: representative station Kabala; start and length of GP: first decade of April and 230 – 270 days respectively, rainfall in GP 2000 - 2500 mm; length of humid period <210 days; dry season between 100 and 120 days.
- Zone G: representative station Makeni; start and length of GP: first decade of April and 230 – 270 days respectively, rainfall in GP 2750 - 3000 mm; length of humid period 220 days; dry season between 100 and 120 days.
- Zone H: representative station Port Loko; start and length of GP: first decade of April and <230 days respectively, rainfall in GP 2500 - 2750 mm; length of humid period <200 days; dry season > 120 days.
- Zone I: representative station Musaia: start and length of GP: second decade of April and <230 days respectively, rainfall in GP <2000 mm; length of humid period <210 days; dry season > 120 days.

2.1.4 Challenges, Opportunities, Policy and Institutional Arrangements

Challenges and Opportunities

The key challenges revolve around improving data collection in terms of quality, its processing and dissemination. There has been serious deterioration of the meteorological data collection capability of Sierra Leone due to the civil war. There were eleven synoptic stations just before the civil war (Lungi, Daru, Kono, Kabala, Makeni, Njala, Bo, Freetown, Shenge, Yele and Bonthe) and at the end of the war only four (Lungi, Bonthe, Makeni and Bo) were operational. The situation is improving and in 2012 there were five automatic stations (FBC, NARC, RARC, Lungi and Kenema) and four more have since been installed (Kabala, Kono, Kenema and Kailahun) and another (Maboima) for the proposed Mamamah Airport. The first set of five were intended to send real time data to two base stations in Freetown and Lungi but this arrangement has not worked properly because of incompatibility of equipment and data had to be sent through the mobile phone companies whose charges are unaffordable by the Meteorological Department.

Another challenge is shortage of adequately trained staff which together with the lack of adequate infrastructure pose a big challenge to providing the required information to its various stakeholders. The interest shown by the international community in responding to the threat of climate change is an

opportunity for strengthening the capacity of the Meteorological Department. Plans are underway to have synoptic stations in all districts and simple rainfall stations in all chiefdoms (one secondary school in each chiefdom) and having the pupils participate in data collection.

Policy and Institutional Arrangements

The Meteorological Department of the Ministry of Transport and Aviation is the body responsible for collecting weather data, processing and disseminating information and related services to end users. Its key policy objective is to make available and accessible weather, climate and climate related information and services to various stakeholders and to strengthen the capacity of the Department to provide good quality information and services. The department has linkages with local and international partners notably Environment Protection Agency (EPA), Ministry of Water Resources, Ministry of Agriculture Forestry and Food Security (MAFFS) and the Disaster Management Department of the Office of National Security. The major way of collaboration is by providing information and services on weather, climate related issues and participation in the activities of stakeholders for example in the new project on strengthening climate information and early warning. Key international partners include WMO, UNDP, IFAD, DFID and UNICEF.

2.2 Soils

2.2.1 Types and Distribution

Soils of Sierra Leone have been surveyed and mapped at various scales depending on intended use. Reconnaissance level survey is satisfactory for planning at the national level including allocation of land to different land use classes, whereas a detailed level survey is required for farm - level planning involving soil conservation, irrigation and water management.

Soils of the bolilands, in the northern province of Sierra Leone, were surveyed by Stobbs (1963). Bolilands are areas of flat treeless grasslands that are annually flooded; there are riverine and inland bolilands. The bolis were surveyed at reconnaissance level (1:50,000) followed by detailed surveys. Oxysols, Ground Water Laterites, Very Acid and Acid Gleisols, and Alluvisols were identified using Charter's system of classification, and soil series and typical profiles described. A soil province map of the country at the reconnaissance level, made up of 16 soil provinces, within each of which

the soil forming factors are reasonably constant or vary in well-defined patterns, was developed (Dijkerman 1969).

A total of 44 soil profiles from 6 of the provinces were characterized in detail (Odell *et al.* 1974) and classified according to the USDA soil taxonomy into the following orders in decreasing importance: Ultisols, Inceptisols, Oxisols, Entisols, and Spodosols. In terms of the FAO/UNESCO system, the major soil classes identified were Ferralsols, Cambisols, Nitosols, and Gleysols. Many of the well-drained soils were classified as Sols ferrallitiques and the poorly drained soils as Sols hydromorphes according to the French system. Information was provided on slope, drainage and parent material of the sites. For each soil horizon information was given on depth, morphology, particle size, water dispersible clay, bulk density, soil moisture contents at 0.33 and 15 atmospheres, exchangeable cations, organic carbon, pH, Bray P1 and P2, total P, total CaO and total K_2O. Selected chemical and physical properties of these soils can also be found in Sutton *et al*. (1989). The UNESCO Soil Map of Africa (UNESCO 1974) at scale of 1:500,000,000 recognized Cambisols, Ferralsols, Nitosols and Regosols as the major soil types in Sierra Leone. A soil map and report of Sierra Leone (UNDP/FAO 1979a) at scale 1: 2,000,000 (reconnaissance level), that was developed on a physiographic basis, identified 12 soil associations (Fig. 2.6).

More recently, Ojanuga (2007) undertook detailed soil surveys at 1:8,000 and 1:10,000 of three pilot areas in the West, North and South of Sierra Leone using the conventional rigid grid soil mapping methodology. The survey report provided information on coordinates of the sites, agro-climatic regions in which they are located, slope, soil depth, soil profile morphology along toposequences, particle size, exchangeable cations, total nitrogen, organic carbon, pH, and Bray P1 of the horizons of sample profiles.

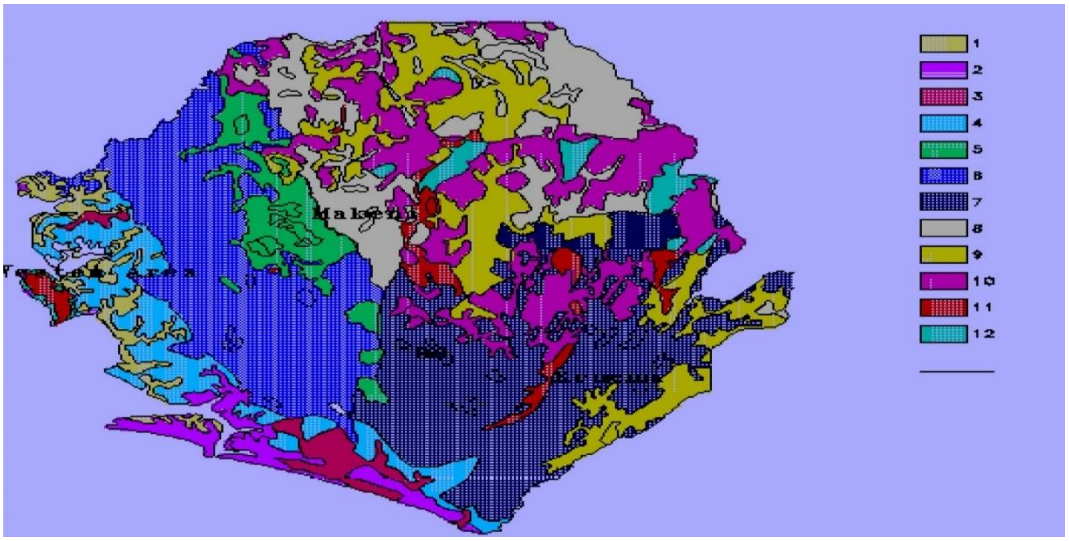

Figure 2.6: Soil associations (Reproduced from UNDP/FAO 1979a)

Note:
1. Weakly developed muds and hydromorphic clays along coastal river estuaries and coastal estuarine swamps (2,347 Km^2)
2. Underdeveloped to weakly developed sands on coastal beach plains (1,433 Km^2)
3. Hydromorphic clays and gravel free ferralitic soils and coastal flood plains or riverine grassland plains (1,404 Km^2)
4. Gravel free ferralitic soils on coastal terraces (5,159 Km^2)
5. Gravely ferralitic and plinthic hydromorphic soils on inland terraces, depressions and flood plains (3,136 Km^2)
6. Very gravely ferralitic soils over colluvial gravel on western interior plains (12,647 Km^2)
7. Gravely ferralitic soils over weathered granite basement or colluvial gravel on southern interior plateau plains (16,965 Km^2)
8. Gravely nodular ferralitic soils over weathered granite basement on northern interior and plateau plains (5,486 Km^2)
9. Stony and gravely ferralitic soils over weathered granite basement or colluvial gravel on low to moderate relief hills (10,267 Km^2)
10. Shallow, stony and gravely ferralitic soils on moderate to high relief hills formed from predominantly acid rocks (9,899 Km^2)
11. Shallow, very gravely ferralitic soils on moderate to high relief hills formed from basic and ultra-basic rocks (2,084 Km^2)
12. Shallow soils on plateau mountains and lateritic hills and terraces (1,499 Km^2)

In general, information on soil types is mainly available at the reconnaissance level and detailed information is at the plot and pilot project levels. There is variability in soil properties across the country but in general, the soils of Sierra Leone are of low inherent fertility (low activity clays). Soils of the savannah agro-climatic regions tend to be sandier than soils of forest agro-climatic regions and the latter tend to have higher organic matter contents and water holding capacities. A variety of soil types can occur

within each agro-climatic region depending on parent material, topography and age.

An important feature of the landscape of Sierra Leone is a sequence of soils from uplands to lowlands within each agro-climatic region. Uplands soils are generally of poor fertility, well drained have varying textures but are mainly of medium textures (sandy loam to sandy clay loam). Soils of the lowlands (inland valley swamps, riverine grasslands, bolilands and mangrove swamps) are in wetland ecologies. They are poorly drained and waterlogging at the surface is of varying durations ranging from less than 1 month to over 5 months. The mangrove soils are of medium to fine textures and the textures of the soils of the other lowland ecologies are variable ranging from sandy to medium textures. They are deeper than the upland soils. The limitations for agriculture of the major soil groups are outlined in Driessen *et al.* (2001) and Jalloh *et al*. (2011).

2.2.2 Challenges, Opportunities, Policy and Institutional Arrangements

Challenges and Opportunities

The National Sustainable Agricultural Development Plan (NSADP) and the Operational Plan of the Sierra Leone Agricultural Research Institute (SLARI 2011) recognized the challenges and opportunities concerning the use of the soils of Sierra Leone. The major challenge is in the sustainable management of the low activity clay soils of inherently low fertility. In addition there are localized problems of soil salinity in coastal mangrove areas and iron toxicity in poorly drained inland valley swamps (IVS). Fully functional soil testing laboratories at Njala University and SLARI are required for informed soil management decision making. In terms of opportunities, the soils can be suitable for the intensive cultivation of a range of crops if properly managed.

Policy and Institutional Arrangements

The policy objectives are to provide for land use based on matching crops to land qualities, avoidance of soil degradation and efficient and safe use of fertilizers and organic materials through integrated soil fertility management.

The Magbosi Land Water and Environment Research Centre, the Njala Agricultural Research Centre, the Rokupr Agricultural Research Centre (all of the Sierra Leone Agricultural Research Institute), Njala University (NU)

and the Engineering Division of MAFFS are responsible for soils research and swamp development work. The latter focuses on irrigation and drainage (IVS development). There is close collaboration between all these institutions - NU staff are associate scientists at SLARI, SLARI staff teach at NU on a part time basis and MAFFS is the supervising ministry of SLARI.

2.3 Hydrology

2.3.1 Water Balance

The water balance at the Guma valley watershed in the Western Area (which is the source of the pipe borne water to Freetown the capital city), has been approximated as components of rainfall, runoff, evapotranspiration and surplus (Balek 1983) as shown in Table 2.2. Annual water balances (distinguishing between total and reliable rainfall) for stations in the east, north, south and west of Sierra Leone was estimated for the period 1961-1990 (MAFFS/MFMR 2004c). There was a deficit in reliable water in Kabala in the extreme north but surpluses in the rest of the country (Table 2.3).

Table 2.2: Water balance at the Guma valley watershed (Balek 1983)

	Annual rainfall (mm)	Run off (mm)	Evapotranspiration (mm)	Surplus (mm)
Wet season (April to November)	5737	4613	572	552
Dry season (December to March)	58	36	439	-417
Annual	**5795**	**4649**	**1011**	**135**

Table 2.3: Annual water balance at selected locations 1961-1990 (Adapted from MAFFS / MFMR, 2004c; A. Bockarie, personal communication, 2014)

Station	ACR	Rainfall (mm)	Reliable Rainfall (mm)	Evapotranspiration (mm)	Total water surplus/ deficit (mm)	Reliable water surplus/ deficit (mm)
Daru	7	2380	1640	1588	792	52

Lungi	5	2988	2193	1786	1231	407
Freetown	1	2945	2134	1751	1194	383
Kabala	8	2194	1432	2034	43	-602
Bonthe	2	3659	2732	1528	2196	1204
Bo	3	2619	1843	1627	990	216
Average		2798	1996	1719	1074	-277

Note:
ACR = Agro-climatic Region
1= Coastal plain; 2 = Coastal plain/savannah woodland/ transitional rainforest savannah woodland; 3 = Transitional rainforest savannah woodland/rainforest; 5 = Savannah woodland/coastal plain; 8 = Savannah woodland/transitional rainforest savannah woodland.

Information is also available on monthly water balances for the Daru, Lungi, Freetown, Bonthe and Bo stations. Monthly water requirements for rice and vegetables for four stations representing the east, west, north, and south are available (MAFFS/MFMR 2004c).

2.3.2 Surface Water

Sierra Leone has 12 watershed basins and 9 major rivers, flowing in north east to south west directions through the agro-climatic regions into the Atlantic ocean with catchment areas varying from 720 km^2 (Peninsular) to 14,140 km^2 (Sewa) and an estimated annual discharge of 73,770 x 10^6 m^3/year (Table 2.4, Figures 2.7). Catchment sizes are perceived to have declined over time, but there is no quantitative data available to ascertain the extent. Major lakes include Lakes Sonfon (Koinadugu District), Mappe (Bonthe District) and Mabesi (Pujehun District). River discharges are high ranging from about 1,000 to 17,000 x10^6 m^3/year (Table 2.4). Data on the mean monthly flow of the Rokel-seli river at Bumbuna from 1970 - 1979 is available (MWR, personal communication, 2014). The average surface runoff computed for each basin based on selected rainfall stations totalled 74 km^3/year (MAFFS/MFMR 2004c). FAO (2005) estimated Sierra Leone's global renewable water resources (surface + ground + atmospheric) at about 160 km^3/year. The Sewa, Little Scarcies and Moa contribute over 55% of the total surface water.

Despite the abundance of water resources, there can be water shortages at the local level for example where swamps have been drained for agricultural purposes and tributaries which used to be perennial have become seasonal. Since inland valleys form part of a continuum from the uplands to swamps in Sierra Leone, management of upslope affects downslope conditions. Lamin *et al.* (1999) studied the hydrology of inland valley swamps in Sierra Leone, with a view of improving water management and crop productivity. Average discharge measured in the wet season in the Tonkolili district (Transitional

savannah woodland rain forest agro-climatic region) ranged from 0.2-1.09 m^3/second with flooding depth ranging from 30-50 cm. Average discharge in the wet season from 6 swamps in the Koinadugu district (Savannah woodland agro-climatic region/transitional rainforest savannah woodland) ranged from 0.2-0.84 m^3/second with flooding depth ranging from 10- 0.3 m. In the Port Loko district (Savannah woodland/ coastal plain agro-climatic region) average discharge from 8 inland valley swamps in the wet season ranged from 0.4-1.36 m^3/second with flooding depths ranging from 30-80 cm because of the nearly level valley bottom.

Table 2.4: Annual water balance at selected locations 1961-1990 (MAFFS/MFMR 2004c)

River basin	Catchment area (km^2)	Mean annual rainfall (mm)	Estimated mean annual discharge ($10^6 m^3$/year)	% Annual discharge
Great Scarcies	3,115	2,750	3,427	4.65
Little Scarcies	13,000	2,413	12,548	17.01
Rokel	10,620	2,411	10,250	13.89
Sewa	14,140	3,017	17,064	23.13
Wanje	4,510	3,133	5,652	9.66
Moa	9,220	3,046	11,233	15.23
Mano	2,530	3,293	3,333	4.52
Coastal Creeks	6,960	3,320	9,243	12.53
Peninsular	720	3,540	1,020	1.38
Annual			**73,770**	**100**

Note:
Estimates were based on the average of selected rainfall stations in each basin. A run off coefficient of 0.4 was assumed in all cases. The perennial rivers are fed by aquifers during the dry season, indicating that a substantial proportion of the rainfall goes to recharge the ground water table.

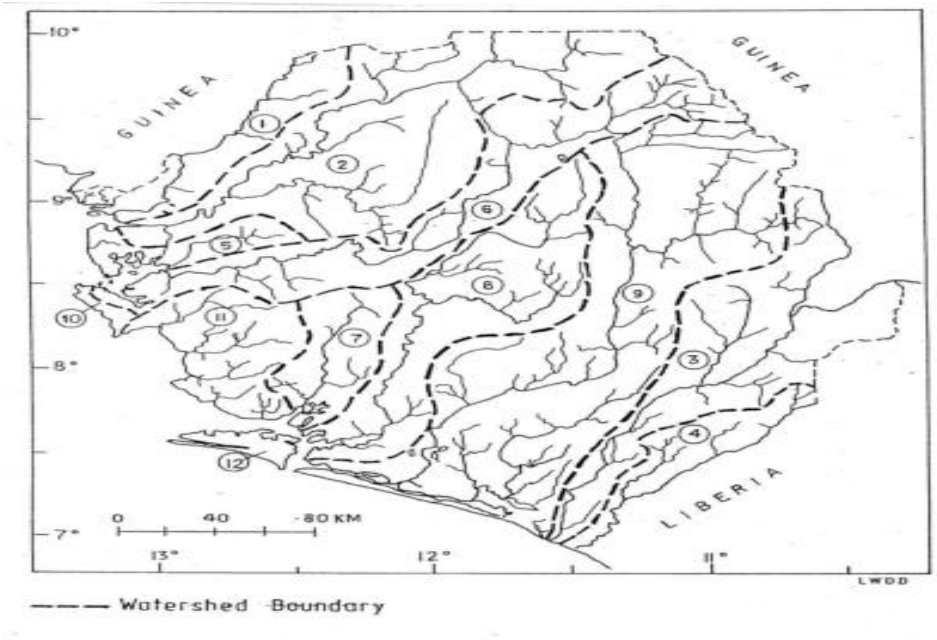

Figure 2.7: Major river basins in Sierra Leone.*(Reproduced from UNDP/FAO 1979a)*

Note: *1. Great Scarcies, 2. Little Scarcies, 3. Moa, 4. Mano 5. Lokko 6. Rokel 7. Gbangbaia 8. Jong 9.Sewa*
10. Western 11. Ribbi/Thauka 12.Sherbro

2.3.3 Soil Water Regimes

Potential evapotranspiration greatly exceeds rainfall during the dry season resulting in soil water deficit in most soils. The duration of the soil moisture deficit depends on available soil water holding capacity and ranges from 5 to 1 month for well drained to imperfectly drained soils and from 3 to 0 month for poorly to very poorly drained soils (Odell *et al.* 1974). In the rainy season, rainfall greatly exceeds evapotranspiration and in poorly drained soils waterlogging occur.

2.3.4 Ground Water

There is limited data on status of the ground water and some are conflicting (MAFFS/MFMR 2004c). The soft rocks (Bullom, Freetown complex, Kasila and Marampa groups) cover more than 70% of the country suggesting that groundwater recharge could be high thus contributing to surface flow in the major river basins even during the dry season. In the Bullom series,

groundwater levels could reach as high as 0- 0.2 m below ground level during the rainy season. In the Saionia Scarp Group ground water levels are 8-10 m, with seasonal fluctuations of 3-5 m. Depth of ground water is related to geology as well as position on the landscape and generally ground water surface ranges between less than 5 - 20 m across the country with most occurring between 5-10 m. Ground water yields in Newton (Western Area) and Mile 91 (Northern Province) were estimated at 250 and 150 m^3/day respectively (MAFFS/MFMR 2004c). In the crystalline basement aquifer system, yields were estimated at 20 - 60 m^3/day. The unconsolidated and poorly consolidated aquifer material belonging to the hard rock formations (for example, Rokel River Group, Saionia Scarp Group) yielded 20-50 m^3/day. The FAOAQUASTAT database (FAO 2005; FAO 2014) reported ground water resources for Sierra Leone of 25-50 km^3/year and overlaps between surface and groundwater of 15-40 km^3/year.

2.3.5 Agro-hydrological Regions

Eight (8) agro-hydrological regions relevant to rain fed agriculture have been identified for Sierra Leone (Kamara and Jackson 1997) using 14 variables combining rainfall occurrence/non-occurrence and soil moisture (Figure 2.8, Annex 3). The study involved analysis of rainfall data over a 20 year period and soil moisture storage capacity. This zonation however does not seem to have been utilized for agricultural research and development.

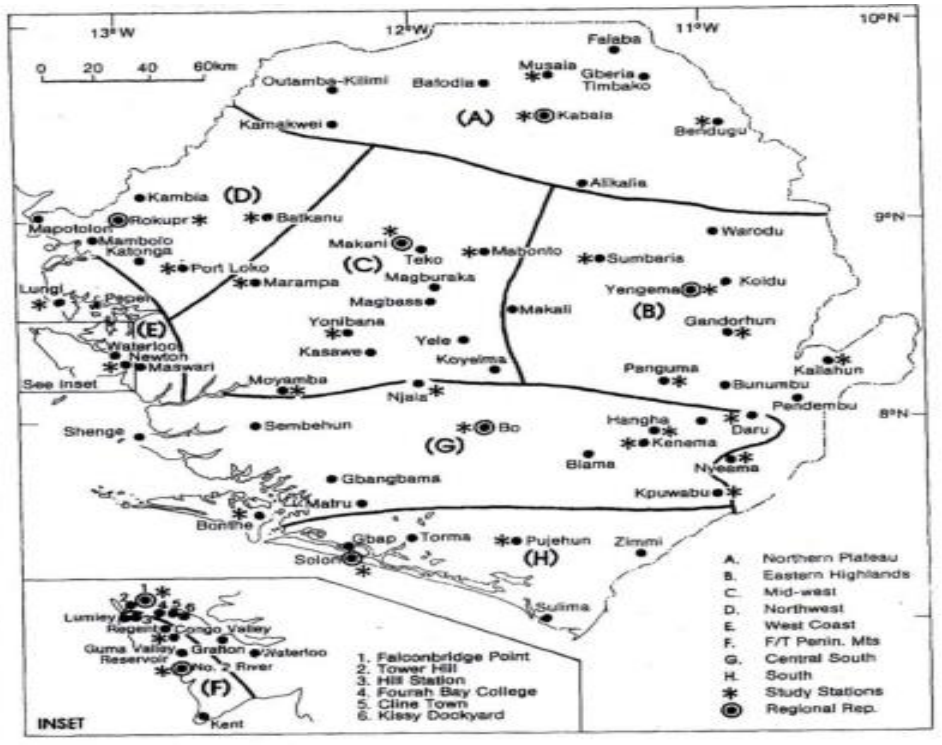

Figure 2.8: Agro-hydrological regions (Reproduced from Kamara and Jackson 1997)

Note: characteristics of the regions

Northern plateau: Many and long maximum spells of drydays with "deficit" soil moisture. Relatively large number and long maximum spells of drydays with "limiting" soil moisture. Relatively few and a short maximum spell of raindays with "surplus" soil moisture. To a lesser extent, relatively long maximum spells of raindays and drydays with "adequate" soil moisture.

Eastern Highlands: Relatively few and short maximum spells of drydays with "deficit" soil moisture, but many drydays with "adequate" soil moisture. Relatively few and short maximum spells of raindays with "deficit" and "adequate" soil moisture. Short maximum spells of drydayswith "limiting" soil moisture.

Mid West: Many and long maximum spells of raindays with "surplus" soil moisture and drydays with "deficit" soil moisture. Few and short maximum spells of raindays with "limiting" soil moisture. Few drydays with "limiting" soil moisture but relatively long maximum spells of such days. Long maximum spells of drydays and raindays with "adequate" soil moisture.

North West: Many and long maximum spells of raindays with "deficit", "adequate", and "surplus" soil moisture. Many and long maximum spells of drydays with "deficit" soil moisture. Few and short maximum spells of raindays with "limiting" soil moisture. Few drydays with "limiting" and "adequate" soil moisture, but long maximum spells of such days.

West Coast: Many and long maximum spells of raindays and drydays with "deficit" soil moisture. Few and short maximum spells of drydays with "adequate" soil moisture. Long maximum spells of drydays with "limiting" soil moisture. Many raindays with "limiting" and "adequate" soil moisture.

Freetown Peninsula Mountains: Many and long maximum spells of raindays with "deficit" and "surplus" soil moisture. Many raindays with "adequate" soil moisture. Few and short maximum spells of drydays with" adequate" soil moisture. Few drydays with "limiting" soil moisture.

Central South: Many and long maximum spells of raindays with "deficit" and "adequate" soil moisture.
Few and short maximum spells of drydays with "deficit" soil moisture. Few drydays with "adequate" soil moisture. Short maximum spells of drydays with "limiting" soil moisture.

Southern: Many and long maximum spells of raindays with "surplus" soil moisture. Few drydays with "limiting" soil moisture. Few and short maximum spells of raindays with "limiting" soil moisture.

2.7 Challenges, Opportunities, Policies and Institutional Arrangements

Challenges

The agricultural water sector is faced with many challenges including coping with the shifting date of onset of the rains, dry spells, uncontrolled water regimes in lowlands, and flood water control in the riverine grasslands. Infrastructure necessary for collection of weather data, like meteorological stations and hydrology gauges, were destroyed during the civil war. Plans are underway to install 13 gauges side by side with meteorological equipment with funding from African Development Bank (ADB). An additional 13 are to be installed through collaboration with China.

Opportunities

The substantial availability of water resources offer potential for dry season cropping with or without irrigation in inland valley swamps when sunshine is abundant. The country can exploit this opportunity for year round cropping and therefore improved agricultural productivity.

Policy and Institutional Arrangements

The Ministry of Water Resources is the government institution responsible for exploitation and management of the water resources. The policy objectives of the water sector (GOSL 2010a) are to provide for: (1) a comprehensive framework for the management of water resources and sustainable development of water supply and sanitation services within an effective legal framework, (2) addressing cross sectoral interest in water resources through integrated and participatory approaches in the planning, development and management of the water resources, (3) improving the provision of safe water supply and sanitation facilities, and (4) a changing role of the government from a major service provider to that of coordination, policy making and formulation of guidelines. The Ministry's partners are similar to those of the Meteorological Department.

3. AGRICULTURAL LAND AND PRODUCTION

3.1 Land, Labour and Capital Resources

The available data/information on land, labour and capital resources does not permit a presentation strictly on the basis of agro-climatic regions; however, where possible the agro-climatic region to which a piece of information pertains is indicated.

3.1.1 Land

The land resources are considered in terms of availability, suitability for agriculture and cultivated acreage, degradation, tenure and access. The land suitable for cultivation on a sustainable basis is estimated at 53,620 km^2 (Table 3.1) equivalent to 74.2 % of the total land (MAFF/FAO 1992). Of the suitable (arable) lands, 4.3 million ha are uplands of relatively low soil fertility and 1.06 million ha of relatively more fertile lowlands (Table 3.1). Lowlands have a good potential for intensive cultivation with proper soil, water and crop management. They are made up of 0.69 ha of inland valley swamps, 0.2 million ha of mangroves, 0.14 million ha of bolilands and 0.13 ha of riverine grasslands (MAFF/FAO 1992).

Table 3.1: Land suitable for cultivation ***(UNDP/FAO 1979a)***

Type	Area (km^2)	Area (%)
Arable upland	43,020	59.5
Arable swampland	10,600	14.7
Total arable land	53,620	74.2

Logging, firewood collection, agriculture and mining are major causes of land degradation which threatens the sustainability for cropping of the arable lands, especially the uplands. Degradation is perceived to be widespread (Fig. 3.1) but differences can only be assessed qualitatively because of little quantitative physical evidence (GOSL 2008b). However, some quantitative information is available on soil erosion and on soil nutrient mining. Sessay and Stocking (1992) reported soil loss by erosion ranging from 4.85-15.45 mt/ha/year in the Makoni catchment in the Transitional rainforest/savannah woodland. A simple model for predicting future production and the residual suitability of land (Biot *et al.* 1989) indicated significant decline in yields of maize and cowpea in the long term in Makeni in the Transitional Rainforest/savannah woodland region as a consequence of soil erosion.

Calculation of nutrient balances, involving soil loss by erosion, indicated an average nutrient loss of about 48kgN+P_2O_5+K_2O/ha annually from soils (soil nutrient mining) of Sierra Leone (Crasswell *et al*. 2004).

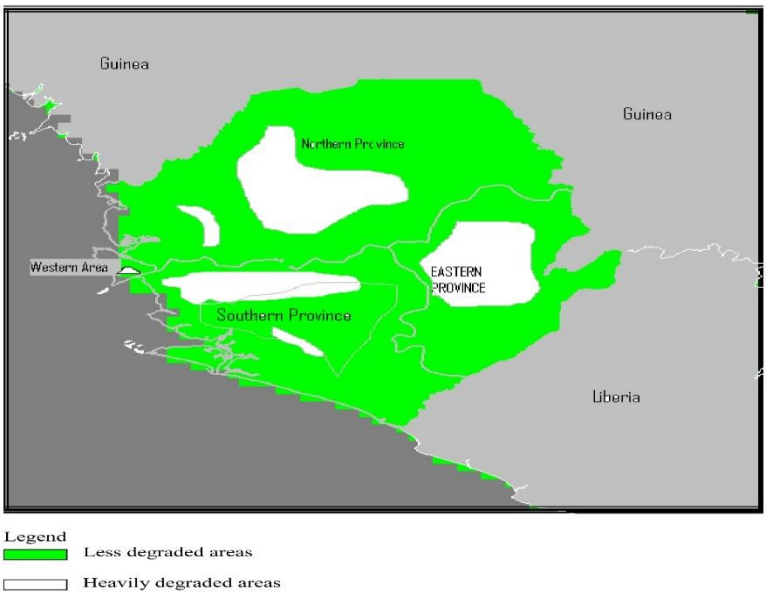

Figure 3.1: Extent of Land degradation *(Reproduced from Blinker 2006)*

Sierra Leone has developed a National Action Programme (NAP) 2008-2018 to combat desertification/land degradation, for sustainable development through improved productivity of land and sustainable land management practices that will lead to improved living conditions (GOSL 2008b). The programme identifies interventions in several sectors including crops, livestock and fisheries.

Land tenure and access are key determinants of vulnerability of farmers to climate change. Land tenure in Sierra Leone is characterized by a dual ownership structure. In the Western area, it is held under freehold interest and can be bought and sold at market values. In the rest of the country, where the bulk of agricultural production takes place, land is held under customary law and controlled by traditional rulers who administer it on behalf of their communities (Unruh and Turay 2006). The paramount chief holds the land in trust for persons in a chiefdom but land in different parts of the chiefdom (except for community lands) is administered by the land

owning families. Allocation of land within extended families is usually the duty of the heads of families. Culture and tradition continue to promote male inheritance of family land and women's access to and ownership of land is limited (GOSL 2014). Of recent, there has been a rapid growth in land access through leasing transactions involving land owned under customary tenure. This leasing especially by foreign based firms has been referred to as 'land grabbing' (GOSL 2014). Land is not regarded as a cost in traditional farming systems in the provinces where it is communally owned. Strangers living within communities are however required to pay rent in cash or kind (ACRE 1983).

3.1.2 Labour and Capital

The national census of 1974 indicated large potential labour force in the agricultural sector with a farm population of 1,188,125 (73% of the total population) which declined to 60% by 2013 (Table 3.2). Out 1,144,439 persons economically active in agriculture (crop farming, livestock, poultry, fishing, forestry, hunting), 52.2% were female and 47.8% male (Lahai *et al.* 2004). Field studies (MAFF/FAO 1992; Unruh and Turay 2006; Spencer 2009) have however reported that there is labour shortage at peak periods of farming, hired labour is expensive, labour use is inefficient and urban areas and mines attract youth away from farming.

Table 3.2: Evolution of population and labour force in Sierra Leone (*FAO STAT 2014*)

	Size (million)				Annual growth (%)		
	1998	**2003**	**2008**	**2013**	**1998-2003**	**2003-2008**	**2008-2013**
Total population	3.96	4.71	5.53	6.09	3.53	3.26	1.95
Total labour force	1.53	1.79	2.09	2.30	3.19	3.15	1.93
Labour force in agriculture	1.01	1.14	1.27	1.34	2.45	2.18	1.08
Agricultural labour force to the total employment (%)	66	64	61	58			
Agricultural population to the total population (%)	64.74	63.31	61.77	60			

Capital in the form of equipment, is mainly limited to hand tools (hoes, cutlasses, axes, transplanting iron, shovel, and harvesting knives) required for labour intensive activities under small holder crop farming. Farm capital

costs are increasing with the government's policy of mechanization and commercialization of smallholder agriculture. The Small Holder Commercialization Programme (SCP) of MAFFS, through a subsidy (40%) and loan scheme empowered farmers groups to become tractor owners with a pay back over 7 years. A total of 239 tractors were distributed in 13 districts, with 159 tractors per district. Included in the loan package were start-up kits of 140 litres diesel, 40 bags of fertilizers, 20 bushels of rice seeds and some herbicides. Operational farming costs include costs of fertilizers (subsidized in the 1970's, 1980's and up to 1995), hire of labour, and hire of equipment.

3.1.3 Challenges, Opportunities, Policy, Institutional Arrangements

Challenges

The challenges facing use of the agricultural land resources relate to lack of systematic monitoring, reducing land degradation, improving equitable access to land and secure tenure, reducing conflicts between crop farmers and livestock holders and between large scale investors in plantations and small scale farmers; balancing the benefits of large scale leasing of land against the risks of land alienation and marginalization of the poor especially women and other vulnerable groups. Concerning labour, a key challenge is how to slow down rural to urban migration of the agricultural labour force.

Opportunities

Small holder households (89%) in rural areas of Sierra Leone reported that they had access to agricultural land (WFP 2011) and that most (74.2%) of the total land area was suitable for cultivation (MAFF/FAO 1992). This offers opportunities for increased agricultural production. The Small Holder Commercialization Programme (SCP) presents opportunities for increasing farm capital.

Policy

The government land policy (MLCPE 2014) provides a vision, objectives, statements and implementation strategies. The vision is an effective land tenure and management system that will provide for clearly defined ownership forms and rights, tenure security, effective and transparent land administration and ensure equitable access to land for all citizens and stimulate investment for the country's continued development. There are a

number of objectives among which are: to ensure the security of tenure and protection of land rights to all land holders regardless of their form of land tenure; promote equitable access to land; promote the eradication and or avoidance and efficient settlement of land disputes by rationalizing and strengthening the capacity of traditional institutions, local and national courts in the speedy and effective resolution of land disputes**.**

The land policy statements include: protection of the rights of access to inheritance and ownership of land for women and children; creating an environment to attract investment; not granting leases to non-citizens for more than 99 years; putting in place measures to mitigate the negative impacts of investments; conservation and sustainable management of land based natural resources; prevention and management of land related disasters including floods and landslides. A related policy is that on Environment Protection (GOSL 2000) which provides for the development of impact assessment for certain projects including those on agriculture, mining, construction, waste disposal and exploitation of the water resources.

Institutional Arrangements

The Ministry of Lands, Country Planning and Environment is responsible for land affairs. A National Land Commission to ensure proper land administration will be established**.**

The key collaborating government institutions are the Ministries of Justice, Tourism, Agriculture, Forestry and Food Security, Trade and Industry and Transport and Aviation. Several donor agencies have collaborated or are collaborating on sorting out the land issues. They include: early warning signs of potential conflicts related to land (UNIPSIL); overall land tenure issue for peace building and development (UNDP); constraints posed by the land tenure issue on agricultural investment (FAO, AfDB); pro-poor land (access) issues (DFID); status of land registration and pilot registration work (IFC); land titling and investment law (World Bank); land administration in the Western Area (Land Registry Unit of UK, IFC/World Bank); and voluntary guidelines on the responsible governance of tenure of land, fisheries and forests in the context of national food security (FAO).

Non-Governmental Organizations (NGOs) are also involved in the land tenure issue for example MADAM on building advocacy and initiatives to prevent loss of land among the poor, JUSTICE IN LAND on the protection of land rights and GREEN SCENERY on various environmental issues including acquisition of large tracts of land by foreign companies for plantation crops.

3.2 Crop Farming Systems and Production

An aerial photography of 1978/79 indicated that 280,000 ha of upland were under annual cropping. MAFFS/MFMR (2004b) estimated total acreage under cropping to be about 600,000 - 660,000 ha (10-12% of cultivable area) and SLIEPA (2010) that less than 1 million ha as being cropped under the bush fallow system. A typical farm holding is made up of 60-80% upland and 20-40% lowland (MAFFS/MFMR 2004a).

3.2.1 Annual Crops

Rice is overwhelmingly the major staple and the most important food crop in Sierra Leone. Because of its importance in the economy of the country and data availability, this section will focus on rice. The widespread distribution of the upland/inland valley swamp rice growing agro-ecologies in Sierra Leone is shown in Figure 3.2. Farming activities are closely linked to the annual rainfall pattern and therefore to climate change with variations by regions and varieties. A fairly typical farming calendar for rice is shown in Table 3.3.

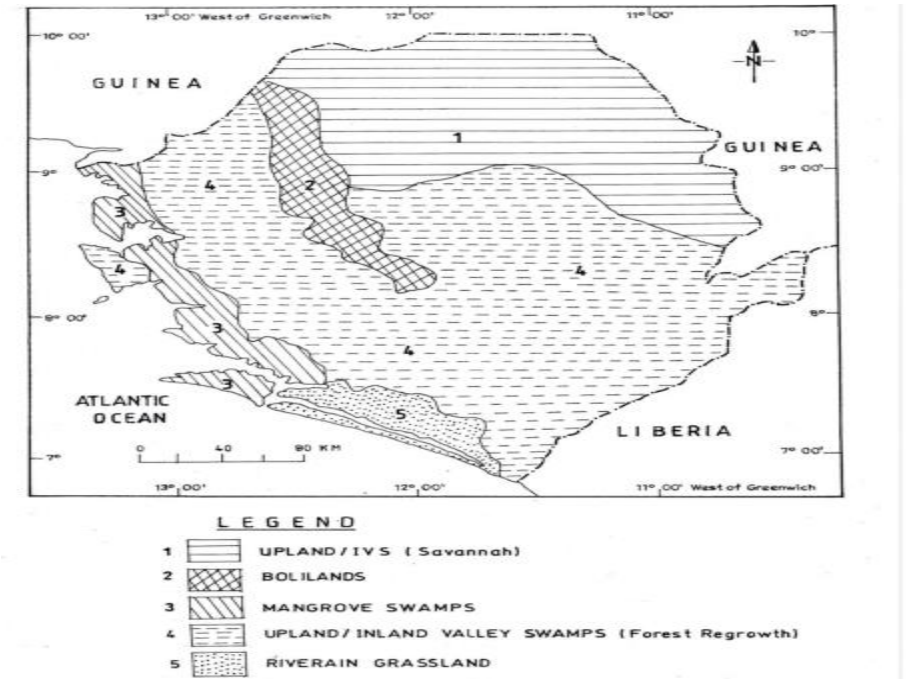

Figure 3.2: Rice Ecologies ***(Reproduced from MAFF/FAO 1992)***

Table 3.3: Farming calendar for rice (*Adapted from MAFFS/MFMR 2004b*)

Rice Agro-ecology	Land Brushing	Land Clearing/ Ploughing	Nursing of seedlings	Planting/ Transplanting	Harvesting
Upland	December-February	March-April	-	April-June	September-December
Inland valley swamp	-	-	June	July	October- January
Boliland	-	-	-	April-July	September-January
Riverine floodplain	-	-	-	Variable	January- April
Mangrove	-	-	May-June	July-October	November-February

Bush fallow rotation is the predominant farming system in the uplands (Jalloh 2006). A plot of upland is cultivated for 2-3 years with rice and a mixture of other annual crops and vegetables and reverts to fallow typically for 10 or more years. However, because of population pressure and competing land use, the length of fallows has declined and the restorative value on soil fertility has diminished accordingly. The lowlands are more intensively cropped than the uplands.

Farms are generally small. Average upland rice farm size in 2006 and 2009 ranged from 0.86-1.53 ha and 0.57-1.7 ha for lowland rice (Tables 3.4 and 3.5). Potential yields of improved rice varieties are 1.5-3 metric tons/hectare (mt/ha) for upland rice; 2- 4 mt/ha for IVS rice; 2- 4.5 mt/ha for tidal and associated mangrove swamp rice; 2-3.5 mt/ha for boliland rice and 2-3.5 mt/ha for riverine grassland (Rhodes 2005).

Table 3.4: Farm size and yield of upland rice by district and agro-climatic region 1970- 2010 ***(Adapted from Spencer 2012)***

		CSO 1970/71		MAFFS 1984/85	WFP VAM 2006/07		ATS 2009		SNAP 2010	
		Size	Yield	Yield	Size	Yield	Size	Yield	Size	Yield
District	ACR	ha	mt/ha	mt/ha	ha	mt/ha	ha	mt/ha	ha	mt/ha
Bo	3	1.54	1.43	1.12	1.41	0.59	1.30	0.49		
Bonthe	2	1.12	1.14	0.59	1.23	0.64	1.34	0.23		
Moyamba	5	1.47	1.28	0.96	1.18	0.80	1.46	0.35		

Pujehun	4	1.21	1.26	0.70	1.25	0.79	1.21	0.35		
South		1.43								
Kailahun	7	1.03	1.31	1.36	1.10	0.80	1.30	0.59	1.25	0.5
Kenema	6	1.22	1.58	1.09	1.09	0.74	1.26	0.41		
Kono	6	1.06	1.43	1.10	1.07	0.70	1.34	0.57		
East		1.13								
Bombali	8	1.52	1.16	0.64	0.87	0.57	1.34	0.49	0.92	0.3
Kambia	5	1.81	1.56	0.99	0.99	0.58	1.46	0.45		
Koinadugu	8	1.46	1.48	1.26	1.53	0.64	1.26	0.61	1.33	0.7
Port Loko	5	1.51	1.53	0.88	1.22	0.59	1.21	0.33		
Tonkolili	9	2.03	0.67	0.80	1.17	0.50	1.01	0.51	1.32	0.45
North		1.65								
W Area	1	0.66	1.53	0.59	0.86	0.29	1.05			
Sierra Leone		1.41	1.31	0.97	1.15	0.63	0.85	0.46		

Note:
The CSO 1970/71 yield data was based on measurements taken in the field from plots.
ACR = Agro-climatic region.
1= Coastal plain; 2 = Coastal plain/savannah woodland/ transitional rainforest savannah woodland; 3 = Transitional rainforest savannah woodland/rainforest; 4 = Transitional rainforest savannah woodland/coastal plain; 5 = Savannah woodland/coastal plain; 6 = Rainforest/transitional rainforest savannah woodland; 7 = Rainforest; 8 = Savannah woodland/transitional rainforest savannah woodland; 9 = Transitional rainforest savannah woodland/savannah woodland.

Table 3.5: Farm size and yields of lowland rice by district and agro-climatic region 1970- 2010 *(Adapted from Spencer 2012)*

		CSO		**MAFFS 1984/85**	**WFP VAM 2006/7**		**ATS 2009**		**SNAP 2010**	
District	**ACR**	**Size ha**	**Yield mt/ha**	**Yield mt/ha**	**Size ha**	**Yield mt/ha**	**Size ha**	**Yield mt/ha**	**Size ha**	**Yield mt/ha**
Bo	3	0.59	1.36	2.91	0.58	1.20	0.57	0.79		
Bonthe	2	0.53	1.28	2.05	1.00	1.37	0.69	0.30		
Moyamba	5	0.64	1.68	3.30	0.83	1.40	1.30	0.38		
Pujehun	4	0.26	1.26	2.72	0.64	1.14	0.61	0.47		
South		0.52								
Kailahun	7	0.55	1.56	3.36	0.72	1.30	0.93	0.52	0.79	0.63
Kenema	6	0.69	1.48	3.38	0.70	1.22	0.69	0.49		
Kono	6	0.94	1.95	3.17	0.82	1.35	1.13	0.50		
East		0.69	1.61							
Bombali	8	0.43	1.38	1.87	1.70	1.00	1.13	0.44	0.65	0.51
Kambia	5	0.57	1.24	3.49	1.17	1.65	1.30	0.49		
Koinadugu	8	0.91	1.61	3.06	1.15	1.21	1.17	0.66	1.1	0.69

Port Loko	5	1.05	1.58	2.89	1.11	0.95	0.61	0.40		
Tonkolili	9	0.46	1.26	2.43	1.23	1.01	0.77	0.54	0.81	0.61
North		1.02	1.43							
WArea	1	0.65	1.58		0.96	0.97	1.54			
Sierra Leone		0.79	1.48	2.96	0.97	1.23	1.01	0.50		

Note:
The CSO 1970/71 yield data was based on measurements taken in the field from plots.
ACR = Agro-climatic region
1= Coastal plain; 2 = Coastal plain/savannah woodland/ transitional rainforest savannah woodland; 3 = Transitional rainforest savannah woodland/rainforest; 4 = Transitional rainforest savannah woodland/coastal plain; 5 = Savannah woodland/coastal plain; 6 = Rainforest/transitional rainforest savannah woodland; 7 = Rainforest; 8 = Savannah woodland/transitional rainforest savannah woodland; 9 = Transitional rainforest savannah woodland/savannah woodland.

National rice yields have been variable over the years (Fig. 3.3) but low; recent yields reported for upland, boliland, IVS, riverine flood plains are 1.03 mt/ha, 2.7 mt/ha, 2.8 mt/ha and 2.77 mt/ha respectively (Table 3.6). Production fell sharply around 1990-2000 during the civil war but increased especially just after the end of the war mainly due to expansion of area brought under cultivation (Fig. 3.3).

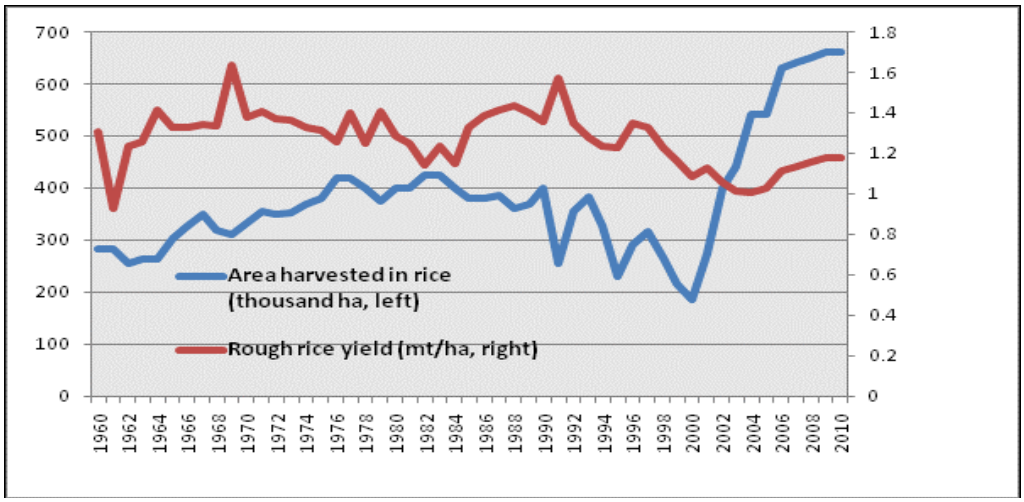

Figure 3.3: Rice area and yields 1960-2010 ***(Reproduced from WFP 2011)***

Table 3.6: Crop yields in the administrative regions in 2013 ***(PEMSD/MAFFS 2014)***

	Yield(mt/ha)				
	Eastern Region	**Northern Region**	**Southern Region**	**Western Region**	**National**
Upland	1.13	1.02	0.97	0.99	1.03
Boliland	-	2.66	2.74	-	2.70
Inland Valley Swamp	2.96	2.76	2.68	-	2.80

Riverine Flood Plain	-	-	2.77	-	2.77
All Rice Agro-ecologies	2.05	2.15	2.29	0.99	1.87
Cassava(upland sole)	9.30	9.55	18.70	-	12.52
Sweet potato(Upland sole)	-	5.55	-	-	-
Groundnut(Upland sole)	-	1.27	1.38	1.90	1.48

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Yields and production have been increasing since 2001 (Table 3.7). Inconsistencies between reports on the statistics of rice yields and production however make data interpretation difficult. The Sierra Leone Seed Certification Agency recently (December 2014) released improved crop varieties developed by SLARI with potential yields ranging from 1.80-2.93 mt/ha for short duration upland New Rice for Africa (NERICA); 30-40 mt/ha for cassava; 1.1-2.0 mt/ha for cowpea and 1.1-1.9 mt/ha for soybean. Potential yields are much higher than on-farm national yields

Table 3.7: Trends in national rice production for 2001- 2013 ***(PEMSD/MAFFS 2014)***

Year	Area (ha)	Yield (mt/ha)	Production (mt)	Milled Equivalent (mt)
2001	258,850	1.20	310,620	186,372
2002	343,142	1.23	422,065	253,239
2003	356,506	1.25	445,633	267,380
2004	426,772	1.27	542,000	325,200
2005	427,907	1.29	552,000	331,200
2006	422,556	1.33	562,000	337,200
2007	432,356	1.36	588,004	352,802
2008	475,592	1.43	680,097	408,058
2009	499,111	1.78	888,417	533,050
2010	549,022	1.87	1,026,671	616,003
2011	603,924	1.87	1,129,338	677,603
2012	717,872	1.59	1,141,417	684,850
2013	671,422	1.87	1,255,559	753,335

Note: Milled recovery = 60%, 2010 to 2013 data are projections.

Other important food crops include, cassava (the second most important staple) cultivated on 16,472 ha, yield 4.93 mt/ha with a production of 81,207 mt and groundnut grown on 13,651 ha, yield 1.09 mt/ha with a production of 14,880 mt in 1970 (C.S.O. 1971). Yields and production, though still low, have increased over time (Table 3.8).

Table 3.8: Trends in national cassava and sweet potato harvested area, production and yields 1990-2012 *(Sheriff and Massaquoi 2012)*

Year	Cassava			Sweet potato		
	Area cultivated (ha)	Yield (mt/ha)	Production (mt)	Area cultivated (ha)	Yield (mt/ha)	Production (mt)
1990	18,240	10.00	182,400	7,462	5.20	38,800
1991	16,340	10.00	163,400	5,923	5.20	30,800
1992	23,227	8.80	204,400	6,692	5.20	34,800
1993	27,330	8.80	240,500	7,696	5.20	39,500
1994	27,898	8.80	245,500	8,442	5.20	43,900
1995	29,739	8.80	261,700	8,692	5.20	45,200
1996	31,977	8.80	281,400	9,320	5.00	46,600
1997	30,048	10.30	309,500	10,060	5.00	50,300
1998	35,275	8.00	282,200	3,460	5.00	17,300
1999	30,000	8.00	240,000	4,000	5.00	20,000
2000	45,506	10.30	268,711	5,620	5.00	28,100
2001	61,768	12.00	741,216	7,640	5.00	38,200
2002	68,909	13.00	895,817	9,090	5.00	45,450
2003	83,936	13.00	1,091,168	16,379	5.40	84,446
2004	134,404	13.08	1,758,004	28,240	5.40	153,196
2005	175,923	13.00	2,287,000	29,652	5.40	160,121
2006	228,700	13.00	2,973,100	31,135	5.40	168,129
2007	297,310	13.00	3,865,030	32,692	5.40	176,537
2008	312,176	13.00	4,058,288	33,346	5.40	180,068
2009	327,785	13.00	4,261,205	34,013	5.40	183,670
2010	344,175	13.00	4,697,992	34,693	5.40	187,344
2011	361,384	13.00	4,474,275	35,387	5.40	191,090
2012	379,453	13.00	4,932,892	36,095	5.40	194,913

3.2.2 Perennial Crops

The perennial crops cultivated include oil palm, cocoa, coffee, citrus, mango, rubber, cashew and sugar cane. A farm survey in districts (Spencer 2009), showed that average farm size of cocoa ranged from 2.7 ha in Kenema to 3.3 ha in Kono with average yields of 0.18-0.32 mt/ha. For coffee, farm size averaged 2.4 ha in Kailahun and 2.9 ha in Kenema with yields of 0.11 mt/ha and 0.24 mt/ha respectively. Farm size for oil palm ranged from 1.8 ha in Kailahun to 3.0 ha in Kenema and oil yields ranged from 98 Litres/ha (L/ha) in Kenema to 204 L/ha in Kailahun. Area, yield and production of cocoa, coffee and oil palm have been increasing over time (Table 3.9). Long term national-level data on crop yields, acreage harvested and production can be accessed from the FAO database

Tree crops are grown on the uplands and upper steam terraces that are not waterlogged. Depending on the hydrology (residual soil moisture), inland valley swamps (IVS) can be cultivated in the dry season for a short period

with cowpea (Rhodes 1983), vegetables or a second crop of rice under irrigation.

Table 3.9: Trends in yields and production of tree crops 2001-2011
(PEMSD/MAFFS 2012, 2014)

Year	Cocoa			Coffee			Oil Palm		
	Area(ha)	Yield(mt/ha)	Prod. (mt)	Area (ha)	Yield (mt/ha)	Prod. (mt)	Area (ha)	Yield (mt/ha)	Prod. (mt)
2001	30,333	0.36	10,920	14,037	1.78	24,986	218,750	4.50	984,375
2002	35,135	0.37	13,000	16,854	1.77	29,832	293,750	4.50	1,321,875
2003	42,105	0.38	16,000	21,910	1.77	38,781	306,250	4.50	1,378,125
2004	49,762	0.42	20,900	28,843	1.78	51,341	312,500	4.50	1,406,250
2005	57,226	0.42	24,035	35,208	1.79	63,022	328,125	4.50	1,476,563
2006	73,576	0.42	30,902	42,725	1.80	76,905	344.531	4.50	1,550,390
2007	84,578	0.42	35,523	49,134	1.80	88,441	361,758	4.50	1,627,911
2008	97,265	0.42	40,851	56,505	1.80	101,709	416,022	4.50	1,872,099
2009	106,992	0.87	93,083	62,156	1.88	116,852	457,624	6.40	2,928,794
2010	117,691	0.91	107,099	68,372	1.97	134,693	503,368	6.72	3,382,633
2011	129,460	0.96	123,699	75,209	2.07	155,570	553,705	7.06	3,906,941
2012	142,406	1.00	142,872	82,730	2.17	179.684	609,075	7.41	4,512,516

3.2.3 Challenges, Opportunities, Policy and Institutional Arrangements

Challenges

Key challenges in the crops subsector include how to improve access by poor farmers to inputs such as affordable good quality seeds, fertilizers and mechanization of farming; transfer of improved agricultural technologies to small scale farmers and for government to adequately plan for the sector in the light of the unsatisfactory quality of crop statistical data (Spencer 2012; IOS 2014a).

Opportunities

The climate and soils permit a range of annual and perennial crops to be grown and IVS are available for dry season cropping when sunshine is abundant and double cropping with short duration NERICAs can be practiced on the upland/colluvial footslope continuum. Improved technologies on the production of rice and other food crops, tree crops, the implementation of agroforestry and postharvest techniques are available and a seed testing agency is functional. The knowledge base on adaptation of cropping systems to climate change and climate smart agriculture is accumulating (Rhodes *et al.* 2014). Access to credit by small scale farmers for financing capital and operational expenses (including labour) is improving.

Policy

The Agenda for Prosperity (Sierra Leone's third generation poverty reduction strategy paper), puts premium on increasing crop yields as a way to achieving its development goals. MAFFS's policy objectives are to promote commercialization of smallholder agriculture by intensification and diversification of production, value addition, improved marketing and building of the capacity of smallholders (GOSL 2009; 2010b). A National Sustainable Agricultural Development Plan, NSADP 2010-2030 that is being implemented and is intended to serve as Sierra Leone's fulfilment of its compact with the CAADP and the ECOWAS Agricultural Policy (ECOWAS 2005). Review of the Smallholder Commercialization Programme (SCP) showed Small and Medium Enterprises were not the target of donors IOS (2014a, b), implying that the policy should be reviewed so that implementation of the investment programme would follow the SCP. A seed policy has been developed with the goal of establishing a well-organized

seed industry leading to improvement of crop yields. Government policy is to fund the replacement of farmers' rice seeds with quality seeds of improved varieties every 5 years.

Institutional Arrangements

The Ministry of Agriculture Forestry and Food Security has overall responsibility for agricultural development and food security. It has six major divisions: Crops, Livestock, Forestry, Engineering, Extension, and Project Evaluation, Monitoring and Statistics (PEMSD) but the bulk of activities are in the crops subsector due to its high contribution to GDP. The National Seed Board, a Variety Release Committee and a Seed Certification Agency are the bodies responsible for implementing the Seed Policy.

MAFFS has numerous partners including other government ministries, SLARI, NU, the private sector, Non-Governmental Organizations and the international and donor community. Partnerships with these institutions and organizations are in the areas of infrastructure, health and sanitation, improvement in crop productivity, marketing and food security, vulnerability mapping and setting up a COUNTRY STAT website for publishing data on agricultural statistics.

3.3 Livestock Resources, Systems and Numbers

The major livestock raised in Sierra Leone are cattle, sheep, goats, pigs and poultry. The bulk of the cattle resources are in the savannah and forest savannah transition zones in the north. Cattle are raised by semi-nomadic herders who sometimes come in conflict with crop farmers for livestock feed. The most important breed of cattle in Sierra Leone is the local dwarf Ndama which has low productivity, (250-350 kg live weight at 5- 6 years of age) and low milk production (2.5 L/day). It is however hardy and resistant to trypanosomiasis, streptothricosis and anaplasmosis diseases. Trials on artificial insemination (AI) of local with exotic cattle are on-going with semen of Freisian Jersey and Sahiwal from the Kenya Animal Genetic Resources Centre.

Sheep and goats are found across the agro-climatic regions. These small ruminants can forage better than cattle under non-intensive management. The common local breeds (Djallonke sheep and West Africa dwarf goat) are hardy but of low productivity and are susceptible to Peste de Petites Ruminantes. Vaccines are however available. Poultry, especially local chicken is raised in most households all over the country under free-range

management. Commercial intensive poultry production of exotic breeds is undertaken in urban and peri-urban areas. Due to the unavailability of feeds and concentrates, farms that have facilities produce feed for their own use. Newcastle disease is endemic but efforts are being made to control it by vaccination. Local breeds of pigs and improved breeds (Land Race, Large White and Duroc) and crosses of local with exotic breeds are raised mainly in the Western area but also in other districts. They are often seen scavenging in dumpsites and by streams under bridges in Freetown. Like for poultry, feed availability for intensive production is low.

Livestock numbers and production are not accurately known. The distribution of cattle population changes with time of the year and location depending on availability of water, grazing potential and socioeconomic factors. The most reliable data is from aerial photography in 1979 which showed the national herd consisted of 333,000 cattle, 264,000 sheep, 145,000 goats, and 17,000 pigs. Estimated livestock numbers increased from 2001-2011 (Table 3.10)**.**

Table 3.10:Livestock types and numbers 2001- 2011

Year	Cattle	Sheep	Goats	Chicken	Ducks	Rabbits	Pigs
2001	109,020	131,280	153,540	1,363,750	127,500	1,938	7,525
2002	130,824	157,536	184,248	1,704,688	159.375	2,422	9,406
2003	156,989	189,043	221,098	2,130,859	199,219	3,027	11,758
2004	188,387	226,852	265,317	2,663,574	249,023	3,784	14,697
2005	226,064	272,222	318,381	3,329,468	311,279	4,730	18,372
2006	271,277	326,667	382,057	4,161,835	389,099	5,913	22,964
2007	325,532	392,000	458,468	5,202,293	486,374	7,391	28,706
2008	390,638	470,400	550,162	6,502,867	607,967	9,239	35,882
2009	470,000	620,000	730,000	8,600,000	729,560	11,087	43,058
2010	517,000	682,000	803,000	9,460,000	802,516	12,196	47,364
2011	560,700	750,200	893,300	10,406,000	882,768	13,416	52.100

3.3.1 Challenges, Opportunities, Policy and Institutional Arrangements

Challenges

The challenges facing the livestock sector include improving productivity of the breeds in the face of shortage of feed for the poultry and piggery subsectors, inadequate veterinary services, and poor marketing infrastructure in general (MAFFS/MFMR 2004a).

Opportunities

Key opportunities are that knowledge and facilities for artificial insemination to improve the productivity of local breeds of cattle in a cost effective manner and how to formulate feeds are available at Njala University and SLARI.

Policy and Institutional Arrangements

The general policy objective of the livestock subsector is to achieve self-sufficiency in domestic animals and animal products for which the country has comparative advantage (MAFFS/MFMR 2004e). The objective of promoting integrated crop-livestock production is not yet being actively pursued.

The Division of Livestock has very close collaboration with the Teko Livestock Research Centre of SLARI and the Animal Science Department of Njala University in the development and dissemination of improved breeds and livestock management practices. The external partners include AU-IBAR, OIE, EU, FAO, GIZ, Heifer International, BRAC and CONCERN WORLDWIDE. The Animal Health Unit with support from AU-IBAR and EU developed the Epidemio-Surveillance Network for Animal Diseases in Sierra Leone (ENADIS).

3.4 Fisheries Resources, Systems and Production

With an Atlantic Ocean coastline of 510 km, an Exclusive Economic Zone (EEZ) of 157,000 km^2, continental shelf of 30,000 km^2 (MFMR, personal communication, 2015) and inshore fishing of 16,600 km^2 (rivers, lakes, and flood plains), Sierra Leone has substantial fisheries resources (MAFFS/MFMR 2004a, 2004d). It is next to the crops subsector in terms of contribution to annual GDP (Table 1.2). The marine resources are exploited by industrial fishing vessels (mainly foreign) and artisanal fisher folk and the inland resources by the artisanal sector. The marine resources are made up of demersal (bottom dwelling), pelagic (surface dwelling) and shrimps, cephalopods, lobsters and crabs.

Estimates of the potential sustainable yield of demersal vary widely from 18,000-55,000 mt per year and that of the pelagic resources are put at about 100,000 mt per year (MAFFS/MFMR, 2004a). The potential sustainable yield of pink and tiger shrimp are estimated at 3000 mt per year and those of the cephalopods and crabs range from 10,000 mt - 21,000 mt per year. Total

marine production declined from 126,000 mt in 1983 to 58,000 mt in 1997 (during the civil war) and rose to 263,000 mt in 2009 (MAFFS/MFMR 2004a; MFMR, personal communication, 2014). The average total production of about 230,000 mt annually (MFMR 2010) seems to exceed the potential sustainable yields. For the inland fisheries sector, the potential sustainable yields are estimated at 16,000-40,000 mt per year. The www.seaaroundus.org database provides detailed information on the EEZ including landings by species from 1950-2010 and the FAO database contains long term data on annual production, imports and exports of fisheries commodities in terms of volume and value.

3.4.1 Challenges, Opportunities, Policy and Institutional Arrangements

Challenges and Opportunities

Challenges facing fisheries include putting in place a good surveillance and control of fishing activities; improving the poor fisheries infrastructure; adding quality and value to raw products; raising the low capacity of artisanal fisher folk who use non-motorized canoes, and illegal fishing gears/methods and improving the quality of data on fisheries capture. The opportunities include exploitation of off-shore pelagic, exploitation of deep water shrimp resources, development and commercialization of inland fisheries and aquaculture, and partnerships with multilateral donors.

Policy

The Fisheries Management and Development Act of 1994 provides for the management, planning and development of the fisheries industry. The draft policy (MFMR 2010) is under review. The policy goals are: to exploit and manage sustainably the fisheries resources; maintain the integrity of the aquatic environment; promote diversification and export; strengthen official controls for fish health certification; empower stakeholders for effective participation in management of fisheries, and promote sustainable aquaculture development. A number of strategies have been developed to achieve these goals but some of the goals and strategies overlap. Implementation plans are not yet developed and there is no mention of climate change and its impact on fisheries.

Sierra Leone has signed up to a number of international treaties including the UN Convention of the Law of Sea, FAO Code of Conduct of Responsible Fisheries, FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High

Seas, FAO Port State Agreement, Minimum Access Condition of the Sub-regional Fisheries Commission, and International Plan of Action to Deter, Eliminate Illegal, Unreported and Unregulated Fishing Activities.

Institutions

Several local, regional and international partners collaborate with the Ministry of Fisheries and Marine Resources on a range of fisheries issues These include the Institute of Marine Biology and Oceanography on research matters and the Sierra Leone Maritime Administration on the determination of license fees for industrial fishing vessels. At the regional and international level, Sierra Leone is a member of several bodies such as the Sub-regional Fisheries Commission established in 1985 and based in Dakar whose role is to harmonize fisheries management policies. Others are INFOPECHE, a fish trade organization based in Cote d'Ivoire; Fisheries Committee for the East Central Atlantic for the development and management of marine resources in coastal countries in West Africa; International Commission for the Conservation of Atlantic Tunas; Conference of Ministers for Fisheries Cooperation among African Countries Bordering the Atlantic Ocean and the FAO working groups on demersal, small pelagic and artisanal fisheries.

4. AGRICULTURAL TRADE AND FOOD SECURITY

In 1980, 1990 (just before the civil war) and 2003 (just after the civil war), the external trade balance (export minus import) as a share of GDP was -15.4%, -1.3% and -17.6% respectively (World Bank 2011). Exports also fell after 1997 and by the time of the official declaration of the end of the war in 2002, food imports accounted for up to 27% of total imports. External trade balance was -12.8% in 2009 and improved to -3.3% by 2013 (World Bank 2011; GOSL 2013a) as export of iron ore rose sharply.

4.1 Agricultural Trade

4.1.1 Trade in Crops

International and Regional Trade: volumes, values and channels

Prior to 1961, Sierra Leone was a rice exporter but it now imports grains (mainly rice). Imports rose sharply by the end of the civil war (Fig. 4.1). The volumes and values of imported rice increased over time, especially after the civil war. Some data on trade, especially with Western Europe, is available at STATISTICS Sierra Leone. Less data is available on trade within ECOWAS. Although there have been some fluctuations, export of coffee and cocoa generally increased between 2001 and 2011(Table 4.1). Changes in produce quality and price may account for some of the variability between years.

The FAO and UN COMTRADE databases provide long term data on aggregate national import and export quantity and value of agricultural commodities

Table 4.1: Trends in Export of Cash Crops 2001-2011 ***(Customs and Excise Department/NRA, personal comminication 2015)***

Year	Coffee		Cocoa	
	Volume (mt)	Value (000US$)	Volume (mt)	Value (000US$)
2001	75	22.9	641	265.9
2002	947	272.1	1,178	1,218.9
2003	113	40.1	2,733	2,572.8
2004	118	52.8	6,188	5,259.4
2005	1,532.0	873.80	6,635	5,236.70
2006	1,475.2	1,093.4	13,940	11,570.8

2007	2,483.2	1,854.7	13,722	11,368.1
2008	1,958.2	1,487.5	17,892	14,981.9
2009	8,144.6	1,312.5	16,937	20,544.6
2010	2,704.2	1,698.22	16,071	37,051.19
2011	3,787.9	2,000.81	18,000	44,021.95

Cross border trade is a subset of regional trade. Bauer *et al*. (2010) found that urban demand of gari (grated and roasted cassava tubers), local rice and palm oil from Freetown, Conakry and Monrovia drives cross-border trade and Sierra Leone is emerging as a supplier for the Guinea market. Groundnut is imported from Mali through Guinea (FEWSNET 2010) and palm oil is exported through informal routes to Guinea for manufacture of soap. The main informal trade route on the Gendema axis is said to include Bombohun, Kalia, Congo, Gbalu and Dassalamu; on the Kambia axis it is Madina, Gbolum and Chychem (World Bank 2013b). Variation in exchange rate of national currencies influences the direction of cross border trade.

A survey on price trends, inflation, seasonality, volatility and volume flows of major commodities noted gaps in data availability (WFP 2013), such as retail price time series not being available at the market level. .

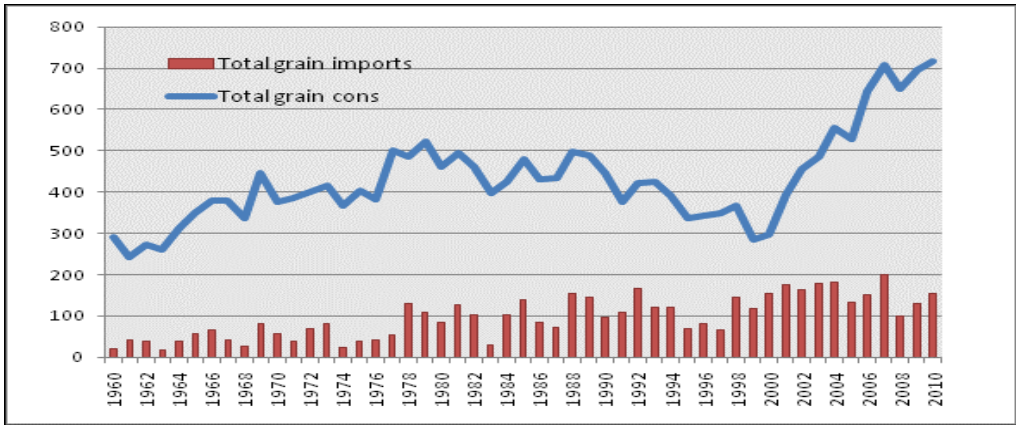

Figure 4.1: Imports and consumption of grains (x1000mt) 1960-2010
(Reproduced from WFP 2011)

4.1.2 Costs and Returns, Value Chains and Comparative Advantage

Costs and Returns

Knowledge of costs and returns is important for analysing trade possibilities. Costs of inputs, value of outputs and margins involved in the cultivation of rice, oil palm, cocoa and coffee show that total costs of production vary with agro-ecology and associated production technology. Surveys conducted at the farm level in selected districts have shown that rice farming with existing technology viz mechanical cultivation without fertilizers in the bolilands and hand cultivation with little or no fertilizers use in the mangrove swamps is profitable to domestic farmers. Smallholder production of tree crops, involving little or no fertilizers is also profitable. (Spencer 2009; Spencer *et al*., 2009).

Profitability and Comparative Advantage for Import Substitution and Export

Comparative advantage analysis can help to orient farming systems towards more efficient activities, under various circumstances. Sierra Leone has comparative advantage in the local production of rice for import substitution, that is, to supply its domestic market. However, moving to an export price regime (export to regional markets) implies a substantial decline in economic profitability for all rice production systems except for the improved inland valley swamp rice (IVS) systems. As shown by the Domestic Resource Cost (DRCs) under the export parity regime, the IVS systems would still have comparative advantage (Table 4.2). MAFFS/MFMR (2004a) also observed that there would be comparative advantage for export promotion of coffee, cocoa and oil palm if high yielding varieties and associated improved management practices are used. About 10 years later, World Bank (2013b) also reported comparative advantage for cassava and cocoa and that palm oil is expected to move into comparative advantage if production and processing improve.

Table 4.2: Comparative advantage of major crops in 2004 ***(MAFFS/MFMR 2004a)***

Product	Net Financial Return (Le/ha)	Net Financial Return (Le/ person	Net Economic Return(Le/ha)	Domestic Resource Cost Import Parity	Domestic Resource Cost Export Parity

		day)			
Upland traditional	725,990	5,299	854,105	0.96	
Upland NERICA	1,617,238	13,942	1,902,633	0.49	1.09
IVS traditional	1,457,223	10,190	1,714,380	0.47	
IVS HYV + fertilizer	1,981,045	14,460	2,330,641	0.20	0.72
Boliland traditional	1,610,867	11,187	1,895,138	0.66	
Boliland HYV+ fertilizer	1,683,152	12,286	1,980,179	0.56	
Boliland HYV + fertilizer + mechanization	1,538,085		1,809,512	0.73	1.33
Mangrove traditional	1,410,392	10,295	1,659,285	0.68	
Mangrove HYV+ fertilizer	1,922,993	14,036	2,262,345	0.53	1.16
Riverine traditional	1,642,944	11,992	1,932,875	0.85	
Riverine HYV + fertilizer	2,312,112	15,211	2,720,132	0.61	
Riverine HYV + fertilizer + mechanization	2,099,612		2,470,132	0.72	1.31
Cocoa traditional	1,687,580	12,318	1,985,389		1.27
Cocoa rehabilitated	3,387,580	20,656	3,985,389		0.68
Coffee traditional	1,088,873	7,948	1,281,027		1.16
Coffee rehabilitated	3,213,873	19,597	3,781,027		0.74
Oil palm traditional	950,948	6,941	1,118,762		1.51
Oil palm rehabilitated	2,013,448	13,982	2,368,762		0.45
Groundnut	2,273,545	16,595	2,674,759		
Cassava	1,721,025	12,562	2,028,768		
Pepper	2,146,045	14,903	2,524,759		

Note: IVS = Inland valley swamp; HYV = High yielding varieties

DRCs are unit free ratios that express the efficiency of alternative domestic production activities by indicating the total value of domestic resources required to generate or save a unit of foreign exchange.Export parity price used is for export to Nigeria.

4.2 Trade in Livestock and Fisheries

Sierra Leone is a net importer of livestock. Most of the cattle are brought across the Guinea border in the north to the cattle market at Gbindi, near Kabala, where they are bought and transported live to consuming centres. Small ruminants are produced and consumed or sold in communities in many parts of the country and itinerant traders buy and sell in urban centres (MAFFS/MFMR, 2004d). Pigs produced in urban areas find ready markets there. Local chickens are reared in most backyards all over the country and sometimes sold. Commercial poultry production in urban areas is important

but large quantities of frozen chickens are imported from Europe and elsewhere.

Sierra Leone is a net exporter of fisheries products. Reported export of fish/shrimps varied from 6861 mt in 2001 to 4282 mt in 2007 and 7350 mt in 2013 (MFMR 2010; SSL 2014). These amounts are very small percentages of the average annual production. The FAO database contains long term data on trade of livestock and fisheries.

4.3 Food Security

The food security status of a region, household or individual is the outcome of social, economic, cultural, and environmental factors and therefore complex to quantify. Proxy indicators of food security status such as available calories and proteins, grain self-sufficiency ratio and food consumption score have therefore been used. Rhodes (2003) outlined trends in available calories and proteins in Sierra Leone from 1987 to 1996 derived from quantities of consumable crop produce obtained from the FAO database. The total available calorific value of 2107 kcal/caput/day in 1996 from plant and animal sources was lower than the minimum required for an average person in a developing country of 2,470 kcal/caput/day (World Bank 1988) and the average supply in 1997 in developing countries of 2,663 kcal/caput/day (UNDP 2000). Total protein supply from plant and animal sources (44.6g/caput/day) in 1996 compared poorly with the average in 1997 of 67g/caput/day for developing countries (UNDP, 2000). Grain self-sufficiency ratio has been variable over the years but there has been an overall decline since 1960, with the sharpest drop during the civil war (Fig. 4.2).

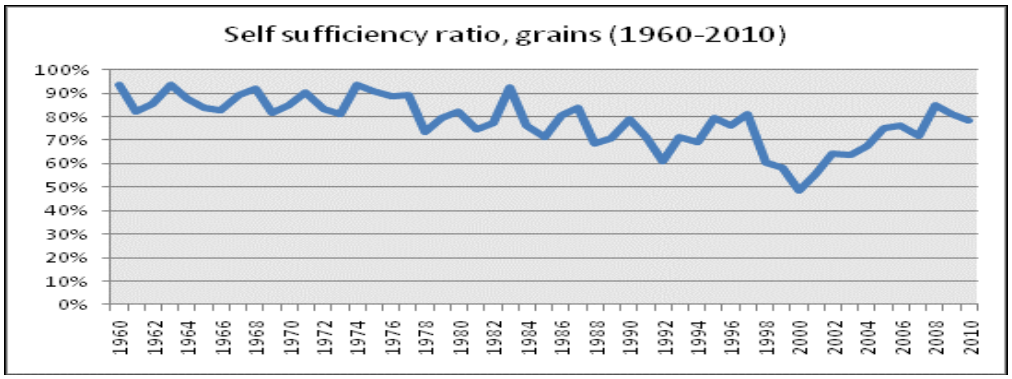

Figure 4.2: Grain self-sufficiency ratio 1960-2010 ***(Reproduced from WFP 2011)***

Surveys have been conducted on food poverty and food security status since 2003, after the civil war. Food poverty declined between 2003 and 2011(GOSL 2013b). Key messages emanating from a 2010 survey (WFP 2011) were that: 70% of the population lived below the poverty line of $2 per day which was the main cause of food insecurity; food insecurity increased sharply during June to August (the lean season) when 45% of the population did not access sufficient food; chronic malnutrition was serious, with 34% of children between 6 and 59 months old, stunted and 10% severely stunted; 7% of children were acutely malnourished, with girls being more affected than boys; only 6% of rice producers relied on their production to feed their entire family throughout the year, which means that producing food did not guarantee access to food; local rice was cheaper than imported rice although the latter was more available during the lean period; households spent on average 63% of their total expenditure on food and fifty percent of households borrowed money to buy food. The average food consumption score in 2010 was 45 (Table 4.3), which was equal to that of 2007.

Table 4.3: Food insecurity and food consumption scores in June/July, 2010
(Adapted from WFP 2011)

Admin sub-division	ACR	Total population	Number food insecure			Percent household food insecure		
			Severely food insecure	Moderately food insecure	Total food insecure	Severely food insecure	Moderately food insecure	Total food insecure (FCS)
Bombali	8	518,909	10,897	121,425	**132,322**	2.10	23.40	**25.50**
Port Loko	5	503,500	25,175	330,296	**355,471**	5.00	65.60	**70.60**
Tonkolili	9	392,997	88,424	202,786	**291,211**	22.5	51.6	**74.10**
Koinadugu	8	303,289	40,641	158,620	**199,261**	13.4	52.3	**65.70**
Kambia	5	308,929	13,284	206,056	**219,340**	4.30	66.70	**71.00**
Northern Province		2,027,624	178,421	1,019,183	**1,197,605**	8.80	50.26	**59.06**
Kenema	6	592,466	11,257	188,997	**200,254**	1.90	31.90	**33.80**
Kono	6	214,956	16,982	85,338	**102,319**	7.90	39.70	**47.60**
Kailahun	7	421,287	15,588	72,883	**88,470**	3.70	17.30	**21.00**
Eastern Province		1,228,709	43,827	347,218	**391,043**	3.57	28.26	**31.83**
Bo	3	596,469	5,368	185,502	**190,870**	0.90	31.10	**32.00**
Bonthe	2	152,059	1,673	32,845	**34,517**	1.10	21.60	**22.70**
Moyamba	5	248,378	44,460	144,059	**188,519**	17.90	58.00	**75.90**
Pujehun	4	306,700	20,856	224,198	**245,053**	6.80	73.10	**79.90**

Southern Province		1,303,606	72,357	586,604	**658,959**	5.55	45.00	**50.55**
Western Area Rural	1	241,438	3,139	49,978	**53,116**	1.30	20.70	**22.00**
Western Area Urban	1	885,473	55,785	147,874	**203,659**	6.30	16.70	**23.00**
Western Area Slum	1	59,905	3,594	20,547	**24,142**	6.00	34.30	**40.30**
National		**5,746,755**	**373,539**	**2,212,501**	**2,586,040**	**6.50**	**38.50**	**45.00**

Note: ACR = Agro-climatic zone

1= Coastal plain; 2 = Coastal plain/savannah woodland/ transitional rainforest savannah woodland; 3 = Transitional rainforest savannah woodland/rainforest; 4 = Transitional rainforest savannah woodland/coastal plain; 5 = Savannah woodland/coastal plain; 6 = Rainforest/transitional rainforest savannah woodland; 7 = Rainforest; 8 = Savannah woodland/transitional rainforest savannah woodland; 9 = Transitional rainforest savannah woodland/savannah woodland.

Food Consumption Score (FCS) is a composite based on dietary diversity, food frequency and relative nutritional importance of various food groups consumed by a household. A higher FCS is related to higher dietary diversity, frequency and nutritional value (WFP 2008).

A more recent national nutrition survey conducted between June - August, 2014 using the Standardized Monitoring and Assessment of Relief and Transitions methodology (Addisu 2014) showed that on average 96% of households had a Food Consumption score greater than 35 and household dietary diversity averaging 4.6. The national prevalence of stunting was 28.8% (27.5-30.2%) and of severe stunting was 7.8% (7.2-8.5%). Nutrition of 6-59 months old as expressed by degree of stunting therefore continued to improve in Sierra Leone (Table 4.4) before EBOLA struck in 2014.

Table 4.4: Household Dietary Score and Food Consumption Score classification in June/August 2014 *(Addisu 2014)*

Province	**District**	**HDDS**	**HHS Food Consumption Categories based on FCS Classification**					
			0-21 (Poor)		**21-35 (Borderline)**		**>35 (Acceptable)**	
			No. of HHs	**Prop. of HHs (%)**	**No. of HHs**	**Prop. of HHs (%)**	**No. of HHs**	**Prop. of HHs (%)**
Northern	Koinadugu	4.2	6	2.1	23	7.3	262	90.0
	Bombali	4	2	0.6	8	2.5	310	96.9
	Tonkolili	4.1	1	0.3	13	4.8	294	95.5
	Kambia	4.7	0	0.0	2	0.5	418	99.5
	Port Loko	4.3	2	0.5	18	4.1	416	95.1
Eastern	Kono	4.5	3	1.0	14	4.8	273	94.1
	Kenema	4.2	9	2.3	50	12.7	334	85.0
Southern	Moyamba	4.1	9	2.0	16	3.5	437	94.6

	Bo	5.5	0	0.3	1	0.3	367	99.5
	Pujehun	4.2	0	0.0	7	2.2	310	97.8
Western	WA Rural	3.9	0	0.0	1	0.2	450	99.8
	WA Urban	5.5	0	0.0	0	0.0	414	100.0
	WA Slum	6.6	0	0.0	0	0.0	427	100.0
	National Average	**4.6**	**33**	**0.7**	**153**	**3.1**	**4,712**	**96.2**

Note: HDD = Household dietary diversity which is an indicator of household economic access to food.

The FAO database on food balance provides long term data on domestic supply, domestic utilization and per capita supply of calories, proteins and fats for a wide range of crops, livestock and fisheries products for Sierra Leone.

4.5 Challenges, Opportunities, Policy, Agreements and Institutional Arrangements

Challenges

The key institutional, organizational and capacity challenges facing the development of the agriculture sector and food security are trade related: they include narrowing the negative trade balance in favour of Sierra Leone; exploiting local, regional and international demand; improving packaging, branding, and advertising; promoting legal cross border trade; increasing efficiency of sea ports; enhancing production efficiency and capacity for domestic and export trade; consumer protection and free trade; protection of intellectual property rights; producing reliable trade statistics; implementing ASYCUDA at all entry points; harmonization of policies in the West African Monetary Zone (GOSL 2010d; World Bank 2013b); reducing transportation costs; improving flow of market information and benefiting fully from trade agreements such as the ECOWAS Trade Liberalization Scheme and the US AGOA through improved capacity to meet external demand (GOSL 2010c).

Some examples specific to the crops and livestock sub-sectors are reducing the gap between potential crop yields and on-farm crop yields include; improving the availability and accessibility of improved seeds, livestock feeds and agrochemicals; enacting and implementing fertilizer and pesticide laws to protect farmers against substandard products; development of national tree crop breeding programmes to reduce imports of seedlings from West African countries. For the fisheries sector, examples are reducing

illegal unreported fishing by unlicensed vessels fishing in restricted areas, reducing destructive fishing practices; improving access to lucrative markets and reducing associated cost penalties; offshore based economy of a largely unfettered industrial fleet; adding value on shore processing; collecting licensed based revenues based on vessel tonnage rather than catch volume and value; improving productivity(catch per unit effort) and achieving EU certification of fisheries products (World Bank 2006).

Opportunities

The feasibility of obtaining higher and sustainable crop, livestock and fisheries yields leading to improved food security and surpluses for trade should be exploited. Other opportunities are the on-going agricultural marketing and trade reforms including investment promotion, policies in critical sectors, improving infrastructure (World Bank 2013b); the construction of the main road linking Kailahun to Kenema, the regional capital that will boost export volumes and reduce transportation costs for cocoa and coffee; the Agribusiness Centres equipped with processing equipment set up by MAFFs and run by farmers groups that are improving the processing segments of value chains; comparative advantage in the local production of rice for import substitution and cassava and cocoa for export; the warehouses of the defunct SLPMB which can provide storage for exporters of cocoa and coffee; increasing price of palm oil in the international market; and the international market niche in organic coffee and cocoa.

Policy

The Sierra Leone Trade Policy is guided by the National Export Strategy (GOSL 2010c) and its vision is a competitive Sierra Leone economy that is integrated regionally and globally. The overall goal of the trade policy is to promote a robust and competitive private sector and support growing production and service sectors to trade at national and international levels and contribute ultimately to wealth and employment generation. The document outlines policy statements, objectives and prescriptions. The core objectives are to build capacity for participation in regional and global trade negotiations; develop a transparent mechanism for trade; provide infrastructure for trade; ensure a trade-supporting labour market; promote competition; protect consumers against unfair practices and unsafe products; generate resources for government and encourage the inflow of aid, private investment capital and migrant remittances (GOSL 2010d). Related draft documents are on the National Food Safety Policy, National Phytosanitary Policy, National Phyto-Sanitary Pest Control and Import Quarantine System.

Trade Agreements

Sierra Leone has signed several multilateral and bilateral trade agreements with economic and trade groups (NCR 2010; World Bank 2013b). In West Africa it has agreements under the Mano River Union and ECOWAS. Since 2004, ECOWAS policy has been to grant preferential treatment on the products that were liberalized in the WAEMU but liberalization has been slow in practice (World Bank 2013b). The ECOWAS Trade Liberalization Scheme permits products from member states to be exported duty free and without quota restrictions to member states so long as they meet the criteria of 30% value addition and 69% local content requirement. All imports that meet the requirements of the ETLS from other ECOWAS countries to Sierra Leone attract no custom under the ETLS which Sierra Leone is currently implementing.

Sierra Leone became a member of WTO in 1995 and since 2002 was eligible for participation in the US AGOA (through 2015). It is also a signatory of The Cotonou Partnership Agreement which envisages the setup of free trade Economic Partnership Agreements (EPA's) between ACP States and between EU and ACP States. Sierra Leone is a signatory of the EU-EBA treaty and ECOWAS is negotiating an EPA with EU on its behalf. An EPA will open Sierra Leone to duty and quota free imports from the EU. This situation is likely to have serious implications for regional trade in agricultural products because Sierra Leone's agricultural products are yet to meet international requirements in terms of volumes and quality (NCR 2010; World Bank 2013b).

Landell Mills (2006) conducted an EPA impact study on the agricultural and non-agricultural sectors to assist in determining Sierra Leone's negotiating strategies and appropriate policies that need to be put in place while pursuing its national development goals. The report acknowledged that data on Sierra Leone trade and productive sectors are not sufficiently robust to allow detailed economic modelling of the trade and economic effects of the proposed EPA. It was concluded that Sierra Leone will have to take a final decision under a high degree of uncertainty because of severe analytical restrictions in balancing economic and non-economic costs and benefits. Sierra Leone's commitment to structural adjustment will play a decisive role in decision making. The report pointed out that there are alternatives to EPAs which are less challenging such as unilaterally granted EU preferences. The latter arrangement would mean full autonomy for Sierra Leone as to the size

and depth of trade liberalization and related structural adjustment measures. An advantage of an EPA is that it would provide the stimulus to put in place economic reforms that are required for integration into the world economy. The bottom line is that there is need for a gradual country specific approach to the liberalization of trade and putting in place complementary compensatory and institutional measures to counteract possible negative repercussions of integration. Sierra Leone also has preferential trade arrangement with China covering 95% of products.

Institutions

The Ministry of Trade and Industry has overall responsibility for the management, coordination and implementation of the Trade Policy. The Sierra Leone Produce Marketing Company (SLPMC), the Produce Monitoring Board, the Sierra Leone Investment and Export Promotion Agency (SLIEPA), and the Standards Bureau are components of the ministry (GOSL 1996; GOSL 2007); GOSL 2013c; GOSL 2013d).

The Sierra Leone Produce Marketing Company (SLPMC) is a Limited Liability Company set up by an Act of Parliament, in which government has 100% of shares that took over from the former Sierra Leone Produce Marketing Board. It is expected to compete with existing exporters of cocoa. The Produce Monitoring Board was also created by an Act of Parliament to monitor the production, processing and marketing of produce and related matters. Its functions include facilitating training and encouraging scientific research aimed at improving the quality of produce; securing favourable arrangements for grading, sealing, certification and sale of produce on behalf of exporters; cooperating with stakeholders to eliminate the smuggling of produce; assisting exporters to find markets and provide other information and assistance to facilitate exports and ensuring that farmers receive fair prices for their produce by periodically announcing indicative prices.

The Sierra Leone Investment and Export Promotion Agency (SLIEPA), came into being through an Act to promote investments and exports including the following :promoting the development of agricultural production; facilitating the export oriented operations of small scale producers and manufactures; providing exporters with marketing advisory services and assisting them in developing marketing plans for foreign markets; identifying potential investors and promoting opportunities for investment; facilitating coordination and cooperation between the public and private sectors; carrying out research on investment, exports and related matters.

The Sierra Leone Standards Bureau is the National Statutory body responsible for standardization, quality assurance and services for both the local market and for export. Its overall objectives are to protect the consumer by enhancing awareness campaigns and to facilitate the provision of quality products, ensure traceability in measurements for international recognition of test and measurement results, facilitate fair trade by the development of standards, promote and coordinate industry competitiveness, adopt, review, strengthen, promote and enforce standards to ensure consumer protection. It is developing Standards based on Codex Alimentarius, International Sanitary and Phytosanitary Measures (ISPM) and ISO for agricultural food products.

The Ministry of Trade and Industry partners with several government ministries such as Ministry of Finance and Economic Development; National Revenue Authority on matters of tariff and customs duties; Ministry of Justice and the Law Reform Commission for legal matters and reform; Ministry of Foreign Affairs for trade and negotiation representation; Bank of Sierra Leone; Ministry of Agriculture, Forestry and Food Security, Ministry of Fisheries and Marine Resources and Ministry of Lands and Environment. The Ministry of Trade and Industry also collaborates with the Sierra Leone Chamber of Commerce, Industry and Agriculture, Sierra Leone Chamber of Agriculture and Development (SLECAD), the Universities and Research Institutes. The Ministry has established a National Coordinating Committee on Trade as a forum for discussing trade policy issues. It is made up of the relevant government ministries, private sector and academic groups. It has sub-committees dealing with various areas of negotiations for example on ECOWAS, EPA and AGOA.

The Ministry of Trade and Industry is member of a technical committee that includes STATISTICS Sierra Leone, the National Revenue Authority (formerly Customs and Excise Department) and Bank of Sierra Leone. The committee harmonizes methodologies in the processing of trade data and thus the usefulness of published data to users. The Ministry of Trade and Industry in collaboration with the Ministry of Fisheries and Marine Resources with funding from UNIDO has recently (2014) set up a Sanitary and Phytosanitary Committee. Included are 15 government ministries, departments and agencies. Its mandate covers food safety, animal and plant health and is part of Sierra Leone's obligation to WTO. Most government ministries and agencies are directly or indirectly involved in the drive for

food security. The institutional arrangements of the Ministry of Agriculture, Forestry and Food Security and the Ministry of Fisheries and Marine Resources were outlined earlier in this report. At the international and regional levels there is collaboration between the Ministry of Trade and Industry and the World Trade Organization (WTO), World Intellectual Property Organization (WIPO), World Bank, ADB, African Industrial Property Organization (ARIPO), African Union and ECOWAS.

5.0 THREATS, IMPACTS AND RESPONSE TO CLIMATE CHANGE

There are a number of climate change threats and impacts concerning the agriculture sector of Sierra Leone. The current major threats include bushfires, dry spells, high temperatures, early rains, late rains, intensive rains, thunderstorms, landslides and floods. Key impacts are reduction in acreage cleared and harvested and crop yields; crop pests and disease outbreaks becoming more frequent; reduction in quality of crop produce, number of livestock, quality and quantity of pasture/fodder and ultimately the food security and health of farmers (GOSL 2008; NAFFSL, personal communication, 2014; Rhodes *et al*., 2014).

5.1 Projected Impacts of Climate Change on Crops, Livestock and Fisheries

5.1.1 Projected Impacts on Yields of Annual Crops

GCMs used in conjunction with crop simulation models (Johnson *et al.* 2013) predicted variability in extent and direction of impacts depending on region, crop and model. For example, CNRM-CM3 and CSIRO Mark 3 predicted gains in rice yields of 5 - 25% by 2050 over the 2000 baseline especially in the north (Savannah zone). ECHAM 3 predicted the greatest decline in yields, but there are areas in Sierra Leone with no significant changes. Yield of groundnut was predicted to decline by 5 - 25% in many parts of the country but CSIRO Mark 3 predicted yield increase of 5 - 25% in the coastal zone.

5.1.2 Projected Impacts on Livestock Production

No actual modelling of the effect of climate change on livestock has been done for Sierra Leone but it is implied that livestock productivity could decline and conflicts between crop farmers and livestock raisers due to shortage of fodder could result (GOSL 2012b).

5.1.3 Projected Impacts on Fisheries Production

Lam *et al.* (2013), using the Seaaroundus database (www.seaarounds.org), projected decline in marine fisheries landings of 14% and 53% by 2050 compared to a 2000 baseline for a low range greenhouse gas emission scenario and a high range scenario respectively.

5.1.4 Projected Impacts on Food Security

Johnson *et al.* (2013), for the same optimistic scenario used for rainfall and crop yields, predicted a larger increase in available calories per capita compared to the baseline. For the pessimistic scenario, (low per capita income growth and high population growth) a decrease in calories through 2030 followed by an increase (although by 2050 there will be fewer available than in 2010) was predicted. Also, rise in food prices was predicted to counteract the positive gains of rising incomes if the incomes rise too slowly.

5.2 Challenges, Opportunities, Policy and Institutional Arrangements

5.2.1 Challenges

The challenges include mainstreaming of climate change issues into agricultural and rural development policies and programmes**;** accurately modelling the impacts of climate change on crop, livestock and fisheries yields and production, food security, hydrology and trade; adapting agricultural farming systems especially livestock and fisheries to climate change; reducing trade-offs and maximizing synergies between adaptation and mitigation measures; improving service delivery for inputs, credit, markets, extension, early warning systems and seasonal weather forecasts; reducing GHG losses under extensive system of livestock management; reducing rural to urban migration of youths which is contributing to farm

labour shortage at critical periods; better coordination across government ministries and with NGOs and other private sector actors; improving access to land for women, non-indigenes (strangers) and large scale investors; and moving away from the linear research to policy model to one that is participatory and brings in policy makers at the start of the research process.

5.2.2 Opportunities

The Extension Services of MAFFS and NGO's as well as farmers themselves are aware of the impacts of climate change and are using recommended adaptation and mitigation measures and/or adapting and mitigating on their own as far as their capacities allow. The measures include short duration/drought tolerant crop varieties for example NERICAs; changes in the farming calendar; efficient fertilizer use; cropping of swamps; intercropping; crop diversification; cultivation of vegetables in the dry season; mulching with crop residues; crop rotations; irrigation; water control in lowland rice cropping; water harvesting; agroforestry; multistorey tree cropping; processing of crops and fisheries products and off-farm employment (GOSL 2008; GOSL 2012b; Rhodes *et al.* 2014).

The nation-wide Smallholder Commercialization Programme (Sierra Leone's compact with CAADP) and the IFAD project in Kono, Kailahun and Kenema on integrating adaptation to climate change into agricultural production and food security are developing frameworks and pathways which can be used or replicated for the successful implementation of adaptation projects involving training of farmers, participatory technology development (Farmers Field Schools) and targeting women.

Responses to the impacts of climate change in Sierra Leone and other West African countries were initially formulated in terms of adaptation (Rhodes *et al.* 2014). Of recent, a more holistic approach referred to as Climate Smart Agriculture (CSA) is being promoted by FAO, CGIAR, continental initiatives and regional research and development organizations such as CAADP, FARA and CORAF/WECARD. CSA is regarded as a way forward for meeting food security in the face of changing climate. Its goal is to build adaptive capacity of communities and contribute to mitigation of Green House Gas emissions and improve food security, by adopting appropriate practices, developing enabling policies and institutions and mobilizing the needed finances (FAO 2010; FAO 2013). Some of the technical adaptation strategies and measures recommended in the National Communications to UNFCCC and the National Adaptation Programme of Action (NAPA) such

as agroforestry, mulching with crop residues and minimum tillage have mitigation values and are climate smart.

A climate smart agriculture youth network has been set up in Sierra Leone. It is a farmer-led multi-stakeholder youth- action coalition group committed to the incorporation of climate smart agriculture within the food and agriculture system (A. Sheriff, personal communication, 2015).

There is acceptance by donors and partners including FAO, IFAD, CGIAR, FARA and CORAF/WECARD of the need for providing technical support and augmenting government funds to combat the effects of climate change, reduce poverty and improve food security. A group of international NGO's has agreed to establish a CSA Alliance for Africa to support scaling up of adaptation and CSA practices (FARA 2014). The AU-NEPAD (2010) Agriculture Climate Change Adaptation-Mitigation Framework provides guidance on sustainable financing for CSA. New funding mechanisms such as the Green Climate Fund are coming on stream.

5.2.3 Climate Change Policy and Climate Change Content of Development Policies

The preparation of a Climate Change Policy, Strategy and Action Plan are underway. There are a number of past and on-going initiatives, which have contributed to the development of the policy. Sierra Leone ratified the UNFCCC in 1995 and the Kyoto Protocol in 2005. An Initial National Communication to UNFCCC was developed in 2006 (GOSL 2006) and a NAPA in 2008 (GOSL 2008). The Second National Communication to UNFCCC was developed in 2012 (GOSL 2012b) and the Third National Communication to UNFCCC is under preparation.

A framework for drafting the climate change policy has been developed by the National Secretariat for Climate Change (NSCC, personal communication, 2014). It consists of a Background, Need for Policy and Vision, Guiding Principles and Policy Objectives, Key Policy Areas each with its own Policy Guidelines, Strategies and Priority Activities. The overall policy objectives are to ensure integration of climate change into sustainable development programmes and sector policies and ensure requisite institutional capacities for climate change issues at all levels. Among the key policy areas identified in the framework relevant to this mapping are sustainable agriculture and food security; sustainable fisheries and coastal zone management; and integrated water resources management.

National development policy documents explicitly recognizing climate change as a threat to livelihoods and agricultural development are the Agenda for Prosperity and the National Sustainable Agricultural Development Plan. The Land policy has a statement on land related disasters including floods and droughts. Tarawalli (2012) made a compilation of the objectives and status of implementation of several signed agreements and conventions relevant to climate change including UNFCCC and Kyoto.

5.2.4 Institutional Arrangements

As a party to UNFCCC and the Kyoto Protocol the government of Sierra Leone is committed to ensure that decisions adopted at the meetings of the Conference of Parties (COP) to the UNFCCC and its Kyoto Protocol (KP) and other meetings are conveyed to decision and policy makers for implementation at local and national levels. The institutional arrangements within the country are as follows:

The Meteorological Department in the Ministry of Transport and Aviation which is the National Focal Point for the UNFCCC and the Environmental Protection Agency (EPA) are the major players in climate change issues. The mandate of EPA is to implement government's environmental policies, plans and programmes and to coordinate, monitor, regulate, supervise and advise on issues of the environment in Sierra Leone and serve as focal point for all environmental issues. EPA set up a National Secretariat on Climate Change (NSCC) to provide guidance on the formulation of a national climate change policy, strategies and regulation of climate and carbon trading issues. The vision of NSCC is a climate resilient and low emission country for environmentally sound and sustainable development. The mission is to promote and strengthen national initiatives relating to climate change adaptation and mitigation in a participatory manner involving all socioeconomic sectors of Sierra Leone, particularly empowering women and youth to reduce their vulnerability to climate change and promote environmental sustainability.

The functions include:

1. Developing a national climate change policy, strategy and action plan in line with national development plans such as the Agenda for Prosperity.
2. Promoting climate education and raising awareness.
3. Serving as the Designated National Authority for Clean Development Mechanism (CDM) and ensuring the development and implementation of CDM and other projects.

4. Promoting mainstreaming of climate change issues into national development planning.
5. Providing for institutional strengthening and capacity building for country adaptation and mitigation efforts.
6. Providing for the formulation of guidance for climate change projects, approval, and establishment of a measurement, reporting and verification mechanism for reporting actions taken and reported through the National Communications to UNFCCC.
7. Coordinating programmes and projects on climate change and ensuring dissemination of findings on climate change impacts
8. Popularizing the National Communications on Climate Change to enable the public, policy makers and students become aware of climate change issues and institutions
9. Facilitating the mobilization of resources for financing climate change projects on adaptation and mitigation from the Adaptation Fund, Least Developed Country Fund, Green Climate Fund and others.
10. Ensuring that all projects that are likely to have climate change impacts on the environment and development undergo an environmental impact assessment.

The Executive Chairperson of EPA has overall responsibility of NSCC. The latter is headed by a Deputy Director of EPA, who works under the guidance of the National Climate Change Standing Committee, with representation from the following Ministries: Energy; Water Resources; Transport and Aviation; Lands, Country Planning and Environment; Finance and Economic Development; Agriculture, Forestry and Food Security; Local Government and Rural Development; Health and Sanitation; Disaster Management Department; Meteorological Department; Universities and Research Institutes; Private Sector (Civil society/ Non-Governmental Organizations); National Strategy and Policy Unit in the Office of the President and Parliament. UNDP is a major international partner.

6 CONCLUSION

Available data/information does not permit a mapping strictly on the basis of agro-climatic zone. Data/information on Sierra Leone is available to varying extents from local sources and international databases on climate, climate change, soils, hydrology, agricultural land, agricultural production, agricultural trade and food security for integration into the regional study (modelling) of climate change, agricultural trade and food security. There is pressing need to improve upon the quality of agricultural statistical data by strengthening the capacity of institutions responsible for their collection, processing and dissemination. Government policies on components of food security and related issues have been developed. Effective linkages with the international research, development, trading and funding organizations are essential for Sierra Leone to achieve its adaptation to climate change and food security agendas.

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8 ANNEXES

ANNEX 1: Persons Contacted

1. Mr. Alpha Bockari, Acting Director, Meteorological Department, Ministry of Transport and Aviation
2. Mr. Ibrahim S. Kamara, Meteorologist, Meteorological Department, Ministry of Transport and Aviation
3. Mr. Sam Goba, Hydrologist, Ministry of Water Resources
4. Mr. Mohamed Juanah, Head Water Resources, Ministry of Water Resources
5. Mr. S.T. Kamara, Deputy Chief Agriculturist, Ministry of Agriculture, Forestry and Food Security
6. Mr. Ajuba Sheriff, Deputy Director, Project Evaluation, Monitoring and Statistics Division, Ministry of Agriculture, Forestry and Food Security
7. Mr. Alusine Kamara, Statistician attached to the Project Evaluation, Monitoring and Statistics Division, Ministry of Agriculture, Forestry and Food Security
8. Mr. Samuel Turay, Principal Statistician, STATISTICS Sierra Leone
9. Mr. Momodu Bah, Deputy Director , Climate Change Secretariat, Environment Protection Agency
10. Mr. Shiaka Kawa, Director of Export Development, Sierra Leone Investment and Export Promotion Agency, Ministry of Trade and Industry
11. Mr. Amadu Jogor Bah, Deputy Director, Standards Bureau, Ministry of Trade and Industry
12. Mr. Sorie Kamara, Director Livestock Division, Ministry of Agriculture Forestry and Food Security
13. Mr. Stephen Medo, Manager, Research Department, Bank of Sierra Leone
14. Mr. T.R. Gbetuwa, Assistant Secretary, Ministry of Lands and Country Planning

15. Mr. T. Bandabla, Statistician, Sierra Leone Agricultural Research Institute
16. Mr. A.A. Bangura, Director, Ministry of Fisheries and Marine Resources
17. Mr. M.B.U. Cole, Acting Assistant Director, Ministry of Fisheries and Marine Resources

ANNEX 2: Climate metadata 1926-1972 (Odell et al.1974) and 1968-2014 (Meteorological Department, Freetown)

Data is available, with some gaps, on the following: mean monthly and annual rainfall; mean number of days with rainfall greater than means; minimum and maximum monthly rainfall and greatest daily rainfall per month; average minimum, mean and maximum monthly and annual temperatures for 1926-1968. Also, relative humidity, sunshine and cloudiness by months for 1949-1966; potential evapotranspiration by months calculated by the formula of Papadakis (1966)as $E_{mm} + 5.625(e_{ma}-e_{mi-2^0C})$ for 1926-1966; open- pan(mm) and Piche evapotranspiration (mm) for selected stations for 1966-1972;mean monthly soil temperatures for the Njala Station at 30cm depth in 1966 and 15cm depth in 1967 and 1968. Data, with some gaps, is available at the Meteorological Department on temperature, rainfall, relative humidity, evapotranspiration, cloudiness and sunshine hours for 1968-2014.

ANNEX 3: Rain days and dry days of the Agro-hydrological regions (Kamara and Jackson 1997)

Rainfall stage	Soil moisture(% soil moisture storage capacity)	Designation	General description
*No rain	0-29	DRYDAY(DD1)	No rain with 'deficit' soil moisture
	30-59	DRYDAY(DD2)	No rain with 'limiting' soil moisture
	60-100	DRYDAY(DD3)	No rain with 'adequate' soil moisture
**Rain	0-29	RAINDAY(RD1)	Rain with 'deficit' soil moisture
	30-59	RAINDAY(RD2)	Rain with 'limiting' soil moisture

	60-100	RAINDAY(RD3)	Rain with ‘adequate’ soil moisture
	>100	RAINDAY(RD4)	Rain with ‘surplus’ soil moisture

*<0.25mm; ** ≥ 0.25mm

Mean annual numbers of different raindays and drydays and their respective maximum spell lengths at the regional stations

Variable	Kabala (Northern plateau)	Yengema (Eastern highlands)	Makeni (Mid west)	Rokupr (Northwest)	Freetown (West coast)	Number 2 River (Freetown Peninsular Mountains)	Bo (Central south)	Solon (South)
Dryday(DD1)	151	112	124	145	142	155	111	113
Dryday(DD2)	19	20	15	13	16	15	17	17
Dryday(DD3)	57	83	57	54	49	50	59	73
Rainday(RD1)	17	13	15	11	15	11	18	14
Rainday(RD2)	9	7	5	5	6	6	6	6
Rainday(RD3)	56	48	48	41	51	27	59	56
Rainday(RD4)	57	85	102	96	86	102	96	86
Dryspell(DS1)	61	46	62	73	61	65	34	43
Dryspell(DS2)	8	8	8	8	8	7	6	7
Dryspell(DS3)	9	9	8	8	6	8	8	8
Rainspell(RS1)	3	3	2	3	3	2	3	3
Rainspell(RS2)	3	2	2	2	3	2	2	3
Rainspell(RS3)	7	4	3	4	5	4	5	5
Rainspell(RS4)	6	6	10	13	12	19	12	12

List of variables

Mean annual number of dry days with "deficit" soil moisture (DD1)

Mean annual number of dry days with "limiting" soil moisture (DD2)

Mean annual number of dry days with "adequate" soil moisture (DD3)

Mean annual number of rain days with "deficit" soil moisture (RD 1)

Mean annual number of rain days with "limiting" soil moisture (RD2)

Mean annual number of rain days with "adequate" soil moisture (RD3)

Mean annual number of rain days with "surplus" soil moisture (RD4)

Mean annual maximum spell of dry days with "deficit" soil moisture (DS1)

Mean annual maximum spell of dry days with "limiting" soil moisture (DS2)

Mean annual maximum spell of dry days with "adequate" soil moisture (DS3)

Mean annual maximum spell of rain days with "deficit" soil moisture (RS 1)

Mean annual maximum spell of rain days with "limiting" soil moisture (RS2)

Mean annual maximum spell of rain days with "adequate" soil moisture (RS3)

Mean annual maximum spell of rain days with "surplus" soil moisture (RS4)

maximum spell of rain days with "surplus" soil moisture (RS4)

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