THE WEST AFRICA FOOD SYSTEM RESILIENCE PROGRAM - Phase 2 (FSRP2)

Pest Management Plan (PMP) for Sierra Leone

April 2022

Contents

ABBREVIATIONS AND ACRONYMS

ABCs	Agricultural Business Centres
Bt	Bacillus thuringiensis
CMVD	Cassava Mosaic Virus Disease
CORAF	West and Central Africa Council for Agriculture Research and Development
CPU	Crop Protection Unit
DAOs	District Agriculture Officers
ECOWAS	Economic Community of West African States
EPA-SL	Environmental Protection Agency of Sierra Leone
EPA-USA	Environmental Protection Agency-USA
EU	European Union
FAO	Food and Agricultural Organization of the UN
FAW	Fall Armyworm
FBOs	Farmer Based Organisation
FFS	Farmers Field School
FMD	Foot-and-mouth disease
GM	Green Muscle (Metarhizium annisopliae)
HCPCMA	Hazardous Chemicals and Pesticides Control and Management Act
IDA	International Development Association / Association Internationale pour le Développement
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPMs	International Standard for Phytosanitary Measures
ITNs	Insecticide-treated beg nets IVM Integrated vector management
LF	Lymphatic Filariasis
LLINs	long-lasting insecticide-treated nets MANR Ministry of Agriculture and Natural Resources
MAF	Ministry of Agriculture and Forestry
MDA	Mass Drug Administration
NaFFSL	National Farmers Federation of Sierra Leone
NaFRA	National Fertilizer Regulatory Agency
NARI	National Agricultural Research Institute
NARS	National agricultural research systems of participating countries
NCD	Newcastle disease
NCS	National Centres of Specialisation
NEA	National Environment Agency
NGO	Non-Governmental Organization
NPMC	National Pesticide Management Committee
NPPO	National Plant Protection Organisation
NTDs	Neglected Tropical Diseases
Oncho	Onchocerciasis
PHCs	Plant Health Clinics
PMC	Pesticide Management Committee
PMP	Pest Management Plan
PPR	Peste des Petits Ruminants
PPRSD	Plant Protection and Regulatory Services Division
PRA	Pest Risk Analysis

PPS	Plant Protection Service
RDA	Regional Directors of Agriculture
SCH	Schistosomiasis
SIDA / AIDS	Acquired Immunodeficiency Syndrome / Syndrome d'immunodéficience acquise
SLeSCA	Sierra Leone Seed Certification Agency
SLICASS	Sierra Leone Cassava Variety
SME	Small/Medium/Entrepreneur
SPAT	Safe Pesticide Application Techniques
SPC	Sahelian Pesticide Committee
ToT	Training of Trainers
UEMOA	West African Economic and Monetary Union / Union Economique et Monétaire Ouest Africaine
UPoCA	Unleashing the Power of Cassava in Africa
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
HIV/AIDS	Human Immunodeficiency Virus / Aquired Immune Deficiency Syndrome
WAAPP	West Africa Agricultural Productivity Programme
WECARD	West and Central African Council for Research and Development
WAPRC	West Africa Pesticide Registration Committee
WHO	World Health Organisation
WTO	World Trade Organization
WTO-SPS	WTO-Sanitary and PhytoSanitary

EXECUTIVE SUMMARY

The Government of Sierra Leone (GoSL) through the Project Coordinating Unit (PCU) of the Ministry of Agriculture and Forestry (MAF) has applied for a funding in the amount of US$ 60.8 million to be used for implementation of Phase 2 of the Multi-Phase Programmatic Approach of the West Africa Food System Resilience Program (FSRP2) in Sierra Leone (P178132). Phase 2 countries include Sierra Leone, Ghana, and Chad, in addition to Phase 1 countries Burkina Faso, Mali, Niger and Togo, in addition to the following regional institutions: The Economic Community of West African States (ECOWAS), the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), and the West and Central African Council for Agricultural Research (CORAF). The PCU coordinate the overall implementation of national subcomponents with national project objectives that are aligned with regional project's objectives.

Overview of the Project Components

Component 1: Digital Advisory Services for Agriculture and Food Crisis Prevention & Management

The objective of this component is to improve agricultural and food crisis prevention and management using digital advisory services and will be implemented through two sub-components:

Sub-component 1.1: **Upgrading Food Crisis Prevention & Monitoring Systems**

The objective of this sub-component is to transform the regional food and agriculture risk management architecture (food security-relevant data collection, analysis, forecast and management) to provide relevant information and advisory services to support risk management decisions.

Sub-component 1.2: **Strengthening Creation and Provision of Digital Hydromet and Agro-Advisory Services for Farmers**

This sub-component aims to increase access to and use of hydro- and agro-met information and advisories as well as early warning information by decision-makers and farmers via multiple dissemination channels including the national agricultural extension systems.

Component 2: Sustainability and Adaptive Capacity of the Food System's Productive Base

The objective of this component is to enhance the resilience of food system's productive base in ways that that enable small and medium producers (especially women and youth) to sustainably meet their nutritional needs and raise income levels from the sale of surpluses in local and regional markets.

Sub-component 2.1: **Consolidating Regional Agriculture Innovation Systems**

The objective of this sub- project is to consolidate the regional research and extension systems to deliver, in a sustainable manner, adaptive technological innovations for the region's food systems. Priority will be given to technologies that are climate- smart, nutrition- sensitive, gender- sensitive and women and youth friendly.

Sub-component 2.2: **Strengthening Regional Food Security through Integrated Landscape Management**

Through the implementation of the integrated landscape management approaches, this sub-component aims to improve household food security and their resilience to climate variability. The intended outcome is a more resilient food system that makes more-efficient use of

already limited land and natural resources and produces a significantly lower environmental footprint.

Component 3: Regional Market Integration & Trade

The component aims to expand food trade in West Africa and to facilitate trade of agricultural goods and inputs within and across national borders. Activities in this component will seek to expand food trade between Sierra Leone and other West African countries in a bid to enabling the efficient distribution of surplus products to loss-making regions. The project will also facilitate the production and marketing of agricultural inputs and technologies within and across national borders.

***Sub-component 3.1*: Facilitate Trade Across Key Corridors and Consolidate Food Reserve System**

The objective of this sub-component is to promote regional integration between ECOWAS member countries by stimulating and streamlining trade. Through this sub-component, the project will support the implementation of sound regional regulations and policies to strengthen agricultural and food input-output markets.

***Sub-component 3.2:* Support to Development of Strategic and Regional Value chains**

The objective of this sub-component is to develop and improve the performance of priority value chains market participation of farmers. The program supports upstream and downstream segments of the two priority value chains (Rice, Cassava and Livestock), in which Sierra Leone has comparative advantage, in order to increase the availability of agricultural products and provide opportunities for value addition for sustainable food and nutrition security. This will have tangible long-term positive impacts on regional food security.

Component 4: Contingent Emergency Response Component (CERC)

This component will allow for a reallocation of credit proceeds from other components to provide immediate emergency recovery support following an eligible crisis or emergency. The contingent emergency response component will be deployed at the national level budget to the participating countries depending on the nature of the emergency which will follow approved criteria for accessing resources to support emergency response activities. The component will finance program activities, works, goods, consultancy services, training and capacity building, technical assistance and studies.

Component 5: Project management

The overall management of the program will be carried out by the Ministry of Agriculture and Forestry's National Development Partners Program Coordinating Office (NDPPCO). NDPPCO is currently anchored within the MAF management and fiduciary structures. A Technical Unit made up of a designated project manager, a fiduciary expert, a safeguards specialist, a procurement specialist and additional technical experts in the areas of Monitoring and Evaluations and Agricultural Economics have been established within the NDPPCO to oversee the day-to-day implementation of the program's activities. Specifically, the activities under this component will include program management; procurement arrangements; results monitoring and evaluation; financial management arrangements and recurring costs.

Purpose and Objective of FSRP2

The FSRP2's objective is to strengthen a regional agricultural innovations system able to strengthen regional food system risk management, improve the sustainability of the productive base in targeted

areas and to develop regional agricultural markets. The regional coordination of the program is ensured by AGRHYMET (Agriculture, Hydrology, Meteorology Regional Research Center) and CORAF on behalf of (ECOWAS).

Rational for Pest Management Plan

The activities of FSRP2 under component 2 are associated with the use of of agrochemicals- including pesticides and fertilizers (phytosanitary and anti-vector control products) to boost agricultural productivity both in the crop and livestock sectors. However, unsupervised, and intensive application of these products could result in the reduction of crop aids. In addition , impacts on human and animal health, contamination of soil, surface and groundwater are some of the consequences that could compromise the achievement of the program objectives.
Hence, the Pest Management Plan sets out strategies to protect the biophysical and human environment through the promotion of the use of pest management methods, capacity building of farmers, environmental impact assessment of agricultural development projects likely to use a considerable quantity of pesticides, the provision to farmers of protection and spraying equipment the management of empty pesticide containers. The PPMP will enable actors and stakeholders to monitor and mitigate negative environmental and social economic impacts of the project arising from the use of agro-chemicals, by promoting and implementing Pest Management (PMP) that will benefit crop and livestock producers in Sierra Leone. in addition, the help protect the environment, in the process increase crop production to enhance food security and reduce poverty in the farming community.

The PMP also addresses the internal and external environmental factors affecting the production of rice, cassava, and livestock (poultry and small ruminants) for domestic production and export with a view to improve the livelihoods of growers to benefit from international trade by complying with the Phytosanitary export and import requirements. For example, production of quality and pesticide free crops for domestic consumption and export, free from pests and pesticide residues, free from alien invasive species and complying with the stringent EU pesticide residue limits. Towards this end the PPMP will strengthen the Crop Protection Unit and the entire Plant Protection Service to build the capacity of growers on IPPM, improve diagnostic facilities and procure additional laboratory materials to enable the Pesticide Residue Laboratory carryout tests and determine Pesticide Residue Levels acceptable for export of crops and livestock.

The World Bank Environmental and Social Standard 3 – Resource Efficiency and Pollution Prevention is relevant for projects under which any procurement of pesticides (agricultural use, vector control, weed control, etc.) either directly by the project, or indirectly through on-lending, co-financing, or government counterpart funding, projects and programs that are expected to introduce new pest management practices or expand or alter existing pest management practices and subsequent environmental and health risks.

National Legislations and policies relevant to the project include:

- Agricultural Policy
- The Land Policy, 2015
- National Gender Strategic Plan (2019- 2023)
- The National Mid-Term Development Plan (2019 – 2023)
- The National Agricultural Transformation Plan (2023)
- The National Agricultural Investment Plan;
- The Food Crisis Management Prevention-Country Resilience Priorities;
- Strategic Private Sector-Led Policy Shifts (2020-2021).

- Environmental Protection Agency Act, 2008 and the EPA (Amendment) Act, 2010;
- Sierra Leone Meteorological Agency Act ,2017
- The Local Government Act, 2004;
- The Constitution of Sierra Leone, 1991
- The Employers and Employed Ordinance, 1960
- The National Water Resources Management Agency Act, 2017
- Forestry Act,1988
- Child Act ,2007
- National Disaster Management Agency Act,2020
- National Biodiversity strategy Action Plan (2017-2026)
- Environmental Policy, 2004 revised 2013
- National Policy on Gender Mainstreaming,2000

Existing and Anticipated Pest and Disease / Management Practices

Potential Impacts and Challenges Associated with FSRP2 Interventions

The use of various agro-chemicals especially pesticides is more likely during the implementation stage of the FSRP2 irrigation and storage interventions. The potential risks/impacts associated with the procurement, transport, storage, use / handling and disposal of pesticides are summarised in the table below:

Steps	Influencing factor	Risk		
		PUBLIC HEALTH	ENVIRONMENT	PERSONNEL
Transportation	Inadequacy of transport and emergency preparedness planning	Pollution of food and other products that has been exposed to pesticide contamination	Accidental discharge, water-table pollution through leaching	Product inhalation : vapour, dust, risk of skin contact Skin and eye contact
Storage	Lack of means Deficit in pesticide management training Inadequacy of facilities	Accidental contamination Inconvenience of populations living in the vicinity	Soil contamination	Skin contact through accidental spillage caused by the narrowness of the premises Skin and eye contact
Handling Manipulation	Deficit in training and sensitization	Contamination of water sources through washing of containers Accidental leaks	Soil contamination through accidental spillage or intentional discharge, water-table pollution	Vapour Inhalation, skin contact through splashing during preparation or product transfer Skin and eye contact

Packaging disposal	Deficit in training, education and sensitization Non availability of disposal facilities	Product ingestion by re-using containers		Skin contact and respiratory tract Skin and eye contact
Washing of containers	Deficit in training, education and sensitization	Skin contact, contamination of wells	Acute intoxication of fish and other crustacean, pollution of wells, ponds, water-tables	Skin contact Skin and eye contact

PMP STRATEGIES,

FSRP2 will adopt the following specific strategies to achieve an effective pest and pesticide management process:

1. **Monitoring and Evaluation Plan**
2. **Training plan of actors involved in pest and pesticide management**
3. **Information and awareness raising among users and the public**
4. **Coordination and monitoring of the PMP**
5. **Institutional arrangements for the implementation and monitoring of the PMP**
6. Reporting;

PMP Implementation Budget

The costing for activities identified in the Budget is provided in Table 5. It is estimated that an amount of about USD345,500 will be required to implement the PMP over the 5-yr period,

1.0 Introduction

1.1 Project Background

The West Africa Food System Resilience Program (FSRP2) is a five-year International Development Association (IDA)-funded project supported with a US$60.91 million credit that seeks to promote agricultural productivity through improved access to markets along the value chains of *rice*, *cassava*, and *livestock*; improved access to finance; and development of inclusive smallholder farmer agribusiness linkages in the targeted project areas of Sierra Leone. FSRP2 is well-aligned with the presidential delivery initiative, national strategic plans and policies[1], and key regional World Bank strategies[2] focusing on addressing the progressive decline of the agricultural sector in Sierra Leone since 2014 driven by declining and more volatile food production per capita as a result of complex interactions between increased weather vagaries as a result of climate change; population growth; a degraded natural resource base; increased incidence of conflicts; and health emergencies like Ebola in 2014 and COVID-19 in 2020 impacting negatively on food production and the agribusiness sub-sectors.

At the request of the Government of Sierra Leone (GoSL), Ministry of Agriculture and Forestry (MAF) is utilizing Smallholder Commercialization and Agribusiness Development Project (SCADeP) funds to support the preparation of FSRP2 that seeks to contribute to the higher-level development objectives of Sierra Leone through the strengthening of the country's food systems to deal with different kinds of shocks. Agriculture has been the backbone of the Sierra Leonean economy for decades. Therefore, making agricultural interventions climate and disaster-resilient are vital for sustained economic growth. Given the sensitivity that exists around the vulnerability of the agricultural sector to weather and climatic conditions, the development and effective use of digital advisory services and impact-based forecasting are critical. For these services to be provided, a strong collaboration is required between private entities and public institutions. Equally important is an investment in technology and innovation through the strengthening of agriculture and research systems in the country, which will boost economic growth and poverty reduction that FSRP2 will contribute to FSRP2 will focus its interventions towards helping the agricultural sector recover quickly from the effects of the Ebola epidemic and COVID-19 and contribute towards higher medium to long-term agricultural growth required to reduce extreme poverty levels among the smallholder farmers and promote shared growth.

FSRP2 fundamental objective and funding directly target 70,000 smallholder farmers with the intention of reaching the target being 45% women and 40% youth. The project also contributes to 12,000 households that were directly impacted by COVID-19 in terms of food production and agribusiness operations. In addition to gender and youth empowerment being mainstreamed across all interventions, the project will implement specific activities that target women and youth groups for mainly components two and three of the project. FSRP2 will also benefit institutions involved in the Food and Nutrition Security Early Warning System (FNSEWS) in the form of training, infrastructure support, relevant equipment, and operational costs. FSRP2 will also strengthen private sector actors

[1] These include the National Mid-Term Development Plan (2019 – 2023); National Agricultural Transformation Plan (2023); National Agricultural Investment Plan; Food Crisis Management Prevention-Country Resilience Priorities; and Strategic Private Sector-Led Policy Shifts (2020-2021).

[2] The project supports Pillar 2 Competitiveness and productivity, Pillar 4 Resilience to shocks of the Africa Regional Integration and Cooperation Assistance Strategy (2018), the new Fragility Conflict and Violence strategy's pillars of engagement #1 prevention and #3 transition out of fragility, the Bank's Adaptation and Resilience Action Plan (2018), the Bank's Country Partnership Frameworks for participating countries (resilience), and the upcoming new generation Africa Climate Change Business Plan.

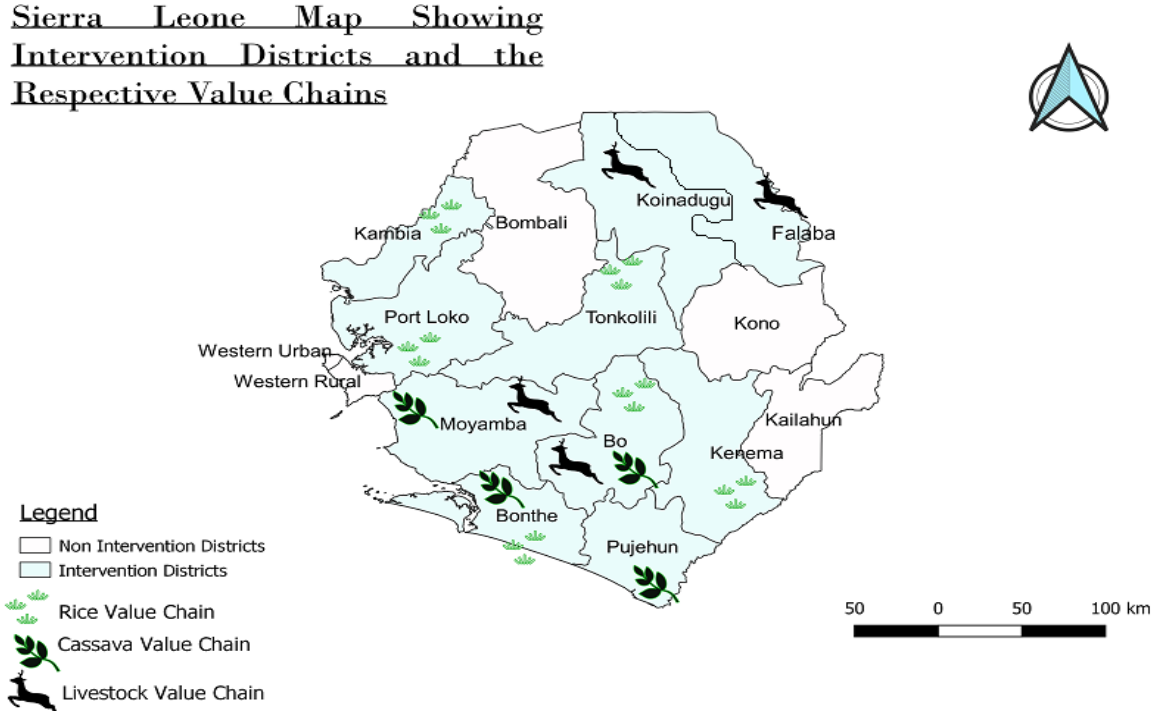
involved in the three selected value chains (rice, cassava and livestock). These private sector actors will benefit from capacity building and business opportunities through matching grant arrangements.

The Program Development Objective (PrDO) is *to strengthen regional food system risk management, improve the sustainability of the productive base in targeted areas and develop regional agricultural markets.* This PrDO will be achieved through support for interventions aimed at 1) building and strengthening national and regional digital advisory services for agriculture and food crisis prevention and management; 2) Strengthening sustainability & adaptive capacity of the Food System's productive base; and 3) Strengthening market integration and trade.

This program will be implemented in all districts in the country. However, for respective value chains, the following ten districts will be targeted:

- **Rice:** Bonthe, Port Loko, Tonkolili, Bo, Kenema and Kambia
- **Cassava:** Bonthe, Bo, Moyamba and Pujehun
- **Livestock:** Bo, Moyamba, Koinadugu, Falaba/ Large Ruminants: Koinadugu, Falaba

See below (Figure 1) map showing areas of intervention for respective value chains.
Figure 1 Map of Sierra Leone showing targeted districts



The FSRP2 has five key components that are based on a shift from responding to the current food insecurity crisis towards more medium to longer-term investments aimed at building the resilience of the food systems and the country's productive base. The total investment allocation to Sierra Leone from the program is US$ 60.8 million. These five core components are:

1. Component 1: Digital Advisory Services for Agriculture and Food Crisis Prevention & Management (US$ 12.5 million). The objective of this component is to *improve agricultural and food crisis prevention and management using digital advisory services.*

2. Component 2: Sustainability and Adaptive Capacity of the Food System's Productive Base (US$ 33.9 million). The objective of this component is to *maintain and improve the natural capital base in the intervention areas to ensure sustainability in the levels of productivity.*

3. **Component 3: Regional Market Integration & Trade** (**US$ 10.5 million equivalent)**. The component aims to expand food trade in West Africa and to facilitate the trade of agricultural goods and inputs within and across national borders.

4. Component 4: Contingent Emergency Response Component (**US$ 0.00 million equivalent).** This component will allow for a reallocation of credit proceeds from other components to provide immediate emergency recovery support following an eligible crisis or emergency.

5. Component 5: Project management (**US$ 4.00 million equivalent).** The overall management of the program will be carried out by the Ministry of Agriculture and Forestry's National Development Partners Program Coordinating Office (NDPPCO[3]).

1.2 Background of Geographical Description of Sierra Leone

Sierra Leone is located on the West Coast of Africa, between the 7th and 10th parallels north of the Equator, bordered by the Republic of Guinea to the North and Northeast, Liberia to the South and Southeast, and the Atlantic Ocean to the west. The country has a total area of 72,000 sq km of which 60, 650 sq km is upland and 11, 650 sq km lowlands spread over four distinct geographical regions: coastal Guinean mangroves, the wooded hill country, an upland plateau, and the eastern mountains. Along most of the coastal areas are mangrove swamps. The rest of the country is a plateau with altitudes ranging from 300m and above. However, the countryside is characterized by hills and mountains, from which it derives the name of Sierra Leone (from Portuguese words Serra Leoa, meaning Lion Mountains). The main mountains are Wara Wara, Sula, Loma, Tingi, Kongotan Range, all in the eastern part of the country, and the Peninsula Mountains in the Southern part of the country. There are also several river systems in the country. The main rivers are the following: Moa, Mano, Rokel, Pampana, Great Scarcies, Little Scarcies' Sewa / Bagbe, Waanjie, Jong / Taia, Bankasoka, Mabole, and Gbangbaia. The river systems have hundreds of tributaries that form a network within the country. There are also numerous lakes, the majority of which are relatively small in size, such as Lakes Mapa, Mabesi, Popei, Gambia, Sonfon and Balama, most in the south of the country. Arable lands in the uplands are estimated at 43,000 sq km while about 90 percent of the lowland area is considered arable. The lowlands are differentiated in four ecosystems and comprise inland valley swamps (630,000 ha), mangrove swamps (200,000 ha), bolilands (120,000 ha) and riverine grasslands (110,000 ha). There are two main seasons determining the agricultural cycle: the rainy season from May to November, and a dry season from December to May, which includes harmattan and temperature can be as low as 16°C (60.8°F) the night-time. The average temperature is 26°C (78.8°F), and rainfall at the Coast ranges between 3000–5000 mm per year. On average rainfall is 2000-2500 mm

1.3 Overview of Agricultural Production and Productivity in Sierra Leone

Agriculture is a way of life for most people in Sierra Leone. Most of the cultivated land is used by small scale farmers for subsistence agriculture. Previous research has shown that returns to agricultural investment are high, but in practice many farmers do not take on profitable investments. Following the end of the civil conflict, domestic food production has continued to increase. It is estimated that the share of households with adequate food consumption has increased from 56% in 2005 to 71% in 2007. With regards to production of specific crops, the level of rice self-sufficiency in the country increased from 57.4% to 71% between 2002 and 2007. It is therefore evident that economic growth

[3] NDPPCO will have a unit under it that will be responsible for day-to-day implementation of specific activities under the sub-component, since their mandate has a broader objective.

and poverty reduction in Sierra Leone will only be sustained with developments in the agricultural sector. MAF seeks to improve agricultural production and productivity in order to achieve food security, by providing an enabling environment for farmers, promoting appropriate research, extension, input delivery and market systems, thereby improving rural incomes, reducing poverty, and maintaining the natural environment. To this end, MAF formulates and implements policies, and coordinates, designs, and monitors programs for the development of the agricultural sector with the following objectives:

- To increase agricultural productivity, output, rural incomes, and employment, while ensuring adequate protection of the environment.
- To ensure balanced regional agricultural growth and equitable distribution of income; PMP (Pest Management Plan) for Sierra Leone.
- To increase diversified domestic production of food, with a view to achieving food security in the medium and long term.
- To increase the opportunity to a new international market
- To maximize foreign exchange earnings from the agricultural sector.

1.3.1 Rice sub sector

Rice is the staple of Sierra Leoneans. Annual per capita consumption of rice (104 kg) is amongst the highest in sub-Saharan Africa. It is grown mainly by small scale farmers on upland and diverse lowland ecologies. Sierra Leone has not been able to produce enough rice to meet its local consumer demand for a very long time . From 1960 to 1975 production of rice has increased through expansion of land area and an increase in yield. In 1975 Sierra Leone is said to have experienced self-sufficiency in rice. Records of over 600,000 tons of paddy are reported at the end of the seventies. In the late eighties, production fell to an average of just above 500,000 tons; further declining to about 460,000 tons in the mid-1990s when the civil war engulfing the entire nation. The lowest production (198,000 tons) was recorded at the peak of the civil war in 1999. Since then, rice production has been increasing from 310,000 tons in 2000 to 637,983 tons in 2007. National rice self-sufficiency is currently about 70 percent.

Rice production in Sierra Leone is in the hands of small-scale farmers who produce barely enough for home consumption with little or none for the market. During the 2004/05 cropping season, 56 percent of the households cultivated less than 1 ha of farmland while only 44 percent cultivated 1 ha or more. Rice field area per household ranged from 0.25 ha to 5.5 ha with an average of 1.06 ha. (GOSL, 2006). The small-scale farmers in Sierra Leone are generally resourced with only the hoe, axe, and cutlass as the main implements while labour is mainly supplied by family members thereby severely limiting their scale of production. On the other hand, the widespread use of unimproved varieties, limited use of fertilizer, coupled with unimproved cultural practices adversely affects rice production. After harvest, most of the farmers leave rice bundles in the field to dry. Threshing and winnowing are invariably done by hand and further drying is on mud floors and tarmac roads. Access to concrete drying floors is limited to a small proportion of farmers in the country. The quality of local rice marketed is low due mainly to the lack of use of modern rice mills. Most of the rice mills were destroyed or rendered nonfunctional during the war. In 2004, a total of 53 small scale rice mills existed in the country. Traditional methods and the use of steel roller mills constitute the major means of rice processing in the country. Parboiling is widely practiced, and parboiled rice constitutes a substantial proportion of local rice in the market particularly. The quality of imported rice in the market ranges from low quality 100% broken rice to higher quality Super A1 long grain rice (including perfumed rice in some supermarkets), providing all classes of consumers with a range of choices that meet their needs.. The price of local rice is about 15 – 20 percent higher than the price of comparable grades of imported rice,also, local rice is more nutritious than imported rice. However, there is a growing

appreciation of non-parboiled imported rice by youth and urban dwellers mainly because of its lower cost.

There is a clear gender dimension in rice production, processing and marketing. Men are mostly involved in brushing, felling and land preparation, while women are heavily involved in planting and weeding. Harvesting is almost equally shared between the sexes while processing and marketing of rice is predominantly done by women. The rice market is now dominated by four importers, three of whom operate as a cartel. Entry is restricted mainly by the capital requirements of the trade (MAF/MFMR, 2004). The system of marketing domestic rice which is dominated by women is quite traditional involving Assemblers, Wholesalers and/or Itinerant Merchants and Retailers.

Since Sierra Leone's independence, agricultural development policy has been focused on the achievement of rice self-sufficiency among other objectives. Major interventions in the sector have included both direct government participation (mechanical rice cultivation in the riverain grasslands around Gbundapi and Torma Bum, and the bolilands in the Bombali and Tonkolili Districts) and indirectly, through the donor-funded integrated agricultural/rural development projects, which covered over 80% of the country in the 1970s and 1980s. All these interventions targeted small-holder farmers, who constitute approximately 90% of the farmer population. The performance of the various interventions were generally disappointing and during the last two decades, the overall performance of the agricultural sector has been poor. Sierra Leone returned to peace in the first half of 2002 after an eleven-year brutal civil war that severely devastated the country's economy including the agricultural sector. The government supported farmers with seed rice and provided tractors that were mainly used for the cultivation of the bolilands. At the end of the five years, food security was not achieved, and it is estimated that over 60 percent of the population are still living under US $ 1 a day. The current government has adopted the national agricultural transformation agenda 2025 which put rice intensification and irrigation as a top priority. However, Rice Yellow Mottle Virus (RYMV) and Bacterial Leaf Blight caused by Xanthomonas oryzae pv. oryzae pathogens have been described as the major causal agents of rice diseases in West Africa.

The four most important strategies for rice disease management are to **rotate crops, plant resistant varieties, plant in warm soil and use fungicides when necessary**. An integrated approach that uses all these methods is the most effective and profitable.

1.3.2 Cassava Sub sector

Cassava (Manihot esculenta Crantz) is the most important root and tuber crop in Sierra Leone and a is the second most important as a source of calories after rice. The demand for cassava has increased due to rapid growth in population and increased need for cheaper sources of calories. The most common cassava products gari, foo - foo flour, and starch and most recently ethanol through ADDAX bioenergy and now sunbird. The low industrial use is probably an indication of the low state of development of processing firms because cassava could substitute for many imported items such as wheat flour, brewing grains, and starch. In addition to the two major diseases threatening cassava production system in Africa (Cassava Mosaic Disease or CMD and Cassava Brown Streak Disease or CBSD), there are several postharvest and socio-economic factors limiting the growth of the cassava subsector. Less than 10 percent of cassava acreage is grown with machines (<10%). Research suggests that costs and time could be saved with the mechanization of cassava production and processing but many elements to allow mechanization are missing dealers, importers, service providers, maintenance engineers, low knowhow entrepreneurial ability. While technical support institutions are weak, there is limited policy implementation to improve the cassava subsector. These manifest in lack of competitiveness at farm-level and in the global cassava market, contributing to inadequate food supply and high expenditure on food importation.

The West African Agricultural Productivity program made a significant contribution in increasing cassava yields from 4t/ha as it was in the nineties to the current yield estimates of 7t/ha.

The Technologies for African Agricultural Transformation (TAAT) supported by the African Development Bank (ADB) is currently implementing activities meet the following objectives:

i. Creating an enabling environment for technology adoption by famers via policies for deployment and adoption of food production technologies that are regionally harmonized, food and nutrition conscious, and environmentally sustainable.
ii. Facilitate effective delivery of technologies to farmers by working with existing Regional Technology Delivery Infrastructure in a compact with RMCs, represented by NARES, private sector actors, and an independent technology Clearinghouse.
iii. Raising agricultural production and productivity through the identification and deployment of appropriate technologies, including nutrient dense crop varieties, and vigorous crop outreach campaigns, extension, and market linkage campaigns, in RMCs.

Another major development in the cassava sector is the development of the national action plan for cassava viruses with support from the central and West African Virus Epidemiology (WAVE). The activities around the WAVE project is to strengthen disease surveillance and diagnostic capacity across the west and central region thereby increase the level of preparedness for diseases of quarantine interest such as the cassava brown streak disease as well as response to outbreaks or insurgence of cassava mosaic virus strains.

1.3.4 Poultry

Population and Housing Census, (2015) report reveals that poultry is the most populated (4,316,349) and it is predominantly owned and managed by women in Sierra Leone Though poultry is the largest livestock rear in Sierra Leone, its calorie contribution has been reported low (0.63 %)compared to other livestock [5.24%) (Kate Schneider, Mary Kay Gugerty& Robert Plotnick, (2010). Current Status of Indigenous Chicken Production in Moyamba District, Sierra Leone, (Abdulai Mahmood Conteh, 2019) indicates that indigenous chicken production (ICP) remains a significant component of livestock production in Sierra Leone. Production is however characterized by poor management systems of which an estimated 80% are indigenous breeds are managed at the traditional free-range system. This system of poultry production has received little attention, it still performs key functions such as supporting livelihood and enhancing economic empowerment. Household consumption, poverty reduction, promoting gender equality and socio-cultural practices, scaling down malnutrition, creating employment and providing extra cash are well documented as contributions of Indigenous Chickens (ICs) to rural and peri-urban households for the rural population in Sierra Leone. Disease outbreaks (see Table 2), predation, poor veterinary and extension services, weak institutional support, inadequate housing and lack of well-structured market facilities are major constraints production in Sierra Leone. Considering these disadvantages, ICP is a preferable system ass a cost-effective way to rear poultry in rural and peri-urban areas. There is growing evidence supporting that poultry that is reared in the free-range system could manage and survive in extremely hostile environments, in addition to their tolerance against some endemic diseases and perform better under inadequate and fewer quality feeds. In Sierra Leone, more than two-thirds of the national population rear livestock including poultry with 90% accounting for the backyard rural poultry.

1.3.4 Small Ruminants

Small ruminant production is important animal husbandry practiced in developing countries including Sierra Leone. This current study was conducted in the Southern Part of Sierra Leone (Moyamba District) to investigate Small Ruminant Production (SRP) at the free-range management system concerning household contributions, practices, and challenges. Data were collected from 192

respondents using a well-structured pretested questionnaire. This was administered randomly to 6 selected chiefdoms in the Moyamba District. Data were analyzed using simple descriptive statistics for mean, frequencies, and percentages. The results of the study showed that 60.4% of the respondents were male whilst 39.6% were females. 80.7% were married, 49.0% were illiterate and 74.0% were unemployed. Household demands were reported as the main purpose for keeping goats and sheep followed by traditional practices, income generation, religious ceremonies, and manure for vegetable production. 67.7% and 89.1% provided supplementary feed and water for their animals respectively. The majority of the respondents (81.8%) built separate shelters whilst the remaining farmers either shared dwelling houses with their animals (25.7%) or did not confine them (18.2%). Disease outbreaks (see Table 3) such as [mange, Peste des Petit Ruminant (PPR), diarrhea, respiratory infections, foot rot, and bloat]; uncontrolled theft; poor market facility; damage; and inadequate animal healthcare services among others were the major constraints reported by farmers. It was concluded that production management practices were done at the traditional level using traditional knowledge and skills with little or no modern input hence low output. The study, recommend that government and non-governmental organizations should implement multi-sectoral interventions that provide t the pre-requisite assistance to the farmers which can help to combat the multiple challenges affecting small production in the study area.

1.4. Objective of the PMP

The objective is to develop an appropriate framework for effective implementation of the Pest Management Plan (PMP) that highlights the major pests and diseases associated with the project's priority commodities: rice, cassava and livestock (poultry and small ruminants) and propose an Integrated Pest Management (IPM) strategy to ensure effective pest management options, minimizing the use of pesticides for improved agricultural productivity and public health. In conformity with the new World Bank Environmental and Social Framework (ESF), the study will also propose a framework for Pest Control Pesticide and Waste Management. More specifically, the study will:

i. identify all potential environmental risks with regards to project envisaged activities related to the use of agrochemicals;
ii. propose a framework of pests and pesticides management including other agrochemicals;
iii. define institutional arrangements for monitoring and inspection to be taken before, during and after the implementation of the project and appropriate measures for eliminating or mitigating environmental and social risk.
iv. identify major pests and diseases associated with the associated crops that will be researched (rice and cassava).
v. identify major pests and diseases associated with poultry and small ruminants.

design an Integrated Pest and pesticide Management (IPM) strategy to ensure the safe use of agricultural pesticides and management of pests using biological or environmental control methods in line with World Bank's environmental and social standards (ESSs) of the newly adopted Environmental and Social Framework (ESF) and National Regulations

2.0 Legal Framework and Institutional Capacities

2.1. National Policy and Regulatory Framework

The key Sierra Leonean agricultural policies as well as environmental and other statutory laws and regulations to guide the FSRP2 from conceptualization of the proposed project to implementation and monitoring as well as decommissioning include the following:

- Agricultural Policy

- The Land Policy, 2015
- National Gender Strategic Plan (2019- 2023)
- The National Mid-Term Development Plan (2019 – 2023)
- The National Agricultural Transformation Plan (2023)
- The National Agricultural Investment Plan;
- The Food Crisis Management Prevention-Country Resilience Priorities;
- Strategic Private Sector-Led Policy Shifts (2020-2021).
- Environmental Protection Agency Act, 2008 and the EPA (Amendment) Act, 2010
- Draft Strategic Plan 2018 to 2023, Meteorological Agency
- The Local Government Act, 2004
- The Sierra Leone Meteorological Agency Act ,2017
- The Constitution of Sierra Leone, 1991

Currently, there is a draft legal framework (policy) to regulate the importation, registration, distribution, sale and application of pesticides in Sierra Leone. Sierra Leone Standard Bureau have a laboratory facility for the monitoring of pesticide residues in food, water and the environment which is currently not operational due to some challenges.

In the 1980s FAO/UNDP supported a project in Sierra Leone to develop a Crop Protection Unit with plant pest diagnostic laboratory established at Magbosi in Mile 91 which was destroyed during the war and has not been reactivated to date. This system functioned satisfactorily until the project terminated and successfully created the existing structure of the Crop Protection Unit in Sierra Leone. The setup is consistent with FAOs strategic objective to fight hunger and poverty in Africa through improvements in national plant protection services to reduce crop losses. This Unit is also the National Plant Protection Organisation of the country.

The term pest is used in this document according to the FAO definition of pest which is “any form of plant or animal life or any pathogenic organism that is injurious or potentially injurious to plants, plant products, livestock, environment, or people; pests include insects and other arthropods, nematodes, fungi, bacteria, viruses, vertebrates and weeds” The Crop Protection Extension Service Unit, incorporating the Pest Control section is responsible for crop protection extension services to farmers; these include pest surveillance, pest risk assessment and reporting, providing technical advice and crop pest control information to farmers, farmer education and training in pest management practices, mass spraying against economic pests; pesticide management unit that registers and licenses and also monitor and manage some part of the pesticide lifecycle. The Phytosanitary Control Unit is concerned with plant quarantine matters, including phytosanitary inspection of plant products, certification and ensuring compliance with the requirements of the IPPC and the WTO-SPS protocol. This unit maintains inspection posts at the International airport, PMP for Sierra Leone 14 the Queen Elizabeth II Quay (Freetown), Kambia/Gbalamuya, Jendema/Bo Waterside, Buedu and Koindu in the Kailahun border posts. This unit was established through the Plant Phytosanitary (Import) Rules in the context of the Agricultural Act (Cap 185) No 66 of 1974.
Regrettably, Sierra Leone experienced a very severe and complex civil conflict which resulted in serious socio-economic challenges. However, commendable efforts have been made with other programme to revive the organizational structure of the Crop Protection Unit (CPU).

2.1.1 Institutional Capacities

Activities of CPU are on-going especially at district and but weak at community levels as only very few plant health clinic are functional; national, regional and international collaboration and linkages are being established and the potentials for developing an efficient plant protection Service are extremely high. Nonetheless, CPU is challenged with serious constraints, including, adequately trained personnel, infrastructure, facilities, mobility, operational funds and revised legal and regulatory

instruments for supporting plant protection activities. Staff capacities at district levels are also very thin on the ground to immediately handle any emergency problems. Basic diagnostic laboratory facilities and equipment, other than hand lenses for visual examination are non-existence. In spite of these gaps, CPU has the full oversight responsibility for plant protection, pesticide management and phytosanitary activities in the country. Ongoing initiatives of CPU are designed to introduce integrated pest and pesticide management (IPPM) into the farming communities. With support from CABI Plantwise, a series of plant health clinics was established at all 15 agricultural districts and some Agricultural Business Centres (ABCs) where extension agents were trained as "Plant Doctors" to provide regular IPM advice and practical field training in integrated pest management practices to farmers. Through technical and financial support provided by CABI in collaboration with Rothamsted Research UK, these clinics were successfully developed in the districts. The CPU and the plant doctors collaborate and share information with the Global Plant Clinic in the UK. The District Agriculture Officers (DAOs) are responsible for managing all agriculture related activities and supervise all Agricultural Extension officers within their districts, including crop protection and other phytosanitary services. Although pesticides are solely managed by the National Plant Protection Organisation (NPPO), however, all pesticides supplied to districts are officially directed to the DAOs. Crop Protection Officers at district level who manage pesticides have been trained in pests and pesticide management practices. Plant doctors only recommend to farmers pesticides that have been purchased or accepted for use by MAF. This way, the use of pesticides is somehow being controlled for crop pests' management.

Notwithstanding, the Environmental Protection Agency (EPA-SL) whose mandate is principally to conduct an environmental impact assessment of all projects with a potential environmental impact and issues permits to all agricultural and infrastructure construction projects, coordinates and monitors actors involved in activities relating to the environmental protection legislation, to ensure compliance with national environmental policies, regulates and monitors the processing of waste, PMP for Sierra Leone 15 pollution and other environmental hazards, is also seen engaged in pesticide management. The Agency collaborates with the Forestry Division of MAF on a number of issues related to environmental regulation in forest concession areas, and most notably on matters related to carbon financing in the forestry sector. Inadequate coordination and collaboration between government agencies and other stakeholders, such as the private sector (e.g. pesticide importers, retailers, and pest control operators), the police, customs, civil society, academia and research institutions is a serious impediment in the management of pesticides in the country. Consequently, problems in pesticide management that could have been recognized and dealt with at an early stage are either overlooked or only addressed when issues arise.

2.1.2 Institutional Constraints

a) There is no enacted plant protection policy (however, a draft exist still waiting to be passed into a law and an Act and regulation to be developed) to direct the delivery of Crop Protection Unit in the country.
b) Although some of the respondents are aware of the benefits of Integrated Pest Management (IPM), it is not operational as a national policy for crop protection in Sierra Leone.
c) The number of staff with the requisite expertise in crop protection is low in relation to the challenges. At least fifteen university graduates are required to fill in the gaps at district level.
d) There is a non-functional pesticide laboratory with equipment not installed for testing of pesticides for their purity and efficacy.
e) Inadequate corporation and support from other relevant government functionaries for compliance in pesticide management due to lack of enforcing mechanism.

The development of sustainable strategies for the effective control of major insect pests and diseases is a major challenge. For the Crop Protection Unit to function effectively the Unit needs to be re-structured, strengthened and adequately resourced. Continuous staff training should be a major focus to upgrade the skills of crop protection and phytosanitary officers at various levels to enable them function efficiently and effectively.

2.2. International Conventions on the Environment

The legal framework that has a direct and/or indirect relation with pest and pesticide management, calls for several legislative and regulatory texts at the national level as well as international agreements, treaties and conventions ratified by the countries. It is against this context that the Government of Sierra Leone with a view to harmonize and fulfill its national, regional and international obligations, Sierra Leone is party to the following conventions:

- International Plant Protection Convention
- Stockholm Convention *on* Persistent organic pollutants
- Convention to combat Desertification.
- Convention on Climate Change.
- Vienna Convention in 1990, for the protection of ozone layers.
- Basel Convention in 1997,
- Rotterdam Convention on the International Code of Conduct on the distribution and use of pesticides (PIC) in 2001.
- Stockholm Convention on Persistent Organic Pollutants (POPs) in 2003,
- Bamako Convention in1999.
- Convention on the Common Regulations for Pesticide Regulation in the Sahel and the revised version in 2003.
- Convention on Biological Diversity
- The GOTG is also a Party to the following international agreements and treaties:
- The Montreal Protocol on Ozone Depleting Substance
- Agenda-21 Global Programme of Action for Sustainable Development (Environmentally sound management of toxic chemicals and prevention of illegal international traffic in toxic and dangerous products)
- The Rio Declaration on Environment and Development- addresses the sustainable use of natural resources and its development

2.3 World Bank Environmental and Social Framework (ESF)

The nature, characteristics and scope of the FSRP2 proposed activities are rated as Moderate risks on the WB's ESF Risk Classification Tool. the following Environmental and Social Standards (ESS) relevant to this project include

ESS 1: Assessment and Management of Environmental and Social Risks and Impacts
ESS 2: Labor and Working Conditions
ESS 3: Resource Efficiency and Pollution Prevention and Management
ESS 4: Community Health and Safety
ESS 5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement
ESS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
ESS 8: Cultural Heritage
ESS10: Stakeholder Engagement and Information Disclosure

In particular, *ESS3, Resource Efficiency and Pollution Prevention and Management*, requires the Borrower to prepare a PMP if the project intends to utilize pesticides or other pest control products. As stated in ESS3 under *'Management of Pesticides',* the Borrower will give preference to integrated pest management (IPM)18 or integrated vector management (IVM)19 approaches using combined or

multiple tactics. Also, additional criteria apply to the selection and use of pesticides: (a) they will have negligible adverse human health effects; (b) they will be shown to be effective against the target species; and (c) they will have minimal effect on nontarget species and the natural environment. The methods, timing, and frequency of pesticide application are aimed to minimize damage to natural enemies. Pesticides used in public health programs will be demonstrated to be safe for inhabitants and domestic animals in the treated areas, as well as for personnel applying them; (d) their use will take into account the need to prevent the development of resistance in pests; and (e) where registration is required, all pesticides will be registered or otherwise authorized for use on the crops and livestock, or for the use patterns, for which they are intended under the project. The Borrower will ensure that all pesticides used will be manufactured, formulated, packaged, labeled, handled, stored, disposed of, and applied according to relevant international standards and codes of conduct, as well as the General World Bank Group Environmental, Health and Safety Guidelines (EHSGs) and Specific WB EHSGs which include ESHGs for Annual Crop and Perennial crop production , Mammalian Livestock Production and Poultry production.

3.0 Pesticide Management in Sierra Leone

Pest and pesticide management are very important factors for safe agricultural products for human and animal consumption as well as in maintaining safe natural environment. Although there is not too much in the use of pesticides in food production, as it is expensive for the smallholder farmers, pesticides use in general is always of concern for human, wildlife, livestock and the environmental health, whilst it is very useful for pest management for production of healthy crops. In Sierra Leone, effective management of public health, environmental and agricultural pesticides remain in the hands of various actors; the Ministry of Agriculture and Forestry (MAF) and the Ministry of Health and Sanitation (MoHS) are the main institutions that utilize more pesticides, and they are managed separately; the Environmental Protection Agency (EPA-SL) also addresses pesticide issues alongside encouraging proper management of the environment (obsolete. Contamination and disposal). With the lack of legislative instruments, importation of pesticides is very much disorganized, and difficult to enforce as different sector who are not supposed to register pesticides give license are doing so. The private sector and pesticide operators lack basic knowledge in proper management of pesticides.

The FSRP PMP is therefore designed to elucidate and address national and institutional challenges that impede effective pest and pesticide management system and to make recommendations for crop pest management with very little of pesticide use during the project implementation.

3.1 Legislative and Regulatory Framework for Pesticide Management

The Government of Sierra Leone through the CPU has the autonomous right to regulate pesticides import to achieve the appropriate level of protection for cultivated, wild flora, human, livestock and the environment for food production and productivity, in a way that is compatible with its international obligations. Currently, there is no legal framework to regulate the importation, registration, distribution, use and application of pesticides and other life stages of the pesticide life cycle in Sierra Leone. The types and quantities of pesticides entering Sierra Leone needs to be known for their effectiveness and their safety for human, livestock and the environment. There are lots of illegal Street trading of pesticide on-going coming through the porous borders. Because of this, two policy documents for pesticides management have been drafted, viz: the Plant Protection Policy document (2014) funded by WAAPP-1C for the establishment of a Plant Protection and Regulatory Services Division (PPRSD), charged with Phytosanitary Inspection, Control and Certification; Policies, Regulations and Standards, and Diagnostics and Laboratory Services; and through funding by EU/BAFS project, a draft National Integrated Pesticides Management Policy document are available awaiting parliamentary enactment into national law. The two draft documents strictly followed recommendations and suggestions by international conventions and agreements including the ECOWAS recommended regulation/REG.3/08/2008 for harmonising the rules governing the registration of pesticides in the ECOWAS region. The move towards a more harmonized and regulated sector is meant to provide farmers and agribusinesses with protective measures that will assure quality and safety when acquiring and using agro-pesticides. The country requires a legal and regulatory framework to encourage the private sector in agro-pesticides trade, use and promote compliance to international conventions and agreements in pesticide management. Consequently, the Government of Sierra Leone published the ECOWAS pesticides regulation and the FAO/IPPC International Standards for Phytosanitary Measures (ISPMs) for pesticides management in the country's National Gazette No.62 dated 20th November 2014; and the enactment of the Sierra Leone Seed Certification Agency (SLeSCA) and the National Fertilizer Regulatory Agency (NaFRA) in November 24, 2017.

The objectives for the regulation are to:

- Protect the population and the environment from the potential dangers of pesticide use;
- Facilitate trade of pesticides through the application of regionally agreed principles and rules that minimize barriers to trade;
- Facilitate access to the best pesticides for farmers at the appropriate time and place;
- Ensure the rational and judicious use of pesticides;
- Contribute to the creation of an environment conducive to private investment in the pesticide industry;
- Promote public-private partnership in pesticide use and distribution

3.2 Institutional Framework for Pesticide Management

Farmers as well as agro-dealers bring in pesticides at will without reference to MAF due to lack of pesticide import regulation and enforcement instrument. Nonetheless, MAF has put temporary mechanism in place for the importation, registration and sale of agricultural pesticides. For the importation of pesticides, the importer needs to complete and submit an import application form. Before an import permit is issued, a pest risk analysis (PRA) is first carried out at the EU Pesticides Database/EPAUSA Pesticides websites for sustainable use of pesticides. These provide guidelines in reducing the risks and impacts of pesticide use on human, animal health and the environment and promoting the use of Integrated Pest Management (IPM) alternative approaches or techniques. This has been particularly helpful where big investors (companies and industries) have been involved since they are interested in following proper and internationally acceptable procedures as well as recognising their international obligations. What is now lacking is the legal and regulatory framework for promoting plant health system, although there is already a draft plant protection policy which lacks the regulatory powers to deter the importation of pesticides and encourage pesticide registration based on ECOWAS regulation for pesticides import. The CPU setup an adhoc National Pesticide Management Committee (NPMC) to look at those pesticides that importers intend to bring into the country. A committee of comprising representatives of the various stakeholders was mandated to examine agro-pesticides applications for import certification and so on.

In response to actual and potential pest threats in the need to intensify agriculture, MAF annually purchase and distribute pesticides (through tender) to the districts through the CPU within Crops Division. A number of private agro-dealer companies play vital roles in the supply of pesticide and pesticides spray equipment. For example, MAF acts upon request of the CPU which prepares the list of pesticides and spraying equipment and protective gears needed for farmers which are distributed nationwide. No pesticides are formulated and packaged in Sierra Leone. However, pesticide companies normally work in consultation with the Crop Protection Unit of MAF for advice and to provide a list of pesticides acceptable for use in Sierra Leone (Appendix II), this is not always the case.

3.3 Pesticide Control and Management (Registration and Post Registration Activities)

The pre- and post-registration of pesticides and license of agro-dealers is the responsibility of the NPMC in Sierra Leone. The registration of pesticides is the responsibility of NPMC and the West Africa Pesticide Registration Committee (WAPRC). The rationale of post registration activities provides a means of measuring the validity of predictions based on registration data, regarding efficacy, safety and environmental effects of a particular pesticide. Thus, the post- registration activities conducted by the NPMC are elaborated below:

a) Monitor and control, the manufacture, import, export, distribution, storage and use of chemicals and pesticides by licensing and any provisions made in the Supplementary Regulations for illegal importation of pesticides.

b) Test the quality of Pesticide formulations authorized and pesticide residue levels in food, plants, water and soils, and applicators of pesticides.
c) Conduct various monitoring activities to monitor impacts of pesticides on plants, food, human and animal health, and the environment.
d) Conduct training programs on the safe use and management of pesticides, including transport, storage and disposal, for all stakeholders.
e) Raise public awareness on the risks associated with pesticides and safety measures.
f) Enforcement of legislation/regulation and provide suitable control measures, to control imports, adverts, labelling and re-packaging of pesticides.
g) Information exchange in accordance with FAO Code of Conduct (Article 9), to decision-makers, contracting parties, users, businesses and applicators, importing and exporting countries. This helps ensure compliance to the regulations in force.
h) Operate Licensing Schemes for Pesticide Applicators and Companies. These activities are conducted by Pesticide Inspectors of the Field Inspectorate, gathered from collaborating institutions (Customs, Agriculture and Health), who are posted at various entry post into the country, supported by a Pesticide Formulation Laboratory to test samples.

3.4 Constraints on Pesticide Management and Control

The main constraints on pesticide life cycle management are elaborated below:

- Lack of a pesticide legal framework
- Non-functional national pesticide management committee
- Lack of functioning of the Pesticides Formulation Laboratory, due to lack of resources to purchase equipment damage and lack of Standards, Columns and Solvents.
- Lack of mobility and resources to conduct monitoring and enforcement activities, and personnel protective equipment
- Lack of resources to conduct training and awareness campaigns.
- Lack of additional equipment to operate the Pesticide Residue Laboratory due to resource constraints.

4.0 Pests found in agriculture and livestock (poultry, small and large ruminants)

4.1 Rice and Cassava

There is currently no official data to define the importance of crop pests and diseases in Sierra Leone and this has retarded the progress of crop protection in every aspect especially in the implementation of agricultural projects. However, with the introduction of a plant health clinics system at Farmer-Based Organisations (FBOs) and the Agribusiness Centres (ABCs) in 2008 as farmers' enquiry points to help identify and solve field crop pests' problems, the following pests (Table 1) have been recorded on specific crops by plant health doctors based upon reports by farmers.

Table 1: Common pests of some crops in Sierra Le

Crop	Pest	Disease
Rice	i. African white stem borer (*Maliarpha separatella*) ii. Pink stem borer (*Sesamia calamistis*) iii. African striped stem borer (*Chilo* spp) iv. Stink bug (*Aspavia armigera)* v. Green stink bug *(Nezara viridula)* vi. Stalk–eyed fly (*Diopsis thoracica*) vii. Rice caseworm (*Nymphula depunctalis*) viii. African armyworm (*Spodoptera exempta*) ix. African rice gall midge (*Orseolia oryzivora*)	i. Blast (Pyricularia oryzae) ii. Brown leaf spot (Helminthosporum oryzae) iii. White tip (*Apphelenchoides besseyi*) iv. Seedling blight (*Entyloma oryzae*)
Cassava	i. Variegated grasshopper (*Zonocerus variegatus)* ii. Cassava mealybug (*Phenacoccus manihoti)* iii. Whiteflies (*Bemisia tabaci*) iv. Green mite (*Mononychellus tanajoa*)	i. *African cassava mosaic virus* ii. Brown leaf spot iii. Bacterial stem rot iv. Cassava brown streak virus disease

Prepared by: IMO Shamie, MAF

In both agriculture and public health, there are a lot of organisms causing damage by feeding on crops, parasitizing livestock, carrying protozoans within human habitat and causing diseases. Pests affecting agricultural crops include insects, nematodes, fungi, viruses, bacteria, mites, etc.

4.1.1 Some Crop Pests of Economic Importance

There are only two serious pests of crops of economic importance in the project operational area; the seasonal variegated grasshopper *Zonocerus variegatus* and the newly invasive transboundary pest of cereal crops the Fall Armyworm *Spodoptera frugiperda.*

I) The Variegated grasshopper (*Zonocerus variegatus*)

Farmers and small/medium/entrepreneur (SME) cassava factories are aware that the variegated grasshopper (*Zonocerus variegatus,* is a major biotic constraint to commercial production of cassava storage roots and stem planting materials and many other food security crops in Sierra Leone.

The pest hatch into nymphs by September/October (end of rainy season) each year. The nymphs and adults spread from hatching points to nearby vegetation and farm where they defoliate and demark crops from end of the rainy season to start of the next rainy season in April/May. The spread and

intensity of the damage is heightened at peak dry season when the crops are also under water stress. Cassava, being the only annual crop with lush foliage in the dry season is particularly targeted by the grasshopper.

Defoliation causes loss of fresh leafy vegetables on the market; debarking cassava stems kills the buds and makes the stems unfit for planting. The loss in planting material undermines efforts by MAFFS partnerships with FBOs and SME factories to secure required volumes of planting materials in April/June. Also, poor plant growth under grasshopper attack either kills the plant or causes poor root yield in cassava. In short, grasshopper infestations undermine agricultural production and productivity by causing significant loss of leaves (food), stems (planting material, especially of improved materials and storage root (food and industrial products). The damage causes significant short falls in availability of cassava planting materials of improved cassava varieties. The annual re-occurrence of food and economic losses caused by grasshoppers can be limited in its impact.

i) Management options

Over the years, farmers in Sierra Leone, under MAFFS guidance, relied heavily on cultural control and harmful pesticide regimes against grasshoppers. The cultural control interventions include handpicking, bush clearing around cassava farms; chemical control interventions include the use of synthetic pesticides (Malathion, Diazinon, Chlorpyrifos, etc). The results have been ineffective, as evidenced by increased grasshopper spread and damage severity each year. The over-reliance on inappropriate synthetic chemical insecticides contaminates the leaf harvest, farm and are hazardous to applicators, farmers, farm workers and farm families, livestock, fish, wild life and the environment. Therefore, grasshoppers control requires environmentally sustainable pest management solutions that also integrate well with commercial food production.

ii) Use of Bio-pesticides

The International Institute of Tropical Agriculture (IITA) has developed a fungus-based bio-pesticide, an ecologically sustainable option against the variegated grasshopper. The product is based on a fungal pathogen called *Metarhizium annisopliae* commonly known as Green Muscle which specifically kills grasshoppers with no harm to man, other living organisms and the general environment. The biological control product is mass produced on demand by IITA. The bio-pesticide has been field tested with excellent results in many countries in West Africa. In 2006, Care International Sierra Leone in collaboration with IITA and the Crop Protection Service of MAFFS field tested the bio-pesticide against the grasshoppers with excellent results.

In collaboration with IITA-UPoCA project, CPS/MAFFS had used this product to contain grasshoppers' seasonal populations. As a result, cassava cultivation has expanded in the last few years to support the several cassava possessing industries already constructed around the country by RPSDP, WAAPP-1C, UNIDO and IITA projects in collaboration with MAFFS. The increased national interest in cassava as a food and economic crop demands that cassava production requires sustainable plant protection solutions such as is provided by Green Muscle against the variegated grasshoppers.

II) The Fall Armyworm (*Spodoptera frugiperda*)

The Fall Armyworm (FAW) is an invasive transboundary insect pest that was not known to occur in Africa until early 2016. It is native to tropical and subtropical regions of the Americas, with the adult moth able to move over 100 km in a single night. It lays its eggs on plants, from which larvae hatch and begin feeding. FAW feeds on more than 80 plant species, causing damage to economically important cultivated cereals such as maize, rice, sorghum, and also to legumes as well as vegetable crops and cotton, among others. High infestations can lead to significant yield loss.

FAW was first detected in Central and Western Africa in early 2016 (Sao Tome and Principe, Nigeria, Benin and Togo) and in late 2016 and 2017 in Angola, Botswana, Burundi, Cote d'Ivoire, Democratic

Republic of Congo, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Namibia, Niger, Rwanda, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. It has recently (Nov 2017) been confirmed in Sierra Leone, Liberia, and Cote d'Ivoire. Currently, about 30 countries have been infested on the African continent.

The presence of FAW in Sierra Leone was confirmed on 4th Nov 2017, during one of FAO backstopping missions. The authentication was based on specimens collected from fields visited and reports from the major maize growing areas across the country.

Subsequently, a quick nationwide rapid assessment was organized to ascertain the level of incidence of the pest to enable Sierra Leone undertake requisite mitigation and management actions. The FAW assessment was conducted by Staff of the Crop Protection and Extension Services of MAFFS, and the pest was found in all the 13 districts of Sierra Leone. The level of infestation as measured by the proportion of plants infested was more than 50% in the Western area, Bonthe, Bo, Moyamba, Pujehun, Kaliahun, and Tonkolili districts and could be described as the hot spots for FAW infestation. Since FAW could also feed on rice and other crops during the years to come, the pest could have a devastating impact on food and nutrition security in Sierra Leone. A robust investment in FAW management is therefore needed. Being the main technical partner in food production and productivity, FAO took immediate actions to support countries in responding to the threat of FAW in Africa. These engagements have strategically positioned FAO as the main hub to manage the FAW.

As it is now, the long-term impact of FAW on agricultural production and food security in Africa cannot be determined. However, as an aggressive transboundary/migratory pest with such wide host range, it has the potential to cause serious damage and yield losses to many food crops, especially its preferred cereal crops including rice that is the national staple of Sierra Leone. Thus it can affect millions of livelihoods of various value chain operators on various commodities. FAW presence in Africa and for that matter Sierra Leone is irreversible. Large-scale eradication efforts are neither appropriate nor feasible. Large-scale eradication efforts are neither appropriate nor feasible. Small scale farmers in the Americas have learnt to manage the pest for many years, using methods that take environmental safety, animal and human health into consideration. To gather and analyze experiences and best practices from this region will help design a sustainable FAW management program, especially for smallholders.

CPS/MAFFS in collaboration with FAO, has set up a special FAW Task Force team at national and district level for the conduct of the assessment survey. The National Task Force responsibilities include:

i. Work with research Institutions and Universities to identify available biopesticides and natural enemies to guide biological control process;

ii. Identify MAFFS staff per district for the control of FAW;

iii. Conduct training sessions for staff and for farmers;

iv. Develop and print posters on A2 sized and distribute in the districts to be pasted at strategic places to raise rapid awareness of the population

v. Set up farmer to farmer programme aimed at educating beneficiaries on measures to take after detecting FAW invasion followed by mounting massive awareness raising campaigns over the local media in different languages

vi. Revise the farmer field school curriculum to capture FAW identification, control and preventive.

Two standard methods, indicated in the FAO Guidance Notes for FAW are to be used for monitoring FAW populations:

a) Pheromone traps:

Trapping male adult moths with synthetic sex pheromone gives a proxy indication of the presence of FAW in an area. Pheromone traps need to be procured and used intensively for surveillance to detect when the first FAW arrives within maize, rice, and other potential host crops during the 2018 planting season. The pheromone traps must be put in place before the planting season starts. FAO has already pre-qualified reliable pheromone and trap vendors in order to streamline the procurement process and ensure high quality products.

b) Field scouting:

Plants are inspected in detail to record the presence of egg, larva, damage and natural enemies.

4.2 Poultry

Common poultry diseases are one of the major challenges facing the poultry production in Sierra Leone. There have been many cases where farmers lost large investments worth several thousand dollars due to sudden poultry disease outbreak. Poultry diseases are commonly caused by bacteria, viruses, parasites, and fungi (Table 2). Apart from these, improper poultry farm management skills, feeding of unhealthy feeds and unclean poultry environment can also lead to poultry disease outbreak. Some of the most important and deadly poultry diseases are: Newcastle disease (NCD), Fowl Pox, ticks, lice and fleas.

(a) Newcastle Disease (NCD)

Newcastle disease is one of the major important poultry diseases. The disease is transmissible and notifiable disease that has the potential of being rapid and wide spread. NCD disease is caused by a virus and is highly contagious, which means that it can spread rapidly among chickens. It has a high death rate and can affect any kind of poultry farm, from backyard to large commercial poultry farms. The NCD virus infects respiratory, digestive and nervous system and in severe cases may cause high economic losses.

(a.1) Management of Newcastle disease

Intensive management of poultry where large numbers of chickens are housed together as well as the transportation of chickens over long distances promote the spread of the disease. The virus causing the disease is present in the droppings of sick as well as healthy chickens that carry the virus. Healthy chickens are infected when they eat food or drink water contaminated by the droppings; chickens are also infected by breathing in small airborne droplets that originate from sick chickens and from healthy chickens that carry the virus. The virus can live for some time outside chickens, and the disease can be spread by the movement of poultry, people, equipment, and poultry products (the virus may be present on the clothing of people, equipment, at markets, etc). Vaccination and isolation of healthy birds from sick ones and proper disposal of dead birds can prevent diseases.

(b) Fowl Pox

Fowl pox is the worldwide disease of poultry caused by viruses of the family Poxviridae. Fowl pox is a slow-spreading viral infection of chickens and many other birds and is characterized by proliferative lesions in the skin that progress to thick scabs (cutaneous form) and by lesions in the and respiratory tracts (diphtheritic form).

(b.1) Management of Fowl Pox

There is no cure for fowl pox, but there are comfort measures that can be provided for affected chickens as well as preventative measures to avoid secondary bacterial infections caused by the lesions. Unaffected birds can be vaccinated during an outbreak. Regular triple-antibiotic ointment can be used even in the corners of the eyes and mouth as long as the ointment does not contain painkillers.

Table 2(a) Poultry Diseases

Diseases	Sign	Treatment / Management	Prevention
Newcastle disease	• Greenish diarrhoea • Ocular and nasal discharge • Neck twisted • Paralysis and collapse	None	• Quarantine new birds for 5 days; • Isolate and kill all sick birds • Vaccination Broilers Apply Hitchner B1 as follow: • 1-4 days • 12 -14 days • 35-42 days Layers • 1-42 days as above with HB1, • 10 Week- Lasota • 16 - Pox
Fowl pox	Nodules on head, around eyes and mouth	• Clear pus from eyes and mouth apply iodine or glycerine	Quarantine new chickens • Isolate stick birds • Disinfection of poultry house 2 times a year

Source: Dr. J.E.D. Terry, Livestock, MAFFS

Table 2: (b) External Parasites on poultry

Parasites	Signs/symptoms	Treatment / Management	Prevention
1. Ticks 2. Lice 3. Fleas	- Irritation - Itching - Loss of - appetite - Drop in production Weight loss	Dust chickens with insecticide/ acaricide powder	Cleaning and regular disinfection

Table 2: (c) Internal Parasites in poultry

Parasites	Signs/symptoms	Treatment / Management	Prevention
Flat or Round Worms	- Loss of appetite - Diarrhoea - Anemia - Drop in production - Slow growth rate	Piperazine citrate	- Clear and disinfect after every batch of chickens leave poultry house for 21 days before restocking - Vaccinate - Layer at 18 weeks old.
Coccidiosis	- Bloody diarrhoea - Sudden death - High mortality in 10 days - Loss of appetite - Pale looking comb	- Coccidiostat (Amprolicin) - Sulphono- mides	Regular cleaning and disinfection

Fowl Cholera	- Inflammation of the joint foot pack crest or comb - Diarrhoea - Loss of appetite - Respiration problem - High mortality	Tetracycline	- Vaccinate chicken about 6 weeks old observe hygiene rules - Avoid stress

Source: Dr. J.E.D. Terry, Livestock, MAFFS

4.3 Pests of Small Ruminants (PPR)

Pest of small ruminants also known as Peste des Petits Ruminants (PPR) is a highly contagious, nonzoonotic viral disease of sheep and goats. The disease is recognized in the field by a sudden onset of diarrhea and fever, discharges from the eyes, nose, and mouth, sores with or without scabs or nodules around the mouth, pneumonia, and significant animal deaths. The disease is more prevalence in West Africa. For other pests of ruminants see Table 3 a,b,c. Management of PPR. Since PPR is none transmissible to human, its control activities could be attractive and cost-effective when integrated with other diseases, such as goat pox, sheep pox, brucellosis (Brucella melitensis), and foot-and-mouth disease (FMD).

Table 3 (a) Diseases of Small Ruminants

Diseases	Sign	Treatment / Management	Prevention
Pest of small Ruminants	- Loss of appetite - discharge from eyes - inflammation of the mouth and nose - Bloody diarrhea - Dehydration - Death	None	Vaccination of animals from 4 months old
Hemorrhagic septicemia	- Swelling of the throat Loss of appetite Increased respiration Salivation - Depression	- Tetracycline - Sulphur dimidine	Vaccinate 1-2 month before the start of the raining season
Foot Rot	- Lameness - increase in temperature - loss of appetite	- coper sulphate 0.5 solution - weight loss inflammation of the interdigital space	- Good sanitation - Dry standing
Diarrhea	- worms - old infection - sudden change in feed	- watery feces - high temperature	- Oral rehydrating salt Deworm with albendazole - Give oxytetracycline
Rumen impaction	feeding on husk rice	- increase respiration	- Epson salt - Castor oil Plenty of water

Diseases	Sign	Treatment / Management	Prevention
		- left flank swollen collapse if not treated animals will die	

Source: Dr. J.E.D. Terry, Livestock, MAFFS

Table : 3(b) External Parasites of Small Ruminants

Parasites	Signs/symptoms	Treatment	Prophylaxis
Mange Mites	- Itching - Loss of hair - Thickening of the epidermis - Anemia	- Acaricidal wash every 7 days - Invention injection	Clear and disinfect pens regularly o Wash animals with acaricide once a mouth
Ticks	- Skin damage - Itching - Weight loss - Inflammation or sores - Anemia	Same as above	Same as above
Flies	- Cause worries - Transmit diseases - Infected wounds		- Dispose manure properly - Disinfect surrounding of pens regularly

Source: Dr. J.E.D. Terry, Livestock, MAFFS

Table: 3(c) Internal Parasites of Small Ruminants

Parasites	Signs/symptoms	Treatment	Prophylaxis
Flat worm (Cestodes)	- Loss of appetite Anaemia - Diarrhoea - Rough coat - Emaciation	Levimisole Tetramizole	Deworm every 3 months
Nematodes	Signs are as above	Same as above	Treat as above

Source: Dr. J.E.D. Terry, Livestock, MAFFS

4.4 Pests of Public Health Importance

There are lot of pests listed in Sierra Leone of public health importance; they include: cockroaches, and crab lice (body, head), mosquitoes, flea, ticks, black flies, bed bugs, various rats, snakes, and mice various microorganisms, including bacteria, viruses, and protozoans etc.

The predominant vector borne diseases in Sierra Leone, namely Malaria, Schistosomiasis (SCH), Onchocerciasis (Oncho) and Lymphatic Filariasis (LF), account for the bulk of its disease burden. Some

vector borne diseases are endemic in the whole country, while others are localized in certain parts where they contribute to the disease burden in the local communities.

Malaria caused by mosquitos is by far the most important vector borne disease which is endemic in the whole country, including the cities. The most vulnerable groups include children under five years and pregnant women. Malaria control has so far achieved significant progress especially in the areas of prevention. In addition to the distribution of long lasting insecticides Nets , the National Malaria Control Programme also launched the Indoor Residual Spraying Programme in four pilot districts in December 2010.

Regarding the Neglected Tropical Diseases (NTDs), in 2006 the MoHS produced a national plan of action for integrated control of Oncho, SCH, STH and LF. The plan aims to eliminate LF by 2015 and to reduce morbidity due to Oncho, SCH and STHs to levels where the diseases are no longer of public health significance. The main strategy is mass drug administration (MDA) through community directed treatment (CDT) and or school-based approach. However, the strategies targeting vectors of LF, Oncho, and SCH were not incorporated in the Plan of Action. Mass Drug Administration alone is unlikely to interrupt disease transmission for some of the NTDs (e.g. SCH) or will take a very long time to do so (e.g. Oncho).

Schistosomiasis, Onchocerciasis and lymphatic Filariasis are among the major neglected tropical diseases (NTDs) that are widespread in the country. Schistosomiasis studies conducted in all 13 Health districts of the country in 2008 showed that 7 districts (Kono, Kailahun, Kenema, Bo, Koinadugu, Tonkolili and Bombali) have prevalence of Schistosoma haematobium and Schistosoma mansoni high enough to be targeted for mass drug administration (MDA) of Praziquantel to be conducted at school and community levels.

Onchocerciasis, the 4th leading cause of blindness after cataract, trachoma and glaucoma, is endemic in the 12 provincial Health districts. The Forest type of the disease is distributed in Eastern parts of the country, while the Savanna type of the disease is found in the North. A mixture of the two types is found in the Southern region. According to data the national prevalence of Oncho is around 46%. MDA is conducted for Oncho except in the Western Area (the only district where the disease is not endemic).

Lymphatic Filariasis is also highly endemic in Sierra Leone. According to a survey conducted for mapping of the disease in all districts of the country in 2005 using immuno-chromatographic test cards, the national average prevalence was 21% and all 13 health districts of Sierra Leone are endemic for LF. Oncho and LF are co-endemic in 12 out of the 13 health districts and preventive chemotherapy with Ivermectin and Albendazole are justified annually in all 13 districts of Sierra Leone including urban areas such as Freetown and district headquarter towns.

Trypanosomiasis has not been considered a disease of importance in Sierra Leone as there have been no cases reported for many years. However, the recent reported resurgence of the disease in neighbouring countries calls for systematic surveillance, particularly in border areas, to be able to control transmission through the appropriate vector control interventions, should the disease reappear.

5.0 Integrated Pest Management

Integrated Pest Management (IPM) uses environmentally sound ways to keep pests from invading and damaging crops. A successful IPM combines several methods to prevent and manage pest problems without harming human, animal, wildlife, or the environment. Integrated Pest Management is a combination of common sense and scientific principles. IPM is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides as well as minimizing risks to human health, animal and the environment. IPM is the best combination of cultural, biological and chemical measures to manage diseases, insects, weeds and other pests. It considers all relevant control tactics and methods that are locally available, evaluating their potential cost-effectiveness; makes good use of local resources and the latest research, technology, knowledge, and experience. In practice, IPM is a site-specific strategy for managing pests in the most cost-effective, environmentally sound, and socially acceptable way, and implementation principally lies with farmers, who adopt the practices they view as practical and valuable to their activities. These management methods could be applied to major crops grown in Sierra Leone (Rice, Cassava, Maize, and Vegetables) depending on when the crops are in the field and the specific target pests that affect these crops.

5.1 Integrated Pest Management Methods

IPM methods involve a systematic decision-making process that aims to prevent pests from becoming economic problems and to determine what actions to take if pest problems occur. Generally small producers use various methods and techniques in combination, including integrated pest management (IPM) to control the pest and diseases of field crops. These control methods include:

- •Traditional or cultural control methods: burning of old crop debris to control stem borer pupae and soil insects, early planting and timely weeding to control Striga weeds and other pest, hand picking and burning blister beetles adults, uprooting Striga weeds before flowering, using repellants and noise devices to scare away village weaver birds.
- •Crop rotation, fallowing, good seed and stock selection, seed treatment, recommended spacing and optimum plant population densities, application of recommended fertilizer dosage rates and manures, use of resistant varieties, early harvesting, crop sanitation, burning of old and affected plants, tethering and timely harvesting.
- •Physical and mechanical control methods: regular monitoring of pest populations, hand picking, digging of trenches and burying to control hairy caterpillars and armyworms, and use of baits for millipedes. Ploughing to expose grasshopper's egg-pods and pupae of other insect pests.
- •Use of chemical pesticides to control major pests and diseases, and weeds attacking crops.
- •Spraying and Fumigation using pesticides and Phostoxin Tablets to control storage pests.
- •Use of Neem Powder and Plastic Containers to protect seeds from infestation.
- •Using IPM methods: combining more than one control methods to control the pest and disease.
- •Research and development of alternative control methods.

Prevention: Many aspects of crop management are designed to prevent initial outbreaks of insects, diseases or weeds. Practical strategies (outlined below) can be combined and optimized for an IPM program for specific crops. The overall goal is to prevent pest populations from building up to economically damaging levels. For example, the variegated grasshopper Zonocerus variegatus attacks cassava and many other crops from the end of the rainy season October/December and throughout

the dry season April/May each year. This reoccurrence of this pest can be prevented by i) locating, dig out egg pods at egg-laying sites and destroy them; ii) clearing of bush about 2 meters around cassava fields, and iii) killing of young nymphs at hatching sites before flying into cassava fields. Pests of rice such as the CMVD can be prevented by obtaining seed from CMVD resistant or tolerant varieties.

Crop Location: Growing crops in locations where they are best suited to climate, soil and topography provides them with optimal conditions from the start. Appropriate land preparation builds on these conditions. There are specific areas within the country best suited for cassava cultivation for maximum yields. For example, cassava must not be grown in areas with high termite populations; otherwise, destructions of termite colonies is recommended prior to planting.

Variety Selection: The cornerstone of IPM lies in choosing beneficial crop varieties, such as those with disease and pest resistance characteristics. Such varieties can be derived from traditional cross-breeding or modern biotechnology practices, pest-resistant and herbicide-tolerant varieties, may reduce the need for other crop protection measures. Selection of fast cassava growing cultivars such as SLICASS 6 or SLICASS 7 can outgrow weeds, resistant to cassava mosaic virus disease (CMVD). Various NERICA varieties are available in country and most are performing very well even under farmer traditional crop management system. Short duration maize varieties are also very prominent for high yielding.

Crop Rotation: Planting similar crops alongside each other such as maize field alongside rice field can substantially increase pests, this should be avoided. Planting different crops in alternate rows or under-sow a crop like maize with a legume such as cowpea will help improve soil fertility and reduce weeds and other pests associated with the previous crop. Growing different crops in rotation also helps reduce the build-up of pests, especially those in the soil such as root-feeding insects and fungi. Crop rotation can reduce weed problems too.

Soil Management: Mechanical, physical and cultural crop protection methods prevent or minimize pests as well as reduce their build-up and carryover from one crop to another. For example, traditional ploughing turns the soil and buries crop residue and weeds before the seedbed is prepared for the next crop. However, tillage can lead to increased erosion as well as loss of soil moisture and organic material. Soil management is very important for quality production and productivity as well as reducing the cost of production.

Water Management: Supplying water to crops is essential to plant health but it can also greatly influence pest incidence and impact. Irrigation may be required, especially in dry areas or with crops that require a lot of moisture, e.g. swamp rice varieties. Irrigating lowland rice fields can control weeds but can adversely affect beneficial soil organisms and provide breeding space for mosquitoes. Drip irrigation or growing crops on ridges or raised beds may help combat these risks and conserve water. Rice gall midge Orseolia oryzivora invaded Sierra Leone from Kambia/Guinea border swamps, but recent studies have shown that the pest is all over the country specifically on swamp rice. Effective water control can reduce the incidence of gall midge infestation.

Monitoring: Management of any crop requires routine inspections to assess how well the plants are growing and what actions need to be taken from seeding to harvest. Walking through a field involves scouting for pests and distinguishing them from non-pests and beneficial insects. This is particularly very important for the new invasive transboundary pest (FAW) on maize, rice, legumes, and many vegetable crops. Pheromone traps, light traps, diagnostics and forecasting systems can assist with monitoring in a timely and accurate way. A successful IPM requires collaborative decisions to provide effective control of pests. Some of these decisions need to be taken by national governments/institutions as the case may be in relation to quarantine regulations and legislation,

provision and training of advisory services and strategies for control of highly mobile pests like the variegated grasshoppers or transboundary pests such as the fall armyworm, larger grain borer Prostephanus truncates, fruit flies Bactrocera invadens, papaya mealybug Paracoccus marginatus, mango mealybug, Rastrococcus invadens, etc.

Cultural Control: Cultural practices are things one can do to discourage pest invasion such as good sanitation, removing debris and infested plant material, proper watering and fertilizing, growing competitive plants, or using pest resistant plants. Practices such as hand weeding or disease control by removing infected plant debris, should be assessed for their impact on plant roots and yields as well as their requirements for labour. The possibility of integrating cultural techniques with the careful use of pesticides should be explored. For example, instead of replacing manual weeding entirely with herbicides, hoeing may be used in conjunction with them. On cassava, hand weeding has been very effective, and the weed used as manure. Hand picking of grasshoppers have however, not been effective in the control of the pest

Biological Control: This is a method of using other living organisms to control pests such as insects, mites, weeds and plant diseases. Biological control relies on introduction of beneficial organisms for predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role for technical expertise such as formulation preparation, field application and resistance management. The use of beneficial insects to control pests has worked well in previous introductions such as for the control of the cassava mealybug Phenacoccus manihoti in Sierra Leone by the parasitic wasp Apoanagyrus lopezi, Rastrococcus invadens by the parasitoid Anagyrus mangicola. However, biological control programmes work best when crops are grown in controlled environments like greenhouses and plastic tunnels. Bacteria, fungi, nematodes or viruses have also been mass produced and used to control some pests. The most common and successful is Bacillus thuringiensis (Bt), a naturally occurring bacterium, which has been used to control several important pests (e.g. caterpillar pests in vegetables and cotton). Reports have also confirmed that Bt is also effective in the control of FAW.

The development and availability of insect sex pheromones and other behaviour-modifying chemicals offer farmers the possibility of:

- Selective trapping techniques to monitor the movement of pests or changes in their populations during the season.
- “Lure and kill” strategies to attract the pest to insecticide deposits and reduce the need for overall crop spraying.
- Mating disruption that slows population build-up to delay or reduce the need for control treatments.

Chemical Control: Chemical crop protection products (pesticides) are biologically active chemicals that control a range of insect and vertebrate pests, diseases, and weeds. They are often the most cost-effective way of controlling infestations as part of an IPM strategy. Before crop protection products are released in the market, they are thoroughly tested for their safety, usefulness, and effectiveness. When sold, they are labelled with explicit use instructions. To get the most out of these products, they must be applied correctly. Responsible use and good handling practices limit potential pesticide residues in crops and the environment as well as help avoid pest resurgence and resistance. Improved application techniques and equipment, such as reduced drift nozzles and spot spraying, help farmers protect natural habitats for wildlife and beneficial organisms. The timing of treatment (season and time of day) as well as the types of products used are also critical factors for their efficiency and efficacy.

6.0 Pesticide management Methods and Usage

Pesticides are one of many tools available to farmers for effective protection of crops from weeds, insect infestation and diseases infection. Pesticides are named according to the type of the pest they can control, such as; insecticides used against insects; herbicides for the management of weeds; fungicides used against fungi and mould diseases; rodenticides used against rodents; molluscicides used against mollusks and snails; Nematicides for the control of nematodes, etc. Because of this and for a better understanding and management of pesticides, there is a need to have foreknowledge on their groupings based on their chemical or biological properties, their various mode of actions and effects. This could guide on what pesticide to use for specific crops and their associated pests.

6.1 Pesticide Use in Sierra Leone

Crops, are attacked by wide variety of pests and diseases which causes economic damage and crop losses. Despite the availability of other pest control methods, producers would opt for chemical pesticides to control pests rapidly and effectively if available and affordable. The types of pesticides used in crop productions are variable and are mostly purchased from the local dealer's station at Weekly Markets (Lumos) or other street market without proper labels, and are used without proper protective gears, thereby poisoning themselves, non-targets species and the environment. Phytotoxicity was observed during this study in field visited, which suggests that heavy dosage rates of pesticides have been used. For the control of migratory pests, pesticides are mainly used to control endemic and migratory species as the main effective control method. The incautious and heavy dependence of pesticides as the most reliable option undermines national economic growth through producers' non-compliance with trade barriers on pesticides residue on export crops, as well as our domestic markets for local production.

6.1.2 Pesticides Used in Agriculture

Chemical Pesticides are generally prepared from synthetic materials that directly kill or inactive target pests. Some examples of chemically-related pesticide groups include the following, some of which have been added to WHO list of "Extremely hazardous" and "Highly hazardous" class of pesticides (Appendix I).

Organophosphates (OP): Most of these pesticides are insecticides and their effects on insects are similar to their effects on humans, livestock and some are very poisonous and highly toxic. However, they are usually not persistent in the environment. Some examples are Fenthion, Dichlorvos, Malathion, Parathion, Diazinon, Dichlorofenthion, Chlorpyrifos, Chlorpyriphos-Methyl, Dicrotophos, Fenitrothion, Methamidophos, Mevinphos, Monocrotophos, Phorate, Pirimiphos-Methyl, Profenofos, Terbufos, Tetrachlorvinphos, etc.

Carbamates: These insecticides are made from carbamic acid and used to kill or control insects. There are many forms of Carbamates, each different in the way they work and in their poisonous effects. Carbamates break down in the environment within weeks or months. They are used as sprays or baits to kill insects by affecting their brains and nervous systems. They are used on crops to kill ants, crickets, aphids, scale insects, and lace bugs. Some Carbamates have been found in groundwater at levels high enough to cause concern. Examples include Aldicarb (Temik), Carbofuran (Furadan), Carbaryl (Sevin), Ethienocarb, Fenobucarb, Oxamyl, and Methomyl; most of these have been classified in WHO class 1a and 1b group of pesticides.

Chlorinated Hydrocarbons- These are group of chemicals composed of carbon, chlorine and hydrogen. As pesticides, they are also referred to other names, including chlorinated organics,

chlorinated insecticides and chlorinated synthetics. Most of the chlorinated hydrocarbons, e.g. DDT, Aldrin, Dieldrin, Heptachlor, Lindane, Mirex, Endrin, Methoxychlor, Chlordecone, Chlorobenzilate, and Chlordane have been banned for use in most countries, although DDT is still in use in some developing countries for combating insect vectors of human diseases. Their persistence is attributed to their long life in the soil. Pyrethroids are synthetic version of the naturally occurring pesticide pyrethrin, modified to increase their stability in the environment. Some synthetic pyrethroids are toxic to the nervous system. Examples are Cypermethrin, Cyfluthrin, Deltamethrin, Permethrin, Phenothrin, Tetramethrin, Tralomethrin, etc.

Biopesticides are certain types of pesticides derived from natural materials such as animals, plants, bacteria, fungi and certain minerals. For example, canola oil and baking soda have pesticidal actions and are considered biopesticides. Biopesticides fall into three major groups:

Microbial biopesticides: These consist of microorganisms (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest. An example is the IITA developed fungus based biopesticide Metarhizium annisopliae commonly called Green Muscle, an ecologically sustainable option for the control of the variegated grasshopper Zonocerus variegatus throughout in West Africa. The product is prepared for field application as follow: 25grams GM in 300ml vegetable oil and 700ml kerosene to spray one hectare.

Biochemical pesticides -These are naturally occurring substances that control pests by non-toxic mechanisms. Biochemical pesticides include substances, such as insect sex pheromones that interfere with mating as well as various scented plant extracts that attract insect pests to traps (e.g. Methyl Eugenol for catching male Fruit flies Bactrocera invadens).

Botanicals -Neem Azadirachta indica pesticides play a vital role in pest management and hence have been widely used in agriculture. The tree has anti-bacterial; anti-parasitic, anti-fungal, anti-inflammatory and analgesic properties. Neem is recognized today as a natural product which has much to offer in solving global agricultural, environmental and public health problems. It is considered as a valuable instrument for sustainable development.

Neem pesticides are being manufactured and exported to various countries as a lot of research has been conducted to test the safety and efficacy of neem for use as a pesticide. Using Neem is very beneficial for proper crop and pest management. It also helps to nourish and condition the soil, environmental friendly, nontoxic and it can be used in combination with other pesticide and oil for more effectiveness. Neem pesticides are generally water soluble and help in the growth of the plants. It acts as pest repellent and pest reproduction controller. Anti-feedant properties found in neem compounds helps to protect the plants. Pests generally do not develop a resistance to neem-based pesticides. Neem oil and seed extracts are known to possess germicidal and anti-bacterial properties which are useful to protect the plants from different kinds of pests. One of the most important advantages of neem based pesticides and neem insecticides are that they do not leave any residue on the plants. The active ingredient Azadirachtin found in neem tree, acts as an insect repellent and insect feeding inhibitor, thereby protecting the plants. Neem insecticides are used to protect both food as well as cash crops like rice, legumes, cotton, other oils seeds, etc.
Azadirachta indica is native to the arid regions of the Indian sub-continent. Farmers are aware of the benefits of neem and the adverse effects of chemical pesticides. Farmers are keen to adopt neem based-pesticides in their plant protection schedules.

The main beneficiaries would be:

a. The resource poor farmers, small scale village level agribusiness enterprises and micro-industries. Farmers would get access to less expensive and abundantly available pesticides improving their self-reliance, and small-scale village entrepreneurs could avail of the opportunity to use the simple technology to set up micro industries manufacturing the pesticides
b. Women and the unemployed rural youth would be particularly benefited as they would be involved in the agri-business of seed collection and processing of neem kernel for the manufacture of the neem-based pesticides, and this would generate employment for them.
c. Technical institutions such as Agricultural Universities e.g. Njala University would benefit from the technology transfer and institutional linkages as well as capacity enhancement through participating in the bio-efficacy studies.
d. Through reduction in use of polluting chemical fertilizers, health hazards from handling chemicals, and soil, water and food contamination would reduce.
e. Benefit to the environment through reduction in the persistent organic pollutants (POPs).

6.2 Impacts of the Use of Chemical Pesticides

6.2.1 Consequences in the improper use of pesticides: Pesticides if used judiciously can provide immense benefit in agriculture as well as in the public health sector. They are used to control insect pests, disease causing pathogens, weeds, etc. to increase yields and improve crop quality. However, when pesticides are not regulated, these could have serious health implications to humans, wildlife, and the environment. There is now overwhelming evidence that some of these pesticides do pose a potential risk, and no segment of the population is completely protected against exposure to pesticides and the potentially serious health effects. High risk groups exposed to pesticides include production workers, formulators, spraying operators, mixers, loaders, and agricultural farm workers.

- health hazard to applicators,
- destruction of natural enemies of pests,
- development of resistant species of pests,
- pest resurgence,
- toxic chemical residues in food,
- soil and water bodies, and environmental pollution

6.2.2 Negative impacts of uncontrolled use of pesticides

When a pesticide applicator system/body is exposed to a pesticide, the manifestation of the pesticide toxicity occurs. Toxic products produce effects on the body from the moment they are absorbed, mainly on the skin, the digestive system and on the lungs; toxic products effect on the body are caused by concentration in targeted organs. Foreseeable risks are related to the following steps: product storage; handling; transportation; dosage during treatments particularly contamination of field agents (applicators) who could be exposed to pesticide effects if instructions related to product utilization standards are not sufficiently applied; use of grazing areas right after treatment, if the populations are not sufficiently informed and associated to preventive control. Major risks in the areas where traditional pesticides should be used are the following:

Environment	Nature of impact
Soil	- Modification of the microbial flora - Pesticide residue content in soil cause pollution
Surface water	Pollutions : Altered pH
Well water	Pollutions : Altered pH

Water-tables	Pollutions : Altered pH
Air	Air pollution
Biodiversity	- Pest chemo-resistance - Fauna poisoning - Poisoning and mortality - Manpower reduction and/or biomass - Extinction/Proliferation of species or group of species - Breakdown of the food chain - Loss of biodiversity

Human Health	- Intoxication : Alteration :
	  - of the embryonic development
	  - of population growth oof reproduction
	- Poisoning
	- Death
	- Drop in cholinesterase level

The intrinsic dangers for each pesticide can be based on five toxicity measures representing various risk factors:

- Acute oral toxicity for the rat; general poisoning risk for human;
- Acute skin toxicity for the rat: occupational hazard for pesticide operators (professional applicators, farmers, formulating plants workers);
- Acute toxicity for fish: risk for fish and fishing;
- Oral toxicity for the bird; risk for birds;
- Acute toxicity through contact for the bee: risk for bees, pollination of crops and honey production.

5.2.1. The population at risks occurs during:

- Pesticides application (for land applicators, pilots, drivers and machine manipulators);
- Transportation (contamination of containers, tank bursting or spillage)
- Monitoring during treatment activities or prospection. Risks affect:
- **Field agents:** These are people (researchers, supervisors) involved in treatment activities and who are more exposed but, it is important to point out that all other agents can be in danger.
- **Populations:** During treatment activities after treatment, empty pesticide containers. 5.3.2. Adverse effects on the environment. The use of pesticides entails a certain number of disadvantages and adverse effects among which are environmental pollution and risks of intoxication often justifying the need of abandoning the method and resorting to other natural protection measures.
- Pesticides pollute water and air, destroy the fauna and dangerously modify the function of the ecosystem. Adverse effects exist on the soil, in the air and on waters in terms of:
  i. mortality on non-targeted species fulfilling important ecological functions: bees and other pollination agents, natural enemies of certain pests (parasites, predators, pathogens);
  ii. pollution during space treatment of parks and natural reserves, fishing and livestock production zones with the contamination of fauna and flora;
  iii. water pollution either directly or through surface water:
  iv. resistance among insect populations.

Pesticides-related accidents- large quantities of obsolete pesticides stocks constitute major risks to human and animal health, and the environment. Storage conditions of this toxic and hazardous waste are most often precarious.

6.2.2. Summary of impacts and risks of pesticides management methods

The impacts and risks associated with pesticide management methods are elaborated in the Table below:

Steps	Influencing factor	Risk		
		PUBLIC HEALTH	**ENVIRONMENT**	**PERSONNEL**
Transportation	Inadequacy of transport and emergency preparedness planning	Pollution of food and other products that has been exposed to pesticide contamination	Accidental discharge, water-table pollution through leaching	Product inhalation : vapour, dust, risk of skin contact Skin and eye contact
Storage	Lack of means Deficit in pesticide management training Inadequacy of facilities	Accidental contamination Inconvenience of populations living in the vicinity	Soil contamination	Skin contact through accidental spillage caused by the narrowness of the premises Skin and eye contact
Handling Manipulation	Deficit in training and sensitization	Contamination of water sources through washing of containers Accidental leaks	Soil contamination through accidental spillage or intentional discharge, water-table pollution	Vapour Inhalation, skin contact through splashing during preparation or product transfer Skin and eye contact
Packaging disposal	Deficit in training, education and sensitization Non availability of disposal facilities	Product ingestion by re-using containers		Skin contact and respiratory tract Skin and eye contact
Washing of containers	Deficit in training, education and sensitization	Skin contact, contamination of wells	Acute intoxication of fish and other crustacean, pollution of wells, ponds, water-tables	Skin contact Skin and eye contact

a) Impact through food commodities

Uncontrolled pesticide use could have severe adverse effects on food commodities for local consumption as well as regional or international trade. In the European Union, a Monitoring of Pesticide Residues in Products of Plant Origin in the European Union' had been established since the 1990s.

b) Impact on the environment

Pesticides can contaminate soil, water and other vegetation. In addition to killing insects or weeds, pesticides can be toxic to a host of other organisms including birds, fish, beneficial insects, and non-target plants. Insecticides are generally the most acutely toxic class of pesticides, although herbicides can also pose risks to non-target organisms.

c) Surface water contamination

Pesticides can reach surface water through runoff from treated plants and soil. Contamination of water by pesticides is widespread. Cleaning of spray equipment in water sources can contaminate water for other users of the water source downstream.

d) Ground water contamination

Groundwater pollution due to pesticides is a worldwide problem. According to the USGS, at least 143 different pesticides and 21 transformation products have been found in ground water, including pesticides from every major chemical class.

e) Effect on soil fertility (beneficial soil microorganisms)

Heavy treatment of soil with pesticides can cause populations of beneficial soil microorganisms to decline; e.g. the soil will degrade if both bacteria and fungi are lost. Overuse of chemical fertilizers and pesticides have effects on the soil organisms that are similar to human overuse of antibiotics.

f) Contamination of air, soil, and non-target vegetation

Pesticide sprays can directly hit non-target vegetation or can drift or volatilize from the treated area and contaminate air, soil, and non-target plants. Some pesticide drift occurs during every application, even from backpack spray equipment. Drift can account for a loss of 2 to 25% of the chemical being applied, which can spread over a distance of a few yards to several hundred miles. As much as 80–90% of an applied pesticide can be volatilised within a few days of application

g) Non-target organisms

Pesticides are found as common contaminants in soil, air, water and on non-target organisms in our urban landscapes. Once there, they can harm plants and animals ranging from beneficial soil microorganisms and insects, non-target plants, fish, birds, and other wildlife. Chlorpyrifos is highly toxic to fish, and has caused fish, kills in waterways near treated fields or buildings. Herbicides can also be toxic to fish.

Application time beneficial organisms are normally always in crop fields but unnoticed. Conserving natural enemies of pests is an important part of IPM and helps to prevent pest resurgence. The effect of a pesticide product or other interventions on both pests and their natural enemies needs to be considered. Timing pesticide application to match periods when natural beneficial organisms are not active, for example, may help protect them. Populations of beneficial species can recover quite quickly, even when broad-spectrum pesticides are used and particularly if they are easily degradable.

6.3 Assessment of Knowledge and Practices in Pesticide Management

Generally, the use of pesticides in Sierra Leone is very low with less than 1% of farmers applying pesticides for pest and disease control. Notwithstanding the rather insignificant use of pesticides to control pests and diseases, pesticide contamination of food and water bodies is a problem in Sierra Leone. There are reported cases of pesticide-related accidents in Sierra Leone including the following:

- Death of humans and wildlife
- Death of aquatic live especially fish
- General illness
- Skin and eye irritations.

The circumstance of pesticide use and the competence required to handle pesticides are largely due to lack of awareness on pesticides risks and hazards caused to human health and the environment, complacency, misuse and abuses, lack of knowledge on pests and disease management, lack of knowledge on product dosage rates, training on the spraying methods and techniques, proper use of application equipment and calibration techniques, use of protective gears, knowledge on risks associated with pesticide use and safe precautions, protection of non-target species and the impact of pesticides to human health and the environment. During control of migratory pests- (grasshoppers and desert locust) using pesticides, training courses are conducted for spraying teams and topics covered include: safety in the transportation, handling and spraying application methods and techniques of pesticides, storage, distribution disposal, cleaning of application equipment and empty containers.

6.3.1 Selecting the Right Pesticides

In developing an IPM program with pesticides, it is essential to review product characteristics, applications and costs, then select the ones that provide the most cost-effective treatment with minimal undesirable effects. Note that some products have a broad spectrum of activity, while others only target a few types of pest species. Selective pesticide substances are less likely to affect natural enemies and other non-target organisms. When these are available, it is important to determine if a limited number of applications are more cost-effective than a cheaper one, or broad spectrum product that requires more applications. Seed treatments, which protect seedlings from early pests, are also beneficial and may prevent the need for pesticide applications later on. Most pesticides have a broad spectrum of activity, and it is important to distinguish between their intrinsic toxicity and bioavailability. Every pesticide should be used according to manufacturer recommendations. Guidelines on the appropriate storage, transport and disposal of unused pesticides and empty containers should also be strictly followed.

6.3.2 The use of Public Health Pesticides

While the use of insecticides, for instance as aerosols, is widely practised in Sierra Leone, so far there is no documentation of the extent of their use by individuals at household level nor is there any official information of their use at commercial levels. There is a need for government of Sierra Leone to institute measures to determine the availability and use of public health insecticides and regulate their importation into the country in line with the relevant regulatory system. The current PMP implemented by CPS/MAFFS is based on recommendations outlined in the draft Plant Protection, and the National Integrated Pesticide Management policies and the introduction of Plant Health Clinics at FBOs and the ABCs. The policies recommend that all agricultural pesticide imports must be approved by CPS/MAFFS. This is to ensure that importers abide by the recommended pesticides for use in Sierra Leone and that such pesticides are NOT on World Health Organisation (WHO) danger list. In collaboration with CABIplantwise, CPS prepared two pesticide usage guides (Appendix II). These in

conjunction with the plant health clinics have been effective and helpful somehow in pest and pesticides management in the following ways:

i) Pesticides dealers have most of the time collaborated with CPS for any pesticide import;
ii) Samples of new pesticides are provided by importers for field trial and evaluation;
iii) Importers have regularly attended pesticides management meetings and workshops to assure compliance;
iv) Farmers associated with the ABCs have ceased from buying pesticides from street vendors;
v) The frequency of pesticide use by farmers has reduced drastically;
vi) Accidental pesticide poisoning has reduced;
vii) The use of bio-pesticide has widely been accepted and farmers are now requesting for Green Muscle (a bio-pesticide) for grasshopper control in cassava fields; Methyl Eugenol traps for fruit fly control;
viii) Farmers now report pests' incidences as are observed for the first time.

6.3.3 Pesticide Use Pattern

The current pesticide use pattern indicates that pesticides are not used in the context of IPM. There is need for change in behavior and attitudes towards producers' dependence on pesticides as the first line of action. The use of bio pesticides and local plants with bio pesticidal properties is currently being promoted by MAF. The process of change is gradual and needs time to achieve it with success.

6.3.4 Types of Pesticides Recommended by the Ministry of Agriculture and Forestry

The types of pesticides recommended by the Ministry of Agriculture Forestry and Food Security for use in Sierra Leone are summarized below :

	ACTIVE INGREDIENT	SUBGROUP
INSECTICIDES	Imidacloprid	Neonicitinoid
	Alpha-Cypermethrin (Alphamethrin)	Pyrethroid
	Cypermethrin	Pyrethroid
	Deltamethrin	Pyrethroid
	Chlorpyrifos	Organophosphate
	Diazinon	Organophosphate
FUNGICIDES		
	Captan	Phthalimide
	Mancozeb	Dithiocarbamate
	Propineb	Dithiocarbamate
	Difenoconazole	Triazole
	Tebuconazole	Triazole
	Cupric oxide (Copper II Oxide)	Triazole
HERBICIDES		
	Ethofumesate	Benzofuran
	Glyphosate	Phosphonoglycine
	Metamitron	Triazinone
FUMIGANT		
	Zinc Phosphide	
	Aluminium phosphide	

6.3.4.5 Guidelines for Pesticides Management (Testing and validation Research and Dissemination and adoption Phases)

Management practices	Recommended action
Procurement/ purchase	Complying with registration process of NEA and the CSP in force. The WHO and FAO guidelines for pesticides and vector control should be adhered to. The Procurement Guidelines of the World Bank and The Sierra Leone Procurement Authority should be adhered to.
Testing the Quality of the Product	Testing the Product Quality is essential for the quality and efficacy of the treatments to be conducted.
Storage and Transportation	Appropriate precautionary measures should be taken and protective gears worn for protection. Compliance to the National Legislation is a must. Pesticides should be stored properly under lock and key, the store must be well ventilated and located away from residences. The store must have fire extinguisher and detergents.
Use	The operator must follow the instructions written on the label. Protective gears must be worn and follow recommended guidelines
Disposal	All the empty containers of pesticides must be gathered and stored at NARI waiting for suitable recommendation from NEA for proper disposal
Monitoring Applicators Pesticide Exposure Levels	Monitoring of exposure levels of pesticide applicators is recommended before the season, and regularly during the season, to determine the levels of exposure to applicators to ensure their health and safety.
Training of all actors involved in the implementation of the research programs	Training of all Actors and Collaborators in Pesticide Management

7.0 ASSESSMENT OF THE IMPLEMENTATION OF EXISTING PMP

There exists a Pest Management Plan (PMP) prepared by MAF. The Crop Protection Unit is the national institution mandated to implement the plant crop protection services in Sierra Leone alongside the extension agents.

7.1 Action plan for Pest and pesticide management

The PMP is designed to build on, and to some extent to strengthen existing national capacities for the promotion of PMP and IVM and ensure compliance with the World Bank Safeguard Policies and Environmental and Social Standards and applicable Environment Health and Safety Guidelines on Pest Management.

This Pest Management Action Plan (PMP) addresses some of the priority areas necessary for effective implementation of the IPM within FSRP2 project in collaboration with existing planned activities of CPU/MAF, Njala University, SLARI and government policies and regulations as identified for effective functioning and sustainability of this PMP. This PMP should be streamlined into the major components of the FSRP2 project in line with the requirements for compliance with the World Bank's safeguard Policies. The PMP also proposes collaboration with other similar agricultural projects or NGOs in agriculture to assist CPU/MAF in the development of an IPM policy to encourage pesticide dealers and importers to comply with international conventions, agreements and guidelines on pesticide trade and distribution.

7.2. Priority issues identified at the country level

Major issues	Actions required	Responsible institutions
Weak response to pest disease insurgence in crops, poultry and small ruminants	Strengthening National Capacity in Promoting the adoption of IPM practices	MAF, NU, SLARI
Limited capacity among producers in pesticide management	Training cassava, rice , poultry and small ruminants producers in pesticides management	Njala University
Weak pest and disease monitoring and surveillance system	Integrated pest Management: surveillance of disease, pests, Vector populations in the country	WAVE, MAF, DSTI, NU SLARI
Limited data on and research on IPM technologies involving farmers	Participatory Research and Development of IPM	NU, SLARI, NaFFSL
Lack of documented regulatory system on pest and pesticide management	Support CPS to enact into Law the draft Plant Protection Policy for the establishment of a Plant Protection and Regulatory Services Division and its enforcement mechanism to ensure the operationalization of the national	MAF

	pest and pesticide management board/committee	
Increased use and reliance on chemical pesticides	• Promote IPM through farmer's education and training. • Monitor use of pesticide among farmers • Monitor adoption of IPM practices. Ensure strict adherence to existing policy on use of new chemical pesticide in project environment. • Create public awareness on banned and approved chemical pesticide and safe use methods. • Monitoring of pesticide poisoning in the farming and beneficiary communities. • Investigate remedial effect of pesticide misuse on agricultural products	MAF, Njala University SLARI, EPA
Introduction of new pest	Monitor crops/livestock for alien or transboundary invasive species.	MAF, WAVE
More focus on IPM and other non-chemical practices	• Develop IPM training modules. Organize training of trainers and beneficiaries on IPM. • Produce and disseminate IPM information materials (posters, factsheets, etc.). • Support participatory research in non-chemical pest control measures. • Strengthen extension support to IPM practices. • Undertake periodic monitoring of pest management practice in use during project implementation. • Support necessary pest management practices. Increase IPM awareness for communities & policy makers.	MAF, NU
Increase in vector population and vector borne diseases	• Raise awareness on vector population and vector borne diseases • Support health campaigns in the project areas in collaboration with MoHS • Conduct regular vector surveillance surveys • Establish linkage between FSRP2 and national health programmes	MAF, WAVE ,NU, SLARI

7.3. Strategy for Intervention and Pesticide Management Action Plan

Successful implementation of this PMP lies with the responsible of MAF. In the light of this, FSRP2 should support and encourage MAF administration to forge ahead with enactment processes of the draft Plant Protection Policy for the establishment of the PPRSD, and the National Integrated Pesticide Management policy for setting up of a National Pesticide Management Committee. This will foster initial pesticide registration and licensing scheme, take inventory of all available pesticides in country and sustainability of the scheme at the end of project life. Information dissemination to the farming communities, the public and pesticide dealers about the dangers of pesticides will be enhanced, hence provisions are made in the legislation for effective monitoring with enforcement mechanism. The PMP implementation programme must be located at CPU/MAF level with field action by farmer groups who will receive training and advisory services from CPU, and community facilitators who would have graduated from the Training of Trainers (ToT) sessions. Training at all levels will be based on participatory learning modules for capacity building in IPM information delivery. Specialized IPM needs, such as the development of crop associated pests list, and beneficial species list, should be addressed by relevant research institutes such as SLARI and Njala University with proven expertise in the respective problem areas. The PMP implementation process will promote environmentally sustainable pest management options and assesses the economic, environmental, and social impact of each the interventions.

The appropriate measures to mitigate these risks are through implementation of the following: The priority activities and intervention should generally include the following:

- Workshop for sharing and dissemination of the PMP with national actors and stakeholders,
- Harmonize Pesticide Legislation with current regional legislations
- Build capacity of actors and stakeholders in pesticides management, including possible FAO Farmers Field Schools
- Provide essential support to Analysis Laboratories (WAVE Molecular plant diagnostic laboratory and other satellite) to enhance the implementation of FSRP2 activities
- Provide essential support to the National disease Control Programs
- Support monitoring of pest and diseases of agricultural and public health importance,
- Support to the one health platform and national task to enhance the timely implementation of their activities
- Procurement of pesticides and inputs for NU, SLARI, to implement research and to MAF for out scaling and extension activities
- Develop and establish a Pesticides Management Database
- Curriculum on pest and pesticide management (Njala University)
- Develop Integrated Pest Management (IPM) Database in Extension Information System for Producers and Extension Agents
- Support for Sensitization Awareness Campaign on pesticides management and its related aspects,
- Strengthening Njala University, SLARI and crop protection unit with vehicles to implement activities under FSRP2
- Procurement of Personal Protective Equipment and Cholinesterase Test Kits
- Strengthening of Institutional Human Resource capacity in Pest and Pesticide Management

7.4. Limitations of implementing the pest management plan

Recent assessment of the crop protection institutions including MAF, NU and SLARI identified several deficiencies and identifiable causes at several levels

i. lack or even absence of sharing and dissemination of PMP

ii. lack of synergies with other programmes or current or future pesticide management activities in the countries
iii. absence of clear specific expectations or responsibilities of each category of actors
iv. absence of differentiation between the research phase and the extension phase. Thus, to reverse these negative trends, this PPMP will be registered in a logical rupture in moving towards the following areas of intervention (at the strategic and technical level).

7.4.1 P

Technical guidelines of the PMP

Since farmers are exposed to pesticides primarily due to the fall army worm and vegetable production especially in the northern province of Koinadugu district which is recording cheaper cost in pesticides, it is concluded that increase pesticide use is apparent, especially at the large scale. In this context, the technical guidelines to be considered are elaborated below:

Institutional Measures

- Establish a National Multi-Sectoral Coordination, Steering and Monitoring Committee involving relevant institutions and stakeholders, (e.g. The Hazardous Chemicals and Pesticides Management Board).
- Conduct a National Workshop to share the Pest and Pesticide Management Plan (PMP) Conduct national planning workshop for development of Annual Work Plan and Budget Conduct mid-term and external evaluations.
- Strengthened National Laboratories (WAVE, quality control , animal science laboratory ETC with essential needs to perform services for the FSRP2
- Support for mobility for NU, SLARI and CPU to enhance the implementation program Activities.

Legislative and Regulatory Measures

- Support the harmonization of national Legislation with the Regional level
- Established and harmonize Pesticide Management Database
- Support research and development of biological control, alternative control methods and demonstrations on the use of biopesticides.
- Training on Pesticide Management for actors and stakeholders involved in the implementation of participatory research and extension phase programs
- Conduct test to determine exposure levels of pesticide applicators
- Conduct sensitization and awareness campaigns on pesticide use and management in all the research intervention areas.
- Support for pest and disease monitoring and control for crop and storage pests.
- Strengthened Institutional Human Resource Capacity in Pest and Pesticide Management
- Support for surveillance of vector borne diseases and control and long lasting insecticide treated bed nets.
- Capacity building of farmers and extension agents on IPM and IVM using the FFS approach.

7.5. Monitoring and Evaluation Plan

Effective monitoring of pesticide in Sierra Leone must be a concerted effort involving many players, from policy makers, law enforcement government functionaries, dealers, MAFFS, and the farming community. This arrangement has already been spelt out in both the draft Plant Protection policy and the National Integrated Pesticides Management policy documents; all relating to pesticide registration The Monitoring Plan is subject to FSRP2 planned activities. Monitoring is supported by data collection

and analysis to check whether the implementation of activities is being carried out as expected and to move to immediate adaptation, if necessary. This involves a short-term evaluation activity to help take a real-time action. The frequency of the monitoring will depend on the type of information available, however monitoring will continue throughout the implementation of the action plan. Community monitoring: will be during the testing and validation phase. During the discrimination and adoption Phase it will be conducted by conducted by MAF, SLARI , NU , One health, Health Services (Malaria and Vector Control).

Activities to be monitored Activities that require regular monitoring and evaluation during project supervision missions include the following:

- IPM capacity building in membership of producers
- Numbers of women farmers who have successfully received IPM training in IPM methods; evaluate the training content, methodology and trainee response to training through feedback
- Number of Pest and pesticide related policy enacted
- Number of functional laboratories dedicated to pest and pesticides analysis
- Numbers of women farmers that attended the IPM training; assess farmers understanding of the importance of IPM for sustainable crop production
- Numbers of women farmers who have adopted IPM practices as a crop protection strategy in their crop production efforts; evaluate the rate of IPM adoption
- The number of many crop production systems IPM was successfully applied

Economic benefits

- Increase in crop production due to adoption of IPM practices
- Increase in farm revenue resulting from adoption of IPM practices, compared with farmer conventional practices

Social benefits

- Improvement in the health status of farmers

Knowledge benefits

- Improvement in the level of knowhow of before and after.
- Numbers of IPM Networks established and types of activities undertaken.
- Extent to which pesticides are used for crop production?
- Efficiency of pesticide use and handling.
- Level of reduction of pesticide purchase and use by the POs for crop production.
- Number of IPM participatory research projects that have been completed.
- Influence of the results of IPM participatory research on implementation of IPM and crop production.

7.6 Training plan of actors involved in pest and pesticide management

To ensure the effective integration of environmental concerns into the implementation of FSRP2 , it has been suggested to implement a capacitation program (training and awareness raising) for all actors, which will focus on the following main issues: make the pest management strategy operational; promote the emergence of an expertise and pest management professionals; raise the responsibility level of employees in pesticide management; protect the health of and ensure the safety of populations and health workers. The training will be targeted and adapted to beneficiary groups; Research Scientists, Plant Protection Officers, Agricultural Production Officers, Health workers, Farmer Organisations and other NGOs active in pest and vector control. Generally, the best trainers are found

among the staffs of ministries responsible for health, environment and agriculture. The training will mainly focus on pesticide management workers, health and environmental workers to enable them to acquire the necessary knowledge about the content and prevention methods, to evaluate their working environment and improve it by reducing risk factors, to adopt precautionary measures that might reduce intoxication risks, to promote the use of protective equipment and to correctly apply the procedures to be followed in case of accident or intoxication. The training will also focus on village-level facilitators and other local people active in pest and vector control. The training modules will concern the risks associated with pesticide handling, sound management methods (collection, disposal, storage, transportation, and treatment), adequate behaviours and good environmental practices, facilities and equipment maintenance, protective measures, and measures to be adopted in case of intoxication, etc. A special emphasis will be laid on the requirements for a secure storage to avoid a mix up with other products of common domestic use as well as on the reuse of empty packages. It is recommended to train trainers by leading them to come out with a guidebook on good pesticide management practices rather than giving them a passive training

The main goals of the training are to maximize product benefits and minimize their risks. Such training covers all aspects of handling and storing pesticides, as well as when to use and when not to use them. Training includes:

- Identification of harmful and beneficial pests
- risk assessment of pest populations and potential crop damage
- Management of pests in accordance with best pest management principles
- Safe and effective application of crop products
- risks management to people and the environment
- Monitoring of Product residues on crops and pest resistance

The contents of the training modules are indicated below:

7.6.1 Training modules

- Information on risks as well as health and safety advice
- Rules governing the storage and the conservation of pesticides by farmers
- Basic knowledge about risk handling and management procedures
- Carrying of protective and safety equipment
- Risks associated with pesticide transportation
- Handling, loading and offloading procedures
- disease pest and disease identification and diagnostics
- Mixing and preparing pesticides
- Proper disposal of empty containers and chemical waste
- Good spraying practices
- Record keeping
- Pesticides and pesticide safety
- Reporting

7.6.2 Farmers' Group Training

Farmer training will focus on group learning for informed decision making on IPM issues. Group learning will be experiential through farmer-led field trials and discussions on practical aspects of crop production, plant protection and indigenous knowledge. Farmer group learning will be facilitated by a pair of Master Trainers (both men and women extension agents). Several training visits must be organized. Group decision making will be achieved through Agro-ecological system by comparing IPM practices with normal farmer practices. At each Agro-ecological system, the Extension staff and farmers will observe, record and monitor changes in soil, crop/livestock and trophic relationships affecting crop/livestock growth. Group learning helps to increase scientific literacy, ownership of

biological and ecological information and knowledge, and informed decisions making habits in the communities.

7.6.3 Short courses on pest and pesticide management

The crop protection department will develop curriculum for the award of diploma, and higher degree on pest and pesticide management as well as other certificate course in related areas such as listed above

7.7 Information and awareness raising among users and the public

Awareness raising is a key factor in the safeguard of the population against harmful effects of pesticides. Sensitization campaigns in the form of workshops, training, radio programmes and press releases and field visits are on-going activities as part of the task of the enforcement personnel. Generally, there is not much awareness in the risk in the use of pesticides despite farmers tend to use pesticides to control their pests. In disseminating pesticide information particularly to the farming community, MAFFS through its international partner CABI Plantwise in pests' management, the establishment of plant health clinics have been very useful. Awareness raising has been affected at the ABCs and PHCs by plant doctors and extension staff at block level as well as at agricultural trade fairs.

For effective information dissemination, the project must support the development and production of the following media packages to reach a wider audience:

- Develop, produce, and distribute pest factsheets for each WAATP target crops; o Develop, produce and distribute pesticide management factsheets (Insecticide, Herbicide, Botanicals),
- Develop posters on Safe Pesticide Application Techniques
- Develop Extension messages for Radio discussion on pest and pesticide management at community levels
- Develop Radio and TV discussion messages for phytosanitary procedures for pesticide import

The project should enhance the Crop Protection Unit with mobility and resources, to facilitate the implementation of mitigation measure outlined above to minimize the risks associated with pesticides. The most impending dangers in farming come from uncontrolled use of pesticides usually meant for plant protection. Hence, there is the need for creating awareness on good use of pesticides and chemical fertilizers. Also, the awareness must target in the first place the users of chemical fertilizers, notably farmers and traders who speculate about the risks involved in using some chemical preservatives dangerous to health. The awareness should seek to disseminate modern conservation methods, traditional granary systems that are very effective as well as biological and natural pest control methods. At the level of importers and traders, it is essential to introduce a requirement that the products must be sold with detailed and simple handbooks providing information on the best use and the risks.

In the same way, users must be cautioned about the quality of the products and the methods used for their conditioning. At public level, the media should regularly organise extension programmes. The risk of intoxication by chemical products poses a serious problem for public health. There is the need to distinguish on the one hand: (i) health problems caused by food, i.e. by the consumption of foodstuffs (especially vegetables and cereals) polluted by dangerous chemical products; (ii) health problems associated with the consumption of spoilt food (according to the expiry date) that have undergone chemical decomposition or contain chemical sweeteners; (iii) health problems associated with the use of expired phytosanitary products whose chemical constituents are corrupt or disintegrated due to failure to observe conservation rules or the non-observance of the normal duration; (iv) health problems associated with overdosing.

Overall, very little progress has been made in terms of information and public awareness on environmental and health risks in the countries. Specific actions by public services and the willingness to put in place regulations through legal texts remain marginal. It is essential to

develop long-term strategies and effective approaches to inform and sensitise all stakeholders (street traders, wholesalers, agricultural users, rural populations, etc.). Information and awareness programmes, especially for the public in general, and decisions makers in particular, are essential for reducing the health risks of the intoxication by pesticides, and in the end, for true behavioural change. These programmes will be multifaceted and will rely on support from several sources. Public media can play an important role in creating awareness among the general public and users.

7.8 Coordination and monitoring of the PMP

The CPU/MAF have been buying and supplying pesticides at district level for farmers use. Large quantities of those unused pesticides are still in MAF stores. The status of those pesticides needs to be known and to be used as benchmark for future monitoring of this current plan. Coordination and support are wholly FSRP2 responsibility in collaboration with CPU/MAF and other relevant stakeholders to see that the following are implemented. Activities for Coordination:

a) Conduct a baseline survey to assess what pesticides are in the field
b) Needs assessment to be carried out across the project area to affect a standardized training for the implementation of the PMP
c) Coordinate research and outreach activities
d) Identify farmers' training needs areas in pest and pesticide management; Consult with CPU/MAF and SLARI to Identify and select suitable local training resource persons within their institutions and outside as well
e) Develop training modules for various levels for farmer groups and frontline extension staff
f) Identify and organize farmers groups for training
g) Training implementation needs to be planned in consultation with farmer groups so that participants could be identified in advance
h) Technical support needed in the preparation and delivering of specific training materials as well as evaluating resource materials;
i) Involve local expert in the preparation and supervising training implementation
j) Monitor performance of farmer trainers and post-training assignments
k) Support local expert for the preparation of training progress reports

The implementation activities will be under the overall guidance of the PCU/MAF. The responsibilities of the various institutions in ESMF and PPMP monitoring are presented in the table below.

Table 4: Institutional responsibilities

No.	Institution	Responsibility
1.0	Project Coordinating Office	• Overall supervision of the ESMF, PMP and RFP. • Trigger the process through application of the environmental and social screening checklist
2.0	MAF – District Agricultural Offices, SLMA, NWRMA, NAFFSL, SLeWOFF	• Assist with environmental and social screening of subprojects and initial identification of impact issues • To assist in grievance redress matters
3.0	Environmental Protection Agency (EPA)	• Review screening reports and advise on level of environmental assessment if necessary • Assist with training and capacity building of other institutions
4.0	FBOs, District Council, Traditional authorities	• To assist with community awareness creation • To assist in grievance redress matters

5.0	Consultants/NGO	• Prepare ESIA if necessary and assist with implementation and capacity building.
6.0	World Bank	• To coordinate the Program at Regional level • To supervision of safeguards implementation

Source: FSRP2 Environmental and Social Management Framework (ESMF)

7.9 Institutional arrangements for the implementation and monitoring of the PMP

The coordination of the PMP will be anchored within the Crop Protection Unit of MAF. Therefore, those that are based within Plant Protection services, will coordinate the monitoring of the PPMP:

- **Plant Protection Services** will carry out the internal monitoring of the PPMP work package on "environment and health", and to that effect, regularly report the project Coordination Units
- **The Crop Protection Unit/Livestock and Veterinary Division** in collaboration with other experts drawn from SLARI and Njala University will provide technical support to the project by contributing field staff to be trained as IPM Trainers and who will subsequently train project farmers in IPM practices. MAF will provide policy guidance/oversight for implementation of the PMP and undertake the monitoring, supervision, and coordination of the IPM activities.
- **Farmers as the principal beneficiaries**. The project will organize its members into farmer groups or FBOs for training and promotion of IPM practices. They will set up Community IPM Action Committees to coordinate IPM activities in their areas. The project Farmer groups will act as the body to discuss general pest/vector problems and make decisions about IPM programs with local experts.
- **The One Health** secretariat in collaboration with the central and West African virus epidemiology project will supervise surveillance activities around the cassava, rice poultry and small ruminants on the incidence of disease , pests, and vectors.

7.10 Cost of activities proposed in the PMP

The environmental management ,awareness creation, capacity improvement and training workshops as well as some logistic support expenses for key stakeholders involved in the implementation of proposed interventions is estimated at **US$347,000** over the 5- year project life as explained in Table 5 below:

Table 5: Budget provisions

	Item	Activity	Unit Cost US$	No. of Years	Total Cost US$	Source of financing
1.	Capacity Building	Induction workshops on IPMP	5000	5	25,000	Covered by Implementation Budget from components
		Farmer groups training	1,500	4	6,000	
		Training of trainers (Village level facilitators)	3000	4	12,000	
	Subtotal				43,000	

2	Implementation of specific PMP	Purchase of equipment eg. PPEs	7000	5	49,000	
		Laboratory analysis support	30,000	-	30000	
		Emergency response support for 5 yrs	5000	5	25,000	
	Subtotal				**104,000**	
3	Environmental Management	Pesticides monitoring on land and in Surface water around project sites	5000	5	25,000	Project Funds
	Subtotal				**25,000**	
4	Public awareness and pest and vector surveillance	Public Awareness/ sensitization	5000	5	15,000	Project funds
		pest and vector surveillance	2,000	5	10,000	
	Subtotal				**25,000**	
5	Coordination and M&E	PMP Coordination	15,000	5	75,000	Project funds
		Reporting	5,000	5	25,000	
		Monitoring and evaluation	10,000	5	50,000	
	Subtotal				**150,000**	
	Total				**347,000**	

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APPENDICES

A. BIBLIOGRAPHY

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2. The Sierra Leone Gazette, Vol.CXLV, No. 62, 2014
3. Food and Agriculture Organization. (2017). Briefing Note on FAO Actions on Fall Armyworm in Africa.
4. The WHO Classification of pesticides by hazard (latest version)
5. World Bank.(1988). World Bank Operational Manual : Operational Policies OP 4.09, - Pest Management
6. World Bank Pest Management Guidebook. (2002)

7. Adda et al. (2013).

B- List of banned Pesticides in Sierra Leone

WHO Class 1a: "Extremely Hazardous" Pesticides
Acrolein, Aldicarb, Arsenous, Brodifacoum, Bromadiolone, Bromethalin, Calcium, Captafol,
Chlorfenvinphos, Chlormephos, Chlorophacinone, Chlorthiophos, Coumaphos, Crimidine,
Cycloheximide, Demephion-o, Demephion-s, Demeton-o, Demeton-s,
Dibromochloropropane, Difenacoum, Difethialone, Dimefox, Diphacinone, Disulfoton,
EPN, Ethoprophos, Fenamiphos, Fensulfothion, Flocoumafen, Fonofos, Fosthietan,
Hexachlorobenzene, Leptophos, Mephosfolan, Mercuric, Mevinphos, Parathion, Parathion,
Phenyl mercury, Phorate, Phosfolan, Phosphamidon, Prothoate, Schradan, Scilliroside, Sodium, Sulfotep, Tepp, Terbufos, Thionazin, Trichloranat.
WHO Class 1 b: "Highly Hazardous" Pesticides
Aldoxycarb, Aldrin, Allyl Alcohol, Aminocarb, Antu, Azinphos Ethyl, Azinphos Methyl, Benfuracarb, Blasticidin-s, Bromphos Ethyl, Butocarboxim, Butoxycarboxim, Cadusafos, Calcium Arsenate, Carbofuran, Carbophenothion, Cloethocarb, Coumachlor, Coumatetralyl, Crotoxyphos, Demeton-s Methyl, Demeton-s Methylsulphon, Dichlorvos, Dicrotophos, Dieldrin, Dimetilan, Dinoseb, Dinoseb Acetate, Dinoterb, Dioxathion, Dnoc, Edifenphos, Endrin, Esp, Famphur, Fenthion, Flucythrinate, Flouroacetamide, Formetanate, Fosmethilan, Furathiocarb, Heptenophos, Isazophos, Isofenphos, Isoxathion, Lead Arsenate, Mecarbam, Mercuric Oxide, Methamidophos, Methidathion, Methomyl, Monocrotophos, Nicotine, Nitralicarb, Omethoate, Oxamyl, Oxydemeton Methyl, Paris Green, Pentachlorophenol, Phenyl mercury Nitrate, Pirimiphos Ethyl, Propaphos, Propetamphos, Sodium Arsenite, Sodium Cyanide, Strychnine, Tefluthrin, Thallium Sulfate, Thiofanox, Thiometon, Triamiphos, Triazophos, Tributyltin Oxide, Vamidothion, Warfarin, Zeta Cypermethrin, Zinc Phosphide