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Revised Final Report

Smallholder Commercialization and Agribusiness Development Project Additional Financing (SCADeP-AF)

Pest Management Plan (PMP)

Ministry of Agriculture and Forestry (MAF)

World Bank Support

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ACRONYMS AND ABBREVIATIONS

ABCs	Agricultural Business Centres
AF	Additional Finance
Bt	*Bacillus thuringiensis*
CMVD	Cassava Mosaic Virus Disease
CPS	Crop Protection Service
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
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
EU	European Union
EVD	Ebola Virus Disease
FAO	Food and Agricultural Organisation of the UN
FAW	Fall Armyworm
FBOs	Farmer Based Organisation
FFS	Farmers Field School
FMD	Foot-and-mouth disease
GBV	Gender Based Violence
GDP	Gross Domestic Products
GM	Green Muscle (Metarhizium annisopliae)
GoSL	Government of Sierra Leone
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPMs	International Standard for Phytosanitary Measures
LF	Lymphatic *Filariasis*
LLINs	long-lasting insecticide-treated nets
MDA	Mass Drug Administration
MAF	Ministry of Agriculture and Forestry
MoHS	Ministry of Health and Sanitation
NaFFSL	National Farmers Federation of Sierra Leone
NaFRA	National Fertilizer Regulatory Agency
NCD	Newcastle disease
NPMC	National Pesticide Management Committee
NPPO	National Plant Protection Organisation
NTDs	Neglected Tropical Diseases
Oncho	Onchocerciasis

PCU	Project Coordination Unit
PHCs	Plant Health Clinics
PMC	Pesticide Management Committee
PMP	Pest and Pesticide Management Action Plan
POPs	Persistent Organic Pollutants
PPR	Peste des Petits Ruminants
PPRSD	Plant Protection and Regulatory Services Division
PRA	Pest Risk Analysis
RAP	Resettlement Action Plan
RPSDP	Rural and Private Sector Development Project
SCH	Schistosomiasis
SLeSCA	Sierra Leone Seed Certification Agency
SLICASS	Sierra Leone Cassava Variety
SME	Small and Medium-sized Enterprises
SCADeP	Smallholder Commercialization and Agribusiness Development Project
SPAT	Safe Pesticide Application Techniques
ToT	Training of Trainers
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
UPoCA	Unleashing the Power of Cassava in Africa
WAAPPSL	West Africa Agricultural Productivity Programme in Sierra Leone
WHO	World Health Organisation
WTO	World Trade Organisation
WTO-SPS	WTO-Sanitary and Phyto-Sanitary

1 INTRODUCTION

1.1 Background

The Government of Sierra Leone, through the Ministry of Agriculture and Forestry, has been implementing the Smallholder Commercialization and Agribusiness Development Project (SCADeP) with an initial IDA credit of US$40 million and a grant of the equivalent of US$15 million from United Kingdom Department of International Development (DfID). The project development objective is to promote smallholder commercialization by fostering productive business linkages between smallholder farmers and selected agribusiness firms and other commodity off-takers in Sierra Leone. This objective is to be achieved through support for interventions aimed at improving agricultural productivity and access to markets as well as development of inclusive smallholder farmer-agribusiness linkages in the targeted project areas of Sierra Leone.

The Government of Sierra Leone in support of the Smallholder Commercialization and Agribusiness Development Project (SCADeP) has requested additional financing in an amount of US$30 million and an extension of the Closing Date by twelve (12) months from November 30, 2021 to November 30, 2022. The proposed additional finance (AF) would address the project's financing gap for its feeder roads sub-component due to: (a) the withdrawal of United Kingdom Department of International Development (DfID) from the financing of the project and (b) higher costs than anticipated at appraisal for this sub-component. The proposed additional financing would be accompanied by a Level 2 restructuring to enhance the achievement of the Project Development Objective (PDO) and strengthen the development impact of SCADeP. This would be the second restructuring of the project, and it would include the following changes: (i) modification of the Agricultural Loan Scheme sub-component, (ii) changes to some outcome indicators and targets in the Results Framework and (iii) reallocation of the IDA credit's proceeds.

The SCADeP was approved by the Board of the World Bank on February 18, 2016, signed on March 15, 2016 and it became effective on November 30, 2016. The Project was originally financed by an International Development Association (IDA) credit of SDR 28.9 million (US$40 million equivalent) and a co-financing by DfID for a total amount of the equivalent of US$15 million to support the feeder roads sub-component of the project under Component 2 (Market Access Improvement). On October 10, 2018, DfID notified the Government of Sierra Leone that it was withdrawing its commitment to the co-financing of the IDA credit with the closing date of the DfID Trust Fund fixed on May 30, 2019. The closing date of the IDA Credit is November 30, 2021. The budget for the PMP implementation under the additional finance is $25,000.

The proposed AF is consistent with Sierra Leone's goal of achieving inclusive growth which is one of the key pillars of the country's Poverty Reduction Strategy Paper (PSRP-III) - (2013-2017). It continues to be with the new Mid-Term National Development Plan (2019–2023). This is to be achieved through the promotion of agribusiness development as a basis for the commercialization of smallholder farmers. Furthermore, the proposed project is aligned to the new National Agricultural Transformation Agenda (NAT) 2023. The project is also consistent with the new Country Partnership Framework for 2018–2022, under preparation, that reiterates the important role of agriculture for inclusive growth and development is well aligned with the World Bank's twin goals of reducing extreme poverty and promoting shared prosperity.

The project development objective (PDO) is to promote smallholder commercialization by fostering productive business linkages between smallholder farmers and selected agribusiness firms and other commodity off-takers in Sierra Leone. The Parent Project is targeting four commodity value chains (rice, cocoa, oil palm and poultry) selected based on their impact on smallholders' incomes and their significant potential for enhance enhancing competitiveness and creating jobs. The project has four components:

Component A: Support for Agri-business-farmer Linkages and Small and Medium Scale Enterprises along selected agricultural value chains (US$19.00million). This is to strengthen linkages between agribusiness firms and farmers and promote producer associations and SMEs linkages operating in selected

agricultural value-chains. The project will address the various financing needs of value chain actors through the design and implementation of proven agribusiness financing instruments that meet actors' specific financing needs. Sub-component A.1. promotes an out-grower model for value chain financing to agribusinesses linked to out-growers, while Sub-component A.2. provides support for farmer aggregation to facilitate inclusion of farmers who produce for the market but do have structured linkages with off-takers;

Component B: Market access improvement (US$26.00 million). This component seeks to address market access and coordination issues that constrain smallholder productivity and market efficiency. Sub-component B1 supports the rehabilitation and maintenance of feeder roads that link agribusinesses to smallholder producers and markets, while sub-component B2 provide aggregation centres for farmers as well as simple market coordination (through Information, Communication Technologies (ICT) or cell-phone based price information systems);

Component C: Capacity building support for state and non-state institutions and producer organizations. This component focuses on addressing the skills and organizational challenges that affect smallholder farmers' inclusion into organized supply chains. The project will provide technical assistance to farmers' producer organizations, strengthen the capacity of state and non-state institutions responsible for the provision of services relevant for smallholder commercialization and agribusiness development; and

Component D: Project coordination, monitoring and evaluation. Caters for the day-to-day management of the project.

The SCADeP aims at supporting sub-projects that could lead to an increase in farmers' productivity, commodity sales and incomes and ultimately the aggregate value added for key agricultural value chains. The project will support: (i) production of commodities such as rice, oil palm, cocoa and poultry (eggs and meat); (ii) processing of agricultural and poultry products; (iii) trading and marketing of these commodities; (iv) rehabilitation and maintenance of feeder roads to facilitate smallholder access to markets; and capacity building of farmers and agribusinesses operating along the four selected value-chains.

The Environmental and Social Management Framework (ESMF) has been developed as a policy guideline that will be used as a decision-making tool to ensure that all the subprojects selected and implemented under the SCADeP are environmentally and socially responsive and sound. The ESMF demands that each subproject will require environmental and social assessment that covers (i) legal and regulatory mechanisms, (ii) institutional arrangements, (iii) environmental management, and (iv) social assessment. The ESMF will be reviewed and approved for disclosure before project appraisal. It is also planned that the ESMF will be regularly updated to respond to changing local conditions.

1.2 Project Components likely to Trigger Pest Management Requirements

It is recognized that, giving the current weather variability, fostering smallholder commercialization with a focus on rice, cocoa and oil palm and poultry value chains, would imply increase in pests and diseases on these crops which would be a challenge to their envisaged production and productivity. The Parent Project therefore acknowledges that some of the planned interventions will likely trigger World Bank Safeguards policy OP 4.09, because the agribusinesses to be supported by the project may engage in agricultural productivity enhancement activities that may involve the use of pesticides and other agro-chemicals. This implies that SCADeP activities, particularly under Component A - Sierra Leone Agribusiness Development Fund and Agribusinesses Services Matching Grants Scheme, which provide matching grants to agribusinesses and producer organizations to foster smallholders' access to markets through productive linkages could involve the use of pesticides at some stages along the value chains.

However, the mode of delivery of the project is demand-driven, whereby the Project supports the implementation of competitively selected business plans that meet pre-agreed eligibility criteria through

a matching grants scheme. Therefore, Project will not be directly involved in the procurement and distribution of inputs to farmers, but through this Pest Management Plan promote the use of a combination of environmentally and socially friendly practices (hygienic, cultural, biological or natural control mechanisms and the judicious use of chemicals), by project beneficiaries to reduce reliance on synthetic chemical pesticides and ensure that health, social and environmental hazards are mitigated.

1.3 Objective of the PMP

As an agricultural project, most activities to be undertaken by the out-growers and agribusinesses will bring about some environmental issues related to crop production. As such, both OP4.01 Environmental Assessment and OP 4.09 Pest Management have been triggered to put in place appropriate risk management plans. The likely environmental risks identified in the ESMF are chemical pollution impacting natural resources and human health due to excessive and improper use of chemical pesticides and fertilizers, and pesticide residues; and health and occupational safety related issues resulting, for example, from the use of chemicals to protect finished products from pests, exposure to harmful chemical at works or due to unsafe disposal of chemicals or during pesticide application, unsafe disposal of crop residues from processing (e.g. oil palm kernel, rice husks etc.), other waste containing pathogens, exposure to polluting emissions and so forth.

The purpose of the Pest Management Plan (PMP) is to provide appropriate guidance for effective management of pests, that highlights the major pests and diseases associated with the project's priority commodities: rice, oil palm, cocoa and poultry (eggs and meat) 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.

1.4 Overview of Agricultural Production and Productivity

Agriculture is a way of life for most people in Sierra Leone. The vast majority of 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 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, coordinates, designs and monitors programs for the development of the agricultural sector. It works 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;
- To increase diversified domestic production of food, with a view to achieving food security in the medium and long term; and

- To maximize foreign exchange earnings from the agricultural sector.

1.5 Patterns of Crop Production

Crop production continues to receive the highest premium in the country's agricultural development processes. Crops are grown for the production of (a) food items for consumption by the people, and (b) non-food items for export for cash generation. Patterns of agricultural production are based on the various cultivable ecologies.

The Uplands which account for 80% of arable land is highly leached with low fertility status, suitable for a variety of food and cash crops. Shifting cultivation is the main farming practice for rice, and mixed cropping being the common cropping pattern although there are significant differences depending on the land type. Several crops (rice, cassava, maize, sweet potato, groundnut, soya bean, cocoa, coffee, oil palm, ginger, cashew and kola nut) are grown for local consumption as well as for the export in the sub-region. Farmers are encouraged for the intensification and value addition of these crops.

1.6 Methodology

This assignment is implemented through a consultative participatory process consisting of the following elements:

- Consultation and working in close interaction with professionals in Crop Protection Service (CPS) Livestock and Veterinary Services Division/MAF and the Ministry of Health and Sanitation (MoHS);
- Discussion and close interaction with relevant officials in the MAF to assess the pests and pesticides management practices by farmers and the Plant Protection Unit;
- Consultation with relevant NGOs and the Private Sector involved in plant protection products and regulatory services;
- Discussion with colleagues on public health issues and remedial actions;
- Discussion with livestock specialists for getting information on prevalent livestock diseases in Sierra Leone;
- Consultations with the Agricultural Extension Division to identify gaps for effective use of agro-pesticides;
- Consultation with CPS authority for relevant phytosanitary standards and other related issues;
- Creating an inventory and compiling lists of pests and pesticides and other documentation;
- Getting information from pest management documents in pdf formats/ internet for new information on transboundary invasive pests of crops and livestock.

2 PESTICIDE MANAGEMENT IN SIERRA LEONE

Pest and pesticide management are very important factors for safe agricultural products for human consumption as well as in maintaining the natural environment. Although there is not 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 health, wildlife and the environment, whilst it is very useful for pest management for production of healthy crops. In Sierra Leone, effective management of both public health pesticides 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) manage their pesticides separately; and the Environmental Protection Agency (EPA-SL) also addresses pesticide issues alongside encouraging proper management of the environment.

With the lack of legislative instruments, importation of pesticides is very much disorganized, and difficult to enforce. The private sector and pesticide operators lack basic knowledge in proper management of pesticides. The details of the available systems and guiding principles for pests and pesticides management are provided below.

2.1 Legal Framework and Institutional Capacities

Currently, there is no legal framework to regulate the importation, registration, distribution, sale and application of pesticides in Sierra Leone; no public laboratory facility for the monitoring of pesticide residues in food, water and the environment.

In the 1980s, FAO/UNDP supported a project in Sierra Leone to develop a Crop Protection Service with plant pests diagnostic laboratory established at Magbosi in Mile 91. This system functioned satisfactorily until the project terminated and successfully created the existing structure of the Crop Protection Service 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.

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 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 and mass spraying against economic pests. 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 Lungi International Airport, 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. On-going programmes were disrupted; facilities and infrastructure were vandalized and destroyed and there was considerable loss of human lives and displacement of communities. However, commendable efforts have been made during the recovery programme to revive the organizational structure of the Crop Protection Service.

2.2 Institutional Capacities

Activities of CPS are on-going especially at district and community levels; national, regional and international collaboration and linkages are being established and the potentials for developing an efficient Plant Protection Service are extremely high. Nonetheless, CPS is challenged by serious constraints, including, adequately trained personnel, infrastructure, facilities, mobility, operational funds and revised legal and regulatory instruments for supporting plant protection activities. Staff capacity at district levels are also very thin on the ground to 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, CPS has the full oversight responsibility for plant protection and phytosanitary activities in the country. Ongoing initiatives of CPS are designed to introduce integrated pest management (IPM) into the farming communities. With support from CABI plantwise, a series of plant health clinics have been established in 13 districts and some Agricultural Business Centres (ABCs) where extension agents have been 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 Bioscience in collaboration with Rothamsted Research UK, these clinics were successfully developed in the districts. CPS and the plant doctors collaborate with 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 Agents 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 the 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 environmental protection legislation, to ensure compliance with national environmental policies, regulates and monitors the processing of waste, 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.

Lack of 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.

2.3 Institutional Constraints

a) There is no Plant Protection Policy to direct the delivery of crop protection services 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 (three) in crop protection is low in relation to the challenges. At least thirteen University graduates are required to fill in the gaps at district level.
d) There is no pesticide laboratory nor are there equipment for testing of pesticides for their purity and efficacy.
e) Lack of 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 Service to function effectively the Service needs to be re-structured, strengthened and adequately resourced. Continuous staff training should be a major focus to upgrade the skills of crop protection officers at various levels to enable them to function efficiently and effectively.

2.4 Legislative and Regulatory Framework for Pesticide Management

The Government of Sierra Leone 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, and 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 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. 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 WHO, 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 agropesticides trade 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

2.5 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 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/EPA-USA Pesticides websites for sustainable use of pesticides. These provide guidelines in reducing the risks and impacts of pesticide use on human health and the environment and promoting the use of Integrated Pest Management (IPM) and of alternative approaches or techniques, such as non-chemical alternatives to pesticides. 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 with regulatory powers to deter the importation of pesticides and encourage pesticide registration based on ECOWAS regulation for pesticides import.

As the government functionary institution charged with agricultural pesticides, using the draft policies, MAF setup an adhoc Pesticide Management Committee (PMC) to look at those pesticides that importers intend to bring into the country. A committee of five comprising both Directors of Crops and Extension Divisions, two Assistants and the Head of Crop Protection was mandated to examine agro-pesticides applications for import certification. This committee continues to function until the draft national policies are enacted into law.

In response to actual and potential pest threats in the need to intensify agriculture, MAF annually purchase and distribute pesticides (through tender) to the ABCs and PHCs in the districts through CPS 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 CPS which prepares the list of pesticides and spraying equipment and protective gears needed for farmers and plant health clinics which are distributed nationwide. No pesticides are formulated and packaged in Sierra Leone. However, pesticide companies normally work in consultation with the Crop Protection Service of MAF for advice and to provide a list of pesticides approved for use in Sierra Leone (Annex I). CPS/MAF always performs crosschecks from country of origin to ascertain import requirements prior to approval.

2.5.1 International Legislation

2.5.1.1 The World Bank Safeguard Policies

The World Bank Environmental and Social Safeguard Policies seek to address potential environmental risks and benefits associated with Bank lending operations. These safeguards policies are designed to avoid, mitigate or minimise adverse environmental and social impacts of projects supported by the Bank. The screening of each proposed project is carried out to determine the appropriate extent and type of Environmental Assessment to be undertaken and whether or not the project may trigger other safeguard policies. The Borrower is responsible for any assessment required by the Safeguard Policies, with general advice provided by the WB staff.

The safeguard policy OP 4.09 Pest Management was triggered from the likely use of pesticides as a result of the agricultural production. OP 4.09 requires the assessment of pest management in the country and supports integrated pest management (IPM) and the safe use of agricultural pesticides. In Bank-financed agriculture

operations, pest populations are normally controlled through IPM approaches, such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The Bank may finance the purchase of pesticides when their use is justified under an IPM approach. Guidance can be taken from the World Bank Group Environmental Health and Safety (EHS) Guidelines on Annual Crops and Perennial Crops with focus on pest management and pesticide use and management (https://www.ifc.org/wps/wcm/connect/f7c71d004ab2c0a9a1b5ede9e68d4b0b/FINAL_Perennial_Crop_Production_November_2015.pdf?MOD=AJPERES).

2.5.1.2 International Plant Protection Convention of FAO (1952)

The International Plant Protection Convention (IPPC) is an international plant health agreement, established in 1952, that aims to protect cultivated and wild plants by preventing the introduction and spread of pests into endangered areas and cooperating to control pests of plants and plant products. The IPPC was modified in 1997 to be compatible with the WTO-SPS Agreement. The IPPC official contact person for Sierra Leone is the Head of Crops Protection at the Ministry of Agriculture and Forestry.

2.5.1.3 World Food Security and the World Food Summit Plan of Action (November, 1996)

The World Food Summit was called in response to the continued existence of widespread undernutrition and growing concern about the capacity of agriculture to meet future food needs. The World Food Summit took place from 13 to 17 November 1996. This historic event, convened at FAO headquarters in Rome, comprised five days of meetings at the highest level with representatives from 185 countries and the European Community. The summit participants adopted the Rome Declaration on World Food Security and the World Food Summit Plan of Action. The objective of the Summit was to renew global commitment at the highest political level to eliminate hunger and malnutrition, and to achieve sustainable food security for all people. The Rome Declaration sets forth seven commitments which lay the basis for achieving sustainable food security for all and the Plan of Action spells out the objectives and actions relevant for practical implementation of these seven commitments.

2.5.1.4 Stockholm Convention on Persistent Organic Pollutants (SC-POPs)

The Stockholm Convention on Persistent Organic Pollutants (POPs) is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have harmful impacts on human health or on the environment. The list of banned pesticides in Sierra Leone and the POPs to be eliminated under the Stockholm Convention are located in Annex II.

2.5.1.5 Rotterdam Convention (RC)

The Rotterdam Convention is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The Convention covers pesticides and industrial chemical that have been banned or severely restricted for health or environmental reasons by Parties. The objectives of the Convention are:

- to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm;
- to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristic, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

3 PEST AND PESTICIDE MANAGEMENT APPROACHES IN AGRICULTURE AND PUBLIC HEALTH

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 Leone

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*)
Cocoa	i. Broad mite (*Polyphagotarsonemus latus*) ii. Flower-eating caterpillars iii. Helopeltis iv. Yellow peach moth	i. Black Pod (*phytophthora* fungus) ii. Swollen Shoot Virus iii. Vascular Streak Dieback (virus)
Oil Palm	i. Mealybugs (*Dysmicoccus brevipes*) ii. Rhinoceros bettle (*Oryctes rhinoceros*)	i. Ganoderma trunk rot (*Ganoderma spp.*) ii. Oil palm wilt (*Fusarium oxysporum*) iii. Freckle (*Cercospora elaeidis*) iv. Blast (*Pythium splendens* and *Rhizoctonia*) v. Armillaria trunk rot (*Armillariella mellea*)

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3.1 Plant Health Clinic System

This programme was introduced and instituted into the agricultural extension system due to the fact that loses caused by pests on farmers' crops constituted major factors resulting to low yields and poor-quality produce. Farmers have been using several pesticides such as Malathion for controlling pests on their fields but those pesticides were ineffective and that farmers have not developed any alternate control measures. Many farmers also expressed that they stopped growing cassava specifically due to pest problems such as the variegated grasshopper infestation especially in the dry season when the second crop of cassava is planted.

Secondly, other pests have also become serious, devastating tree crops and vegetable crops. The most serious pests that have recently invaded Sierra Leone include the fruit fly species *Bactrocera invadens*, *Anastrepha* spp and the papaya mealybug *Paracoccus marginatus.* These pests attack a wide range of fruits extensively grown nation-wide (e.g. mango, guava, papaya, citrus spp, banana, cashew, apple, avocado, etc.) causing losses even to the local market. Production of crops used for human and animal consumptions are increasingly at high risk due to pests, weeds and diseases of both crops and animals. The fall armyworm *Spodoptera frugiperda* has recently been confirmed in Sierra Leone that attacks maize and several other crops including rice.

The idea of plant health clinic system was developed by CABI (UK) to help farmers understand their pest problems. This approach combines different management strategies and practices to grow healthy crops and minimize the use of pesticides. Plant Health Clinics are places where farmers are given information on the pests affecting their crops and how to control them. Farmers who attend plant clinics share information with others about problems affecting their crops. These clinics operate in places close to where farmers live and work or where farmers visit regularly in the course of their normal routine activities such as market places, ABCs, etc. WAAPP-1C had supported the training of plant doctors, purchased plant clinic equipment and established plant health clinics for their cassava/rice FBOs. One of the remits of the clinics is to provide pest surveillance data for the government of Sierra Leone on new plant health threats, in line with policy of the Ministry of Agriculture and Forestry on production and commercialization programmes. The clinics are managed by "plant doctors" of the Crop Protection Services Unit of the MAF. When national experts need assistance, they refer their queries to the plant health diagnostic laboratory. This has helped to minimise the indiscriminate use of pesticides by the farming population, recognising that some of those pesticides used by farmers without seeking advice could belong to WHO class 1a or 1b categories. The strategy is fully promoted by FAO as the preferred approach to crop protection and regards it as a pillar of both sustainable intensification of crop production and pesticide risk reduction.

Pesticides also have a role to play in public health as part of sustainable integrated mosquito management options. Components of pesticide management include surveillance, source reduction or prevention, biological control, repellents, traps, and pesticide-resistance management.

3.1.1 Plant clinics operational objectives include:

- Awareness raising about plant health and its benefits towards food security, poverty reduction and environmental protection in order to strengthen national, regional and international plant health initiatives in improving the livelihood of farmers.
- Diagnose pest problems affecting crop production as the basis to develop a shared vision on priority needs and integrated pest management opportunities.
- Develop the capacity of the farming community to understand and manage pest problems through farmer-participatory learning approaches with research on feedback issues emanating from farmers field experiences.
- Introduce and promote microbial pesticides such as the Green Muscle and other and botanical pesticides as alternatives to harmful synthetic pesticide regimes thereby reducing environmental and personal health risk hazards in agriculture and the community.
- Teach farmers more about their crops including how plants are affected, symptoms, and management practices.
- To create better effective and efficient plant health system to the farming communities.

3.1.2 Pests found in agriculture and public health

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.

3.1.3 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.*

3.1.3.1 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 MAF 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 MAF 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 MAF field tested the bio-pesticide against the grasshoppers with excellent results.

In collaboration with IITA-UPoCA project, CPS/MAF 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 MAF. 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.

3.1.3.2 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 MAF, 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 analyse experiences and best practices from this region will help design a sustainable FAW management program, especially for smallholders.

CPS/MAF 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 MAF 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 PESTS OF POULTRY

4.1 Poultry Diseases

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.

4.1.1 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.

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.

4.1.2 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).

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 pain-killers.

Table 2: (a) Poultry Diseases

Diseases	Sign	Treatment/management	Prevention
1. Newcastle disease	• Greenish diarrhoea	None	• Quarantine new birds for 5 days; • Isolate and kill all sick birds

Diseases	Sign	Treatment/management	Prevention
	• Ocular and nasal discharge • Neck twisted • Paralysis and collapse		• 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
2. 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, MAF

Table 2: (b) External Parasites on poultry

Parasite	Sign/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

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

Table 2: (c) Internal Parasites in poultry

• Flat or Round Worms	• Loss of appetite • Diarrhoea • Anaemia • 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, MAF

4.2 Pests of Public Health Importance

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

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 November 2010, Sierra Leone conducted a one-week National Integrated Maternal and Child Health Campaign to provide health interventions, which included distribution of over 3.2 million long-lasting insecticide-treated nets (LLINs) to all households in the country and was aimed at achieving 100 percent household possession of LLINs. In addition to the distribution of LLINs the NMCP also launched the Indoor Residual Spraying Programme in four pilot districts in December 2010.

Regarding the 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. MDA 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 **s**tudies 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 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.

In spite of such a heavy burden of malaria and neglected tropical diseases (NTDs), control of vector borne diseases in Sierra Leone is focusing mainly on case management and mass drug administration (MDA). More efforts should therefore be made to reduce and interrupt disease transmission.

5 PESTICIDE MANAGEMENT METHODS AND USAGE

Generally, pesticide is the name used to describe a range of substances or mixtures used to kill, reduce, repel or manage many types of pests. They 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.

5.1 Chemical Pesticides

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 (Annex I).

5.1.1 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.

5.1.2 Carbamates

These insecticides are made from carbamic acid and used to kill or control insects similar to organophosphates. 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.

5.1.3 Chlorinated Hydrocarbons

These are a group of chemicals composed of carbon, chlorine and hydrogen. As pesticides, they are also referred to by several 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.

5.1.4 Pyrethroids

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.

5.1.5 Biopesticides

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. By the end of 2001, there were approximately 195 registered biopesticide active ingredients and 780 products worldwide. Biopesticides fall into three major groups:

5.1.5.1 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. In Sierra Leone, Green Muscle was field tested with excellent results in 2006 with support from Care International Sierra Leone in collaboration with IITA and the Crop Protection Service of MAF. The product is prepared for field application as follow: 25grams GM in 300ml vegetable oil and 700ml kerosene to spray one hectare.

5.1.5.2 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*). Because it is sometimes difficult to determine whether a substance meets the criteria for classification as a biochemical pesticide, the Environmental Protection Agency Sierra Leone (EPA-SL) has established a special committee to make such decisions.

5.1.5.3 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, environmentally friendly, non-toxic 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 is 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. It was introduced in Sierra Leone at the then Njala University College herbarium in 1949. FAO officially launched the Neem in Sierra Leone as a crop in 2010 and supported the establishment of 10,000 seedlings in the Kaffu Bullom chiefdom, Port Loko district. Currently, with support from UNIDO, a large number of trees are now being planted all over the country, and Njala University has done some research on the plant. 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. Neem is now established in many districts nationwide, with 2 acres as Integrated Agroforestry at Njala University, 10 acres in Yakemo Kpukumu Krim chiefdom in Pujehun district and several acres in Bombali district.

A pilot neem production factory supported by UNIDO has been established at the Levuma Beach under the supervision and operation of the National Farmers Federation of Sierra Leone (NaFFSL). Promoting this crop will be great idea as no pest has ever been recorded to have built up resistance to neem-based pesticides. 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).

5.2 Impacts of the Use of Chemical Pesticides

5.2.1 Consequences in the improper use of pesticides

- 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

5.2.2 Negative impacts of uncontrolled 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 human, 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.

5.2.3 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. During such routine monitoring, pesticides such as acephate, chlopyriphos, Chlorpyriphos-methyl were analysed in apples, tomatoes, lettuce, strawberries and grapes. Currently, the European Union uses the EUROPHYT NOTICIFICATION SYSTEM to inform countries of any interception of consignment in which organisms or pesticides residues are found in export food commodities.

5.2.4 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.

5.2.5 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.

5.2.6 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.

5.2.7 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.

5.2.8 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.

5.2.9 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.

5.2.10 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.

5.3 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 wild life
- Death of aquatic live especially fish
- General illness
- Skin and eye irritations

Until the invasion of the African Armyworm *Spodoptera Exempta* in 1979 and 1982, the use and application of pesticides was not a common practice in pest management. Large quantities of insecticides were imported amass to combat the pest in rice and maize fields. Within that period, the then Ministry of Agriculture and Natural Resources (MANR) with UNDP technical support and through Act of Parliament, established the Pest Control Unit (PCU) for pest management within the country. The MANR opened regional pest control offices and set up pest control teams at district levels to manage pests and pesticides and pest control activities. The presence of those teams made it possible for effective management of pesticides. Farmers were carefully guided on the use and application of pesticides and related precautionary measures.

However, over the years, with the invasion of other crop pests such as the cassava mealybug *P. manihoti*, mango mealybug *Rastrococcus invadens,* fruit flies *Bactrocera invadens,* with the introduction of biological control agents (parasitoids) and biochemical (pheromone traps), and the establishment of plant health clinic system, pesticide use has been minimized. Prior to PHC system, some of the practices instituted for the management of those pesticides include the following:

5.3.1 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.

5.3.2 Timely application

Targeted and timely application of any pesticide is key to effective and efficient pest management system. This requires the use of appropriate and well-maintained equipment as well as knowledge of the pest and pesticide.

5.3.3 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/MAF 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/MAF. 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 CABI plantwise, CPS prepared two pesticide usage guides (Annex 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.

5.4 Use of Pesticides in Project Activities

Although the project will not directly finance the procurement and distribution of pesticides, agribusinesses and producer organizations whose subproject business plans/proposal may be approved under Component A, sub-projects Sierra Leone Agribusiness Development Fund (SLADF) and the Agribusiness Services

Matching Grant Schemes (ASMG) are likely to use pesticides and other agro-chemicals for crop pests and diseases control in combination with other methods of prevention and control when other methods have failed.

The mode of delivery of the project is demand-driven. As a result, activities supported are based on tasks elaborated in business plans provided by applicants (agribusiness and producer organizations) that are competitively selected and approved. Through the proposal screenings and assessment processes all safeguards risks are assessed and proposed mitigation measures reviewed before the business plans are approved. Therefore, type and quantity of pesticides purchased by the grantees is determined by their approved business plans and market demand. However, this PMP provides guidance for the project to promote best practices and among supported agribusinesses, and through its capacity building and advisory services to farmers, the safe use of agro-chemicals at appropriate application quantities and methods. It will also ensure that supported agribusiness, who obtained annually renewed environmental licenses from the EPA, do not procure unsafe or use banned (hazardous) and obsolete pesticides (see annex II for list) under this project. The types of pesticides approved for use in Sierra are listed in Annex I.

Moreover, it is envisaged that there will be a minimal increase in pesticide use due to project activities, as most grantees are using IPM approaches or biopesticides. The main users of pesticides will be the rice farmers, especially for any possible outbreak of fall army worm, which is a common occurrence. The use of pesticides can lead to environmental and social impacts or risks as outlined in Section 5.2. The table below illustrates some measures that will mitigate these negative impacts of pesticides. Also, Annex III outlines the Code of Practice for pesticide handling, storage, transport and disposal.

Table 3 -Measures to Mitigate the Negative Impact of Pesticides

Environment	Nature of impact	Mitigation measures
Soil	Falling fertility	• Popularize the use of manure or compost; • Use mineral fertilizer rationally; • Apply appropriate farming techniques and recommended by the departments of the Ministry of Food and Agriculture; • Fight against deforestation and erosion.
	Acidification	• Minimize and respect the dosages of nitrogen fertilizer use • Apply appropriate cultivation techniques
	Pollution by phosphates, heavy metals (Pb ++, ZN ++, Mn ++)	• Strengthen the pesticide control system; • Provide obsolete and outdated pesticide disposal devices; • Use pesticides efficiently; • Popularize and encourage integrated pest management (IPM); • Establish empty container storage facilities and regulate their removal by manufacturers.

Surface and underground water	Pollution by nitrates, heavy metals	• Minimize the use of nitrogen fertilizers; • Establish empty container storage facilities and require their removal by the manufacturers
Flora	Deforestation	• Fight against deforestation and erosion.
Biodiversity	Chimoresistance of pest	• Identify pests and pesticides that are specific to them; • Rational application of pesticides; • Diversification of pesticides used.
	Intoxication of aquatic and terrestrial fauna	• Educate users about the risks of intoxication; • Sensitize livestock farmers on watering at safe water points.
	Terrestrial biodiversity loss	• Apply integrated pest management methods (biological control, genetics, use of attractants, repellents, hormones, etc.).
Health	Intoxication Poisoning, Death, Cholinesterase	• Respect the storage and storage conditions of pesticides; • To sensitize the populations on the risks of food poisoning: • Strictly apply rational measures of use; • Use personal protective equipment.

The input e-voucher scheme to be promoted under the project will be a tool to help government to management its subsidy programs. The project will help the government pilot with seed subsidy with the project will finance. Upon successful, the Government could use it to drive its fertilizer subsidy program to improve targeting and motivate private sector participation in agro-inputs and services delivery.

5.5 *Code of practice for pesticide use, handling, storage, transport and disposal*.

The following criteria apply to the selection and use of such pesticides: (a) they will have negligible adverse on 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. Annex I present the list of pesticides approved for use in Sierra Leone. Annex III details the code of for pesticides handling, storage, transportation and disposal, while annex IV presents the basic principles for reduce pest management to mitigate the effects of excessive pesticide usage.

The management of pesticides containers is currently under the responsibility of resellers and farmers because of the retail sales system. They find themselves with the most important share of the empty containers which are differently managed. With commercial farms or agribusinesses, the management of pesticide containers are expected to be clearly stated in their environmental management plans (EMP) to the EPA. Usually, these agribusinesses indicate that they will liaise with the appropriate MAF office to provide guidance to the disposal of the containers. Nevertheless, Annex III of this framework provides detailed recommended improved management and pesticides management measures to promoted under the project.

6 INTEGRATED PEST MANAGEMENT (IPM)

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, 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, livestock and the environment.

IPM is the best combination of cultural, biological and chemical measures to manage diseases, insects, weeds and other pests. It takes into account 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, Coco, Cassava, Maize, and Vegetables) depending on when the crops are in the field and the target pests as discussed below.

6.1 Integrated Pest Management Methods

IPM methods involve a systematic decision-making process that aims to prevent pests from becoming problems and to determine what actions to take if pest problems occur. These processes include:

a) 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; 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.

b) 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.

c) 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. However, a new transboundary pest the fall armyworm (FAW) has been identified as a primary pest of the crop. Knowledge of the lifecycle of the pest could help in selection of maize variety.

d) 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. Nonetheless, it is not advisable to rotate rice with maize as most of the pests attack and damage both crops.

e) 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. For SCADeP target crops, soil management is very important for quality production and productivity as well as reducing the cost of production.

f) 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.

g) 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.

h) 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.

i) Biological Control

Biological control 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.

j) 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.

6.2 IPM Implementation Strategy

Successful implementation of the IPM lies with the responsible of MAF. In the light of this, the SCADeP PCU 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 the initial pesticide registration and licensing scheme, taking 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 general 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 IPM implementation programme must be located at CPS/MAF level with field action by Extension staff and farmer groups who will receive training and advisory services from CPS 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 IPM implementation process will promote environmentally sustainable pest management options and assesses the economic, environmental and social impact of each the interventions.

6.3 Integrated Pest Management (IPM) Action Plan

6.3.1 General objective

To strengthen crop and livestock pest protection at the local levels by improving on the efficiency of protection through enhanced cultural practices and reduced pesticides usage that is free or minimized from human health or environmental hazards.

6.3.2 Specific objectives

- Support the crop protection unit of the MAF in strengthening pest management approaches and encourage minimum pesticides usage in accordance with the National Action plant on food hygiene and safety, food security, adaptation to climate change and other approved international conventions.

- Strengthening the capacity for IPM in SL through capacity building of field extension staff involved in rice, cacao, oil palm and poultry production, distribution and marketing.

- Strengthening environmental protection and food safety through enhanced roles for natural enemies, such as parasites, predators and pathogens that are safe for human interactions.

- Packing pest management practices that will be effective and at the same times ensure reduced pesticide residues in food and environmental pollution (i.e. air, water and soil).

6.3.3 IPM approach and definition

This approach focuses on the reduction of the risks of abuse and excessive use of chemicals for plant and livestock pest protection and emphasizes community knowledge on pest identification and monitoring, cultural practices used in the farming activities and farm sanitation/diversification. IPM is thus defined in this specific context of the environmental management as a ‘pest management system utilizing the combined approach of the population dynamics of the species causing damage and all possible appropriate techniques and measures to maintain the density of the pests below those causing economic damages.’

6.3.4 The basic principle of the IPM framework

The following principles will be applied in the implementation of the project in terms of chemical pesticides and fertilizers usage:

- The prohibited list of banned pesticides will be prepared and used to inform purchase (if needed).

- The IPM strategy for the project will be designed in conformity to the Government policies on food safety and security, sustainable land use, environmental safety emphasizing reduced chemical pesticides and increased fertilizer use.

- Improvement in the community knowledge and experience in the use of chemicals through research surveys and farmers field training courses will be emphasized.

- Integration of all possible measures/practices will be utilized for effective and cost-efficient control of the selected crops and livestock.

6.3.5 The contents of the IPM model

- Collection of information and selection of solutions.
- Before implementing the IPM programme, investigation must be mounted and discussion with local stakeholders to solicit necessary information such as:
  - Pest identification and their status on the selected crops and livestock.
  - Damage levels and impacts.
  - Control measures in use.
  - Knowledge about and the experience gained using the control measures.

6.3.6 Priority issues and actions required

The priority areas for effective implementation of this IPM in collaboration with existing planned activities of CPS/MAF, other institutions and government policies and regulations are listed below in Table 3.

Table 3: Priority issues and actions required

Major issues	Actions required	Institutions Involved	Cost
Use and reliance on chemical pesticides	• 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.	• SCADeP PCU • Crops Protection Services (CPS) • MAF Extension Staff	• $5,000.00
Infestation by new pest	• Monitor crops/livestock for alien or transboundary invasive species.	• Crops Protection Services (CPS) • MAF Extension Staff	• MAF internal cost

Major issues	Actions required	Institutions Involved	Cost
Raise awareness of IPM and other non-chemical practices	• Develop IPM training modules. • Organize training of trainers and beneficiaries on IPM. • 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 and policy makers.	• SCADeP PCU • Crops Protection Services (CPS) • MAF Extension Staff	• $5,000.00

7 INSTITUTIONAL ARRANGEMENTS FOR THE IMPLEMENTATION AND MONITORING OF PEST MANAGEMENT PLAN (PMP)

Effective implementation of the PMP will involve many actors. However, SCADeP will play a pivotal role in the implementation of the PMP, whilst other institutions will provide technical support for implementation of the plan. The PMP also proposes collaboration with other similar agricultural projects or NGOs in agriculture to assist CPS/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.

The major actors will be:

a) Ministry of Agriculture and Forestry (MAF) – The Crop Protection Service Unit/Livestock and Veterinary Division in collaboration with other experts drawn from SLARI and Njala University will provide technical support to SCADeP project. MAF will provide policy guidance/oversight for implementation of the PMP and undertake the monitoring, supervision and coordination of the IPM activities.

b) SCADeP Farmers and Agribusinesses – as the principal beneficiaries, SCADeP will organize training and promotion of IPM practices. SCADeP farmer groups will act as the body to discuss general pest/vector problems and make decisions about IPM programmes with local experts.

c) The Ministry of Health and Sanitation will advise on use of treated bed-nets and re-treatment of bed-nets within the project area.

d) SCADeP PCU – the Environmental and Social Safeguards Specialist (ESSS) will be responsible for overseeing the implementation of the PMP and work with a Consultant and relevant actors to develop an appropriate IPM plan.

7.1 Inter-departmental Cooperation

The draft Integrated Pesticide Management (IPM) policy recognizes that effective and efficient management of pesticides must be a concerted effort that requires inter-departmental coordination from a range of team players. Then the responsibility for the enforcement of pesticide regulation will be shared among various ministries and agencies with MAF and MoHS having the statutory responsibility.

Recognizing that these departments will have complementary responsibilities, MAF and MoHS and the various government ministries and agencies need to develop inter-departmental Memorandum of Agreement (MoA) in relation to pesticide management issues. These MoAs are intended to foster a strong working relationship between the parties by delineating their respective responsibilities and identifying areas of mutual interest for effective monitoring.

7.2 Monitoring and Research

Many pesticides are known to accumulate in the environment and to have detrimental effects on human health and the environment. Long-term monitoring programmes and targeted research are essential in order to evaluate these impacts. Without adequate and reliable data, it would be impossible for the government to assure Sierra Leoneans that pesticides in current use are not posing such a risk to human, wildlife and the environment.

7.3 Training Plan of Actors Involved in PMP

Long-term and sustainable adoption of IPM by farmers will only occur if they get information about it along with the tools and technologies to implement it. To effect this, in collaboration with the CPS/MAF, the project would actively engage in training of farmers, frontline extension staff, CPS staff (Plant doctors) and Agro-dealers, in partnership with the public sector. Within MAF/SLARI/Njala University, there are already master trainers on pests' management for training of farmers and plant health doctors. The capacity of these could be upgraded on the area of pesticide management.

Key components include:

- Training technical staff as Master Trainers, who may teach advisory and sales staff about IPM.
- Training MAF field staff, private extension staff as well as pesticides dealers and seed distributors and retailers.
- Developing education and training programs for farmers.
- Practical ways of reaching farmers may include Farmer Field Schools, community radios and social media, newsletters, direct mail, videos, factsheets and posters.

A major goal of the training is to maximize product benefits and minimize their risks. Such training covers all aspects of handling and storing pesticides, safe use and application of pesticides, including how to:

- Identify pests and beneficial insects
- Assess risk of pest populations and potential crop damage
- Manage pests according to IPM principles
- Apply crop products safely and effectively if required
- Avoid unacceptable risks to people and the environment
- Minimize product residues on crops and monitor for pest resistance

7.3.1 Training of Trainers (ToT)

Six to ten days intensive courses should be conducted for 20-30 men and women extension staff. The course will consist of participatory learning modules (PLM) developed in line with identified farmers' training needs. Participants will be trained in:

a) Purchase, transport and storage of pesticides
b) Health and Safety including personal protective equipment (PPE)
c) Mixing and preparing pesticides
d) Disposal of empty containers
e) Portable application equipment
f) Good spraying practices
g) Record keeping
h) Pesticides and pesticide safety
i) Reporting

7.3.2 Farmers' Group Training

Farmer training will focus on group learning (FFS) 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 staff). 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.

7.3.3 Information and Awareness Raising

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, MAF through its international partner CABIplantwise established very useful plant health clinics. 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, SCADeP PCU should support the development and production of media packages, including factsheets on pests and pesticides management, safe pesticide application techniques and radio discussions to reach a wider audience.

Table 4 – Awareness Raising activities to support the implementation of the IPM.

Awareness Raising Activity	Deliverables	Target Audience	Responsible Entity	Cost ($)
1. IPM and Pesticide Management Factsheets and Posters	Factsheets and posters	Farmers	SLARI, Njala University and CPS	$1,000.00
2. Radio Discussions	Monthly radio discussions on national radio stations	Farmers and Extension staff	CPS and SCADeP PCU	$1,000.00
3. Public awareness and sensitization campaigns	Quarterly events, including agricultural trade fairs where possible	Farmers, agro-dealers and extension staff	CPS and MAF	$3,000.00

8 Monitoring and Evaluation

Many pesticides are known to accumulate in the environment and to have detrimental effects on human health and the environment. Long-term monitoring programmes and targeted research are essential in order to evaluate these impacts. Without adequate and reliable data, it would be impossible for the government to assure Sierra Leoneans that pesticides in current use are not posing such a risk to human, wildlife and the environment.

Farmer-educational activities will be central to an exit strategy which will feature increased roles and responsibilities of national institutions to take primary responsibilities in the development of action plans and expertise exchange for IPM development and promotion. Committed national partners will take primary responsibilities for influencing the development of national policies that fully recognize and promote IPM as important integral component of agricultural production and productivity.

For PCU Monitoring and Evaluation Specialist will be responsible for producing quarterly M&E reports on all activities of the project, including the implementation of the PMP and other safeguard instruments. The indicators listed below will be captured in the quarterly reports to measure the progress of the implementation and its effectiveness. Any suggested changes will be discussed with the ESSS and relevant implementing institutions for more effective implementation of the PMP.

8.1 Indicators to be monitored

The following indicators will determine effective implementation of the PMP:

1. Types and number of training modules delivered;
2. Number of extension staff and farmers trained;
3. Types of management practices preferred by crop farmers;
4. Types of management practices preferred by livestock farmers;
5. Management practices adopted most by farmers**:**
6. Number of other farmers trained by SCADeP project trained farmers;
7. Number of farmers who have correctly applied the skills they had learned;
8. Assess the level of pest damage and crop losses;
9. Assess the rate of adoption by SCADeP farmers of IPM practices and impact on production and productivity;
10. Compare increase in crop production by adopting IPM practices with farmer normal practices;
11. Compare the two practices with increase in farm revenue;
12. Assess the level of reduction in pesticide purchase and use;

9 BUDGET FOR PMP

The estimated budget for implementing the PMP is presented in the table below (Table 5)**.** The PMP will be the basis for the preparation and implementation of the Integrated Pest Management (IPM) plan.

Table 5: PMP Implementation Estimated Budget (US dollars)

Activity	Indicative Cost (US $)
1. Capacity Building for Participating Institutions	**5,000.00**
Training modules with MAF, SLARI and Njala University	2,000.00
ToT trainings	3,000.00
2. Awareness raising with SCADeP beneficiary farmers	**5,000.00**
Media packages including factsheets, posters and radio discussions	2,000.00
Public awareness/sensitization campaigns	3,000.00
3. Integrated Pest Management (IPM) plan	**10,000.00**
4. Monitoring and Evaluation	**5,000.00**
Total Cost	**25,000.00**

10 ANNEX

Annex I: Approved Pesticides by the Ministry of Agriculture and Forestry (MAF) for use in Sierra Leone

Active Ingredient	Substance Group	Target pests	Mode of Action	Toxicity to Mammals	Toxicity to Birds	Toxicity to Bees
INSECTICIDES						
Imidacloprid	Neonicitinoid	Sucking and soil	Systemic, with contact and stomach action	Moderate	High	High
Alpha-Cypermethrin (Alphamethrin)	Pyrethroid	Sucking and soil insects	Non-systemic, with contact and stomach action	Moderate	High	High
Cypermethrin	Pyrethroid	Many different insects	Non-systemic, with contact and stomach action	Moderate	High	High
Deltamethrin	Pyrethroid	Many different insects	Non-systemic, with contact and stomach action	Moderate	High	High
Chlorpyrifos	Organophosphate	Soil and foiage insects, mites and nematodes	Non-systemic, with contact and stomach action	Moderate	High	High
Diazinon	Organophosphate	Chewing and sucking insects	Non-systemic, with contact and stomach action	Moderate	High	High
FUNGICIDES						
Captan	Phthalimide	Many fungi	Non-systemic, with preventive and curative action	Low	Moderate	Moderate
Mancozeb	Dithiocarbamate	Many fungi	Non-systemic, with preventive and curative action	Low	Moderate	Low
Propineb	Dithiocarbamate	Mildew, leaf spots, scab, black rots, grey moulds	Non-systemic, with contact action	Low	Low	Moderate
Difenoconazole	Triazole	Many fungi	Systemic, with preventive and curative action	Moderate	Low	Moderate
Propiconazole	Triazole	Many fungi	Systemic, with preventive and curative action	Moderate	Low	Moderate
Tebuconazole	Triazole	Smuts, bunts	Systemic, with curative, preventive and eradicant action	Moderate	Moderate	Moderate
Cupric oxide (Copper II Oxide)	……	Many fungi and bacteria	Protective, inhibits spores and prevents pathogens from entering host	Moderate	Moderate	Low
HERBICIDES						
Ethofumesate	Benzofuran	Grasses and broad-leaved weeds	Systemic, absorbed through roots and shoots	Low	Moderate	Moderate
Glyphosate	Phosphonoglycine	Grasses and broad	Systemic, with contact action	Low	Moderate	Moderate
Metamitron	Triazinone	Grasses and broad	Systemic, absorbed through roots	Moderate	Moderate	Moderate
FUMIGANTS						
Zinc Phosphide	……	Vertebrates	Nerve toxin, with respiratory action	High	High	……
Aluminium phosphide	……	Vertebrates, insects	Nerve toxin, with respiratory action	……	High	High

Annex II: List of banned pesticides in Sierra Leone and POPs listed in the Stockholm Convention

1) 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.

2) 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.

POPs listed in the Stockholm Convention for Elimination

Parties must take measures to eliminate the production and use of the chemicals listed below.

Aldrin

Chlordane

Chlordecone

Decabromodiphenyl ether (commercial mixture, c-decaBDE)

Dieldrin

Endrin

Heptachlor

Hexabromobiphenyl

Hexabromocyclododecane (HBCDD)

Hexabromodiphenyl ether and heptabromodiphenyl ether

Hexachlorobenzene (HCB)

Hexachlorobutadiene

Alpha hexachlorocyclohexane

Beta hexachlorocyclohexane

Lindane

Mirex

Pentachlorobenzene

Pentachlorophenol and its salts and esters

Polychlorinated biphenyls (PCB)

Polychlorinated naphthalenes

Short-chain chlorinated paraffins (SCCPs)

Technical endosulfan and its related isomers

Tetrabromodiphenyl ether and pentabromodiphenyl ether

Toxaphene

Annex III: Code of Practice for Pesticide Management

Pesticides are one of many tools available for effective protection of crops from pests (insects and diseases) and weeds. However, pesticides require special care and handling before, during and after application. The following are some vital recommended practices for pesticide use and handling that can help protect human, the environment, livestock, wildlife and water resources.

Handling pesticides

- Eliminate or minimize exposure to pesticides during mixing, loading, cleaning and applying. Always read the pesticide label for information on required personal protection equipment.
- Know what to do in case of accidental pesticide exposure. Emergency wash area must be prepared ahead of spraying operations for personnel exposed to pesticides.
- Wash affected areas after possible exposure to skin and remove personal protective equipment prior to eating, drinking or smoking. Shower at the end of the day or after completion of application.
- Wash and inspect personal protective equipment after each use. Wash clothes exposed to pesticides separately from other laundry.
- Know what to do in case of pesticide poisoning. Have a pesticide first aid kit readily available. Check the product label for instructions in the event a pesticide is swallowed, or in the event of a serious dermal or inhalation exposure.
- Purchase only the amount of pesticide needed for the job.
- Develop an incident response plan for dealing with pesticide incidents quickly and effectively. A plan describes the pesticide storage, handling, disposal, and incident response practices at a given location. Incident response plans are required for locations involved in commercial pesticide application, non-commercial pesticide application, structural pest control, and locations which have bulk storage of pesticides and fertilizers.
- Mix and load pesticides and clean pesticide equipment to capture and contain spills, leaks, and wash water.
- Never mix, load pesticides, or clean application equipment near water wells. Follow product label requirements for safe isolation distances between pesticide use activities and water sources.
- Spraying operators must know the exact location of the area to be treated, as well as the potential hazard of spray drift or subsequent pesticide movement to surrounding areas.
- Calibrate spraying equipment properly before mixing and loading pesticides.
- Apply post-emergence herbicides when weeds are at their most vulnerable growth stage.
- Apply pesticides uniformly across the target.
- Use the lowest appropriate rate to minimize pesticide loss to the environment.

Storage of pesticides

- Follow label use, storage and disposal instructions.
- Store pesticides only in the original labelled container, separated from other products such as food, feed and seed, and in a locked building with appropriate warning signs.
- Rinse containers immediately after emptying.

Transporting of pesticides

- Follow all national regulations regarding the transport of pesticides.

Disposal of pesticides

- Dispose of empty paper bags, plastic bags and other types of containers.
- Do not burn any pesticide container in an open fire, such as in the field, in trash barrels or on burn piles.
- Do not reuse pesticide containers unless they are dedicated for reuse or unless they have been cleaned according to the pesticide manufacturer's protocol and are intended to be refilled with pesticides.
- Dispose of unusable or unwanted pesticides properly. The EPA-SL provides opportunities for the disposal of unusable and unwanted pesticides.
- Always read and follow all product label directions and precautions appearing on or included with pesticide containers.

Annex IV: Basic Principles of Integrated Pest Management

1. Identify pests, their hosts and beneficial organisms before taking action

The cause of the problem and associated plant or animal species must be correctly identified. For many plant problems, If the pest is not easily found, consider other causes, including abiotic (non-living) disorders, such as sunscald, wind or cold damage, inadequate moisture, etc. If the pest is found, an Entomologist can help identify insects. Once the pest is identified, determine the pest's life cycle, growth cycle and reproductive habits.

1. Establish monitoring guidelines for each pest species

Routine monitoring of both pests and natural enemies, is an important part of IPM. Methods of monitoring include visual inspection, pheromone and sticky traps, and sweep nets. Document and track both pest and beneficial organism population numbers. The ratio of natural enemies (usually insects) to pests should be taken into account before a pesticide is applied.

2. Establish an action threshold for the pest

A fundamental concept of IPM is that a certain number of individual pests can and should be tolerated. Farmers start by determining whether the pest will cause unacceptable damage to the value of their crop. What will happen if no action is taken? The action threshold in crop production is generally based on economics. The economic threshold is defined as the pest population level that produces damage equal to the cost of preventing damage by controlling the pest. The threshold is the pest density, or population level, at which management should occur.

3. Evaluate and implement control tactics

Select tactics that will be most effective, economical and have least impact on non-target species and the environment. Select methods that will impact beneficial organisms as little as possible while suppressing the pest. If a pesticide is one of the selected management tools, beneficial enemies will likely also be killed.

4. Monitor, evaluate and document the results

Use routine monitoring to determine the success of any management strategies. This allows to make adjustments to improve the effectiveness of future pest management strategies. Keep records to help determine what worked well, and what to change the following year.

Annex V: Persons met

a. Dr. Amadu T. Jalloh, Deputy Director, Animal Health, Livestock and Veterinary Services Division, MAF, Youyi Building
b. Dr. Amara Leno, Veterinary Officer, Livestock and Veterinary Services Division, MAF, Youyi Building
c. Dr. Braima D. James, Founder and CEO, Home Foods and Drinks, 14 Sumaila town, Freetown, Sierra Leone
d. Dr. J. E. D. Terry, Veterinary Consultant, 4 Mansaray Drive, Benguema, Waterloo Rural District
e. Foday M. Koroma, Plant Protection Officer (Retired), Allen Town, Freetown
f. Mr. Sorie Mohamed Kamara, Director, Livestock and Veterinary Services Division, MAF, Youyi Building
g. Ms Raymonda A. B. Johnson, Assistant Director/Head of Crop Protection, MAF, Freetown, Sierra Leone
h. Mohamed Ajuba Sheriff, Planning Evaluation Monitoring and Survey Division/MAF

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