PEST AND PESTICIDE MANAGEMENT PLAN
FOR THE
SECOND RURAL ECONOMIC DEVELOPMENT INITIATIVE (REDI II)
PROJECT

October 2018

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1.0 EXECUTIVE SUMMARY

The Government of Jamaica (GoJ) is in the process of seeking a $US 40 million loan from the World Bank to finance the second Rural Economic Development Initiative (REDI II). The project is aimed building on the gains of the first Rural Economic Development Initiative (REDI I) and is geared at improving market access and climate change resilience in tourism and agriculture. The project will be implemented by the Jamaica Social Investment Fund (JSIF) which has implemented REDI I as well as other World Bank Projects including the Inner-City Basic Services Project (ICBSP), Integrated Community Development Project (ICDP) and the Disaster Vulnerability Reduction Project (DVRP).

The project development objective (PDO) is to enhance access to markets and to climate resilient approaches for targeted beneficiaries. The project will include four components (Component 1, 2, 3, and 4) as described in section X. The implementation of sub-project interventions under components 1 and 2 are expected to benefit the country significantly through expansion and improvements in agriculture and community based tourism enterprises; increased access to markets; improved resilience to natural disasters; and promote social inclusion with a focus on youth and women.

Component 1 will involves investments in agricultural operations which requires the use of pesticides to improve crop quality and yield. Considering the significant environmental risks associated with the use of pesticides, the World Bank Operational Policy OP 4.09 will be triggered. This means, the Bank's environmental safeguards with respect to pesticide management must be applied and adhered to in addition to any other local environmental requirements when executing the project. OP 4.09 requires the preparation of a pesticide management plan as a standalone document. The objectives of the Pest Management Plan are to i) protection of human health and safety and the environment through the use of environmentally friendly and non-chemical best management practices; ii) effectively guide the use of pesticides by farmers through capacity building and monitoring; iii) perpetuate integrated pest management (IPM) technologies and practices as the first option for control of agricultural pests and diseases; and iv) Ensure compliance with the Bank's safeguards policies and national, regional and internal laws.

The JSIF environmental management system (EMS) was certified to ISO 14001:2004 Standards from January 2009 up until November 2017 after which our certification was upgraded to the most recent Standard, ISO 14001:2015. The JSIF also has significant experience implementing Bank funded projects including REDI I and therefore possesses the required capacity to implement the project within the confines of the required safeguard policies.

2.0 INTRODUCTION

The is currently seeking to secure a loan from the World Bank to fund the REDI II project with a view to enhance access to markets and to climate resilient approaches for targeted beneficiaries in agriculture and tourism. The proposed project will build on the achievements of REDI I on further improving market access to rural enterprises. The enhancements are expected to: (a) expand tested approaches to improve the environment for fostering rural growth, including by addressing relevant policy issues; (b) increase market orientation and strengthen commercial linkages between agricultural/fisheries and community tourism SMEs and their respective markets (c) further exploit tourism and agriculture linkages; (d) increase access to new technologies to improve productivity and adoption of climate smart technologies/practices in agriculture; and (e) improve basic infrastructure and agro-logistics for enhanced market access by rural producers and services providers, incorporating critical climate-resilient infrastructure specifications and methods.

The project consists of four (4) components as follows. Component 1 will fund investments in Climate Resilient Agricultural and Community Tourism Enterprises. Subcomponent 2.1 will finance subprojects aimed at strengthening public infrastructure (IBRD US$ 5.0 million). Component 3 will focuses on funding for project management (IBRD US$6.0 million) while Component 4 which is a "zero component" is geared at contingent emergency response which will be triggered only in the case of an emergency of a specified threshold.

Some of the agricultural activities to be implemented under Component 2 will include the application of agricultural chemicals. These chemicals known as pesticides are used to kill or control weeds, insects, rodents, nematodes and pathogens with a view to improve agricultural production and product quality. Unfortunately, some of the pesticides used in farming are hazardous to human health and the environment, especially if they are incorrectly transported, stored and applied (See Appendix 2). Some of the potential risks associated with pesticides are environmental pollution; killing of fish and other wildlife; reduction in water quality and availability of potable water; possible long-term and short-term human health effects from chronic or acute exposure; eradication of beneficial insect species and pests' natural enemies; pest resurgence due to resistance to pesticides; carcinogenicity; and teratogenicity.

The adverse impacts of pesticides is exacerbated by the fact that there is inadequate health and safety data on many pesticides currently in use. Also, there are some inconsistencies in the regulation of pesticides. Considering the high possibility of pesticide use in the execution of REDI II, the World Bank's Operational Policy on Pesticide Management (OP 4.01) is triggered. This requires the preparation of a pesticide management plan which

provide a comprehensive guide for the use of pesticides under REDI II. The Pest Management Plan will complement the ESMF to ensure that environmental and social impacts associated pest control activities are minimized. The objectives of the Pest Management Plan are to i) protection of human health and safety and the environment through the use of environmentally friendly and non-chemical best management practices; ii) effectively guide the use of pesticides by farmers through capacity building and monitoring; iii) perpetuate integrated pest management (IPM) technologies and practices as the first option for control of agricultural pests and diseases; and iv) Ensure compliance with the Bank's safeguards policies and national, regional and internal laws.

REDI II is characterized as a Category B project as it is not anticipated to cause significant adverse environmental and social impacts. However, some of the proposed sub-projects including construction of agro-processing and sanitation facilities, rehabilitation of roads and bridges, construction of greenhouses, installation of irrigation systems and creation of nature trails may have localized but reversible environmental impacts.

As an ISO 14001:2015 certified organization, the JSIF is committed to environmental protection and preservation of human health. In keeping with JSIF's Policy to protect Jamaica's natural environment, the organization will manage pests in the applicable agricultural operations using the principles and approaches of integrated Pest Management (IPM). The JSIF's IPM plan seeks to:

- Minimize the risk to human health and the environment
- Promote the use of environmentally friendly practices and non-chemical pest management strategies;
- Provide for implementation of an IPM action plan in the event that serious pest management issues are encountered;
- Apply technologies, practices and procedures that requires a significant reduction in the application of pesticides;
- Minimize the use of pesticides or use pesticide as a last resort;
- Effectively minimize pesticide pollution through capacity building and monitoring of farmers;
- Ensure compliance with applicable local and international laws, regulations and requirements of World Bank OP/BP 4.09
- Adopt a comprehensive approach to pest management; and
- Improve agricultural product quality through proper pest management; and

3.0 RATIONALE

The protection of the environment and human health is a key concern of multiple stakeholders including the World Bank, local environmental authorities and

environmentalists alike. The Pest Management Plan (PMP) provides the framework which guides the procurement, handling, transportation, storage, distribution, application and disposal of pesticides to prevent undesirable environmental and human impacts. It seeks to allay some of the concerns of the relevant stakeholders by providing a systematic approach to managing pesticides when it becomes necessary to use them. The plan serves as a means to protect our natural ecosystems, wildlife and potable water resources, and to ensure food safety, through the application of integrated pest management or non-chemical approaches.

4.0 PROJECT COMPONENTS

Component 1. Climate Resilient Agricultural and Community Tourism Subprojects
This component will support the identification, design and implementation of competitive and climate resilient business ventures in the agricultural/fisheries and community tourism sectors put forward by beneficiaries, including small farmer/fisher associations (i.e., cooperatives, friendly or benevolent societies, or any formal form of legally established associations), agribusinesses, community tourism operators and related entrepreneurs such as craft makers . The activities under Component 1 are small in scale and scope and therefore unlikely to have long-term or cumulative impacts. Any impacts would be short-term, highly localized, and therefore easily mitigated through standard mitigation measures.

Subcomponent 2.1 – Strengthening Public Infrastructure (IBRD US$ 5.0 million). This component will finance small scale public investments aimed at improving the efficiency of priority value chains for selected products and capacity building of related public-sector agencies. This sub-component will provide financing for civil works, goods and consulting services, with the objective of improving the overall investment opportunities and removing existent constraints for rural development. These public investment subprojects could comprise civil works, goods, consulting services and incremental operating costs, to help implement. Most of the impacts related to the implementation of

Component 2 would therefore be minor, short-term and highly localized and thus easily mitigated through standard mitigation measures.

Component 3. Project Management (IBRD US$6.0 million). To implement the Project, JSIF will establish and maintain a technical Project Management Team (PMT), funded by this component.

Component 4. Contingent Emergency Response (US$ 0). The objective of this component is to support the Government's emergency response and reconstruction efforts in case of an eligible emergency. An eligible emergency is an event that has caused, or is likely to imminently cause, major adverse economic and/or social impacts associated with natural or man-made crises or disasters at the national or regional levels.

LEGAL AND REGULATORY FRAMEWORKS

National Regulatory Framework

The National Environment and Planning Agency (NEPA), the body primarily responsible for environmental regulations, administers a Permit and License System (P&L) to which construction and operation of all Jamaican Facilities and development projects are subscribed. NEPA operates under the auspices of the National Resources Conservation Act (NRCA). Some of the proposed projects to be implemented under REDI II will require an environmental permit from NEPA. The permit will include the necessary terms and conditions for implementation of the projects. Depending on the environmental sensitivity or vulnerability of contiguous ecosystems, as well as the scale of the project, NEPA may require the preparation of a full Environmental Impact Assessment (EIA) prior to granting the environmental permit. NEPA also grants license to facilities that discharge effluents into the atmosphere, ground, and/or surface water. Considering the potential for environmental pollution associated with the use of pesticides, it is possible that REDI II can cause some interaction with NEPA if a discharge occur.

There are also other Government agencies that have environmental management and regulatory responsibilities as indicated below as well as in Table 1.

I. Pesticide Control Authority, Pesticide Act 1975
II. National Irrigation Commission, Irrigation Act 1949
III. National Land Agency, Land Acquisition Act 1947
IV. National Land Agency, Registration of Titles Act 1973
V. Water Resources Authority, Water Resources Act 1995
VI. National Environment and Planning Agency, The National Resources Conservation Authority Act 1991

Pesticide Control Authority

The Pesticides Control Authority (PCA) is a statutory body of the Government of Jamaica, mandated through the Pesticides Act of 1975 to regulate, manage and control pesticide usage in Jamaica. Other Acts also impinge on pesticide control, but the Pesticides Act (1975) was legislated to allow for specific control of the pesticide industry.

Embodied within the Pesticides Act (1975) is the formation of a Pesticides Control Authority (PCA). The members of the Board are appointed by the Minister of Health and are made up of representatives from public and private sector organizations that have the expertise required for pesticide related matters. The Board meets monthly and sets the policies to regulate the industry in relation to the importation, manufacture, use, distribution and control of pesticides, among other things.

The Ministry of Health has portfolio responsibility for the Pesticides Control Authority (PCA).

The PCA maintains a register of:

- Pesticides;
- Pesticide manufacturers;
- Pesticide control applicators;
- Premises license to sell pesticides;
- Pest Control Operators (Businesses);
- Pest Control Servicemen; and
- Managed and restricted pesticides.

Most of the above information can be found on the organization's website http://www.caribpesticides.net/index1.asp.

The functions as outlined in the Pesticides Act are to:

i. Register pesticides;
ii. License persons to import or manufacture registered pesticides;
iii. Authorize persons to sell restricted pesticides;
iv. Register premises in which a restricted pesticide may be sold;
v. License pest control operators;
vi. Consider and determine applications made pursuant to this Act and to deal with all aspects of the importation, manufacture packaging, preparation for sale, sale, disposal and use of pesticides and to advise the Minister on all matters in relation thereto; and
vii. Do such other things as may be expedient or necessary for the proper performance of its functions under this Act.

The PCA is required to make available to the public instructional materials concerning pesticide management techniques. For the purpose of this plan, the Farm Store Regulations are considered very important considering that we are concerned with agricultural projects. While integrated pest management (IPM) is not addressed specifically in any regulations, however, this approach is considered the best management practice for pesticides.

National Irrigation Commission

The primary role of the National Irrigation Commission Limited (NIC) is to provide irrigation services to the agricultural sector. In addition to irrigation, water is made available to some industrial and commercial operations through some of its systems.

NIC's main functions are:

i. To manage, operate, maintain and expand existing and future irrigation schemes and systems as may be established by the Government of Jamaica;
ii. To provide drainage services in the "Black Black River area", that is a) that portion of the Black River including the banks thereof, from the sea to Lacovia Bridge; b) the Upper Morass area; c) the Y. S. River area; d) the areas described in the Additional Areas (Parish of St. Elizabeth) Reclamation Order, 1953, published in the Jamaica Gazette Supplement Proclamations, Rules and Regulations on the 26th day of January, 1953; and e) such other areas in the parish

of St. Elizabeth as the Minister may, by order, specify for the purposes of Irrigation Act.

iii. To fix and collect the rates or charges and to be paid for the use of such water

National Land Agency

The National Land Agency (NLA) is an Executive Agency that falls under the Ministry of Economic Growth and Job Creation. The establishment of the NLA is the result of the Public Sector Modernization Programme of the Government of Jamaica. It brings together the core land information functions of Government under one roof, and includes: Land Titles; Surveys & Mapping; Land Valuation & Estate (Crown Land) Management. This merger enables the Government to build on the synergy of these combined functions and create a modern national land (spatial) information system to support sustainable development.

It is recognized that more timely information about Jamaica's geography is critical for decision makers in both the public and private sectors. The traditional services that the Agency provides, such as land registration, is one of the corner stones for development, in that most investment decisions for both small and large enterprises, are linked to land titling. A simple example is, the requirement for most business loans to be registered against a Registered Title. Titling also extends into the social fabric of civil society with the Government's initiative to provide land to the less fortunate so that they may improve the quality of life for their families.

Water Resources Authority

The Water Resources Authority (WRA) is responsible for the management, protection, and controlled allocation and use of Jamaica's water resources. The WRA maintains a hydrological database and provides data, information, and technical assistance to government and non-government institutions. The mission of the WRA is to ensure the sustainability of Jamaica's water resources through continual assessment and proper management, promotion of conservation and protection, and optimal development of these resources. The WRA also will ensure rational and equitable allocation of the nation's water resources and to reduce conflicts among water users.

The major activities of the Water Resources Authority (WRA) include hydrologic data collection, compilation, and analysis; water resources investigation, assessment, and planning; water resources allocation; and environmental monitoring and impact assessment.

i. Water resources allocation through licensing of surface and underground water abstractions.
ii. Licensing of well drilling and altering of wells.
iii. Assessment of water resources for agricultural and housing developments.
iv. Selection of solid and hazardous waste disposal sites; cemetery sites and other waste disposal sites.
v. Groundwater pollution risk mapping.
vi. Flood plain mapping.
vii. Hydrological forecasting.
viii. Preparation of water management plans to satisfy national development objectives.

National Environment and Planning Agency

NEPA operates under the following Acts and all Regulations made hereunder:

The Natural Resources Conservation Authority Act (1991)

The Natural Resources Conservation Authority Act provides for the management, conservation and protection of the natural resources of Jamaica. The Act establishes the Natural Resources Conservation Authority, a body of persons appointed by the Minister of the Environment. The functions of the Authority include the taking of such steps that are necessary to ensure the effective management of the physical environment of Jamaica; and the management of marine parks and protected areas. Section 10 of the NRCA Act gives the NRCA the power to directly request EIAs from any applicant for a permit or (even more broadly) from any person who is doing any undertaking in a prescribed area where it is of the opinion that the environment is likely to have adverse effects due to the activities. The Natural Resources (Prescribed Areas) (Prohibition of Categories of

Enterprise, Construction and Development) Order, 1996 and the Permits & Licensing Regulations was passed pursuant to section 9 of the Natural Resources Conservation Authority Act, 1991. The Order provides that the entire island of Jamaica is a prescribed area and lists specified categories of enterprise, construction or development that require a permit. The Act also addresses Sewage and Trade Effluent discharges as well as air emissions. Regulations are being developed to specifically address these sources of pollution. Under the new regulations the polluter pays principle will be incorporated.

Operational Policy 4.09 on Pest Management seeks to ensure that rural development and health sector projects avoid or minimize the use of harmful pesticides and where use is inevitable, measures are put in place to mitigate against environmental impacts. A preferred solution is to use Integrated Pest Management (IPM) techniques and encourage their use in the whole of the sectors concerned. The Bank requires that any pesticide it finances be manufactured, packaged, labelled, handled, stored, disposed of, and applied according to standards acceptable to the Bank. The Bank does not finance formulated products that fall in WHO classes IA and IB, or formulations of products in Class II, if (a) the country lacks restrictions on their distribution and use; or (b) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, store, and apply these products properly (see **Appendix 2**).

Table 1: Agencies with applicable regulatory responsibilities

AGENCY	REPONSIBILITY	ACT/LEGISLATION
Office of Disaster Preparedness and Emergency Management (ODPEM)	The Act gives ODPEM the authority to coordinate national disaster response activities and gives limited power to the Prime Minister in making disaster declarations. The limited power can be exercised by the Prime Minister during disaster events or an impending threat based on the advice of ODPEM. The revised Disaster Management Act will	Disaster Preparedness and Emergency Management (DPEM) Act (1993)

	provide guidelines for the declaration of disaster areas, and evacuation orders. It will also give power to ODPEM to create regulations in disaster management and gives legal standing to authorities and documents pertaining to disaster management.	
Ministry of Local Government and Community Development (MLGCD)	The MLGCD through the Parish Councils enforces the requirements or guidelines for land use based on legal instruments known as Development Orders which covers most of the urban and coastal areas of Jamaica. "Development Orders are to control both rural and urban development, ensure proper sanitary conveniences, coordinate building of roads and other public services, and protect public amenities (conservation areas, wetlands, mangroves)". The Act outlines specific standards for land use, density and zoning in reducing disaster related risks.	The Town and Country Planning Act (1958)
National Solid Waste Management Authority (NSWMA)	The Act governs the actions, procedures and operations of the National Solid Waste Management Authority (NSWMA) as it relates to the collection and disposal of waste in safeguarding public health. The Act also highlights operational guidelines for hazardous waste as a transboundary hazard. Sanctions are incorporated into the Act and enforcement is the responsibility of various organizations/agencies. The NSWMA is the chief regulatory	The National Solid Waste Management Act (2002)
	Agency for the enforcing provisions under this Act.	

NEPA	The Act was established to protect and manage Jamaica's natural resources and control pollution. The guidelines provided by this Act cover monitoring and enforcement of environmental laws and regulations with regards to watershed protection and beach control among other issues. "The Environmental Management Unit of the Ministry of Health and local planning authorities monitor construction work to ensure that all development restrictions and requirements are properly adhered to"13. Sanctions and penalties can be assigned to particular offences based on breaches of the Act.	The National Resources Conservation Authority (NRCA) Act (1991)
MLGCD	The Building Act 2018 has been passed by both houses of Parliament and will be enacted into law. The Local Authorities or Municipal Councils under the auspices of the Ministry of Local Government and Community Development (MLGCD) are responsible for enforcing the building regulations under the Act.	Building Act
MLGCD	The Parish Building Regulation and Development Orders outline and guide the development process in Jamaica. The Parish Building Regulations provide guidelines to developers based on the existing building codes. The Parish Development Orders are used to ensure that premises in areas of the parish are not used contrary to the purpose provided by developers and residents. Other regulatory and related instruments pertaining to DRR include but are not limited to the Severe Weather Orders, Draft National Building Codes, and international legislative considerations and guidelines.	The Parish Building Regulation and Development Orders

Water Resources Authority (WRA)	The Act gives the WRA authority regulatory power over the country's water resources. The WRA is responsible for planning, development and equitable allocation of water resources. The Act gives power to the Minister of Water Land Environment and Climate Change to guarantee loans to the WRA where needed. Provisions for the abstraction and use of water, control of water quality, control and protection of underground water are all outlined (WRA 1995). The Act allows for punishment of polluters of water resources.	The Water Resources Act (1995)
Ministry of Health (MOH)	The Public Health Act (1974) outlines the provisions and guidelines for the establishment of the Central Health Committee and Local Boards to contain and treat various diseases. The MOH regulates the immunization of children, assembly of persons, and closure of public places for health reasons. In 1985, the Act was amended to include monitoring of imported food, food preparation and distribution. Hazard Analysis Critical Control Point (HACCP) system is a procedure utilized by the Ministry of Health to ensure safe food production. Penalties can be applied where provisions and guidelines are not adhered to.	The Public Health Act (1974)
Forestry Department	The Act provide for the protection and management of designated forest reserves. It empowers designated persons to enter premises in forest Reserves, Forest management/protected Area or lands which need to be declared; and to ensure compliance with the Act and Regulations.	The Forest Act (1996)

Pesticide Control Authority	The Act is designed to manage and regulate the use of pesticides which are potentially harmful to the environment. It empowers designated personnel to enter any premises or vehicle where extermination is being carried out, pesticides are manufactured, stored, kept to inspect, investigate and take samples and where required seize and detain any records or articles as evidence of the commission of an office.	The Pesticides Act (1987)
Ministry of Health	The Act is designed to control air pollution by regulating the amount of any noxious or offensive gas, which is permitted to escape or discharged from any affected premises into the air. The Law empowers designated persons to enter, inspect or examine premises where work is in progress and take samples, test of smoke, fumes, gas, or dust or make enquiries.	The Clean Air Act (1964)
NEPA	The Act provides for the protection of watersheds and areas adjoining watersheds and promote the conservation of water resources.	The Watersheds Protection Act (1963)
Jamaica Defence Force	The Defense Act (1962) governs the actions, procedures and operations of the Jamaica Defense Force (JDF). The Act outlines the development of the regular and reserve forces along with their names. It also outlines the duties of the Defense Board as defined by the Act and charges the JDF with the defense and maintenance order of Jamaica. The JDF is deployed during the public state of emergency once declared by the Governor General to ensure that public order is maintained.	The Defense Act (1962)

Ministry of Labour and Social Security (MLSS)	The Factories Act speaks to: Ensuring the safety, health and welfare of persons who are employed in any factory or in connection with machinery, and in particular, and without prejudice to the generality of the foregoing provisions, any such regulations may provide for: • the safe means of approach or access to, and exit from, any factory, or machinery; • the fencing and covering of all dangerous places or machines; • life-saving and first aid appliances; • securing safety in connection with all operations carried on in a factory; • securing safety in connection with the use of cranes, winches, pully-blocks and of all engines, machinery, mechanical gear and contrivances generally whatsoever; • the proper ventilation of any factory, having regard to the nature of the process carried on therein; • the sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory	The Factories Act (1943)
	The National Heritage Trust Act: ▪ outlines the role of the trust in the preservation of national monuments and anything designated as protected national heritage, and also the recording of any precious objects or works of art to be preserved as	The National Heritage Trust Act (1985)

	well as protecting botanical or animal life ▪ Governs the administration of penalties and imprisonment for the destruction or removal of anything designated a national monument or protected.	
Ministry of Science Technology Energy and Mining	The vision of the National Energy Policy is for Jamaica to have modern, efficient, diversified and sustainable energy sector providing affordable and accessible energy supplies with long-term energy security and supported by informed public behavior on energy issues and an appropriate policy, regulatory and institutional framework. Some of the goals of the National Energy Policy are: • Government Ministries and Agencies are model/leader in energy conservation and environmental stewardship in Jamaica. • Jamaicans use energy wisely and aggressively pursue opportunities for conservation and efficiency. • Jamaica realizes its energy resources potential through the development of renewable energy sources and enhances its international competitiveness, energy security whilst reducing its carbon footprint.	National Energy Policy (2009)

5.0 IMPACTS AND CHALLENGES IDENTIFIED

Pesticides are very harmful pollutants. The transportation, storage, handling and application of pesticides will have negative impact on the environment and human

health if proper procedures are not followed. There are multiple impacts and challenges associated with pesticide use. These include:

- Pollution of ground and surface water resources;
- Killing of fish and other aquatic life;
- Development of pest resistance due overuse of pesticides;
- Public health issues associated with chronic and acute exposure to pesticides;
- Bioaccumulation or bio-concentration of pesticides in food chain;
- Food safety issues;
- Poisoning from improper use of pesticides by farmers and farm assistants;
- Impact from improper disposal of pesticide containers;
- Accidental or incidental introduction of invasive species;
- Unauthorized production and distribution of pesticides;
- Limited capacity of farmers to adequately manage pesticides.

6.0 ACTION PLAN

The sustainable management of pest will require an integrated approach which involves collaboration, consultation, awareness training and capacity building, adoption of non-chemical and chemical approaches coupled with other sound environmental management strategies.

The plan of action to achieve the objectives of the pesticide management plan will include bot not limited to:

- Stakeholder consultation and involvement
- PMP Communication and IPM/PMP Orientation Workshops
- Awareness and capacity building in IPM
- General pesticide management awareness creation through the work of Government and industry stakeholders
- Prevention of new pest Infestations and management of established pests
- Participatory monitoring and evaluation
- Ensuring sustainability
- Annual reporting and management reviews

7.0 GENERAL APPROACH

The focus of the agricultural operations to be supported under the project is to produce high yield and excellent quality product. However, in order to achieve this, pest and

disease must be controlled adequately which may require the use of pesticides. However, our approach will focus firstly on integrated pest management as the strategy for pest control. The strategy will support an integrated and comprehensive approach which includes cultural practices, plant nutrition, traps, natural enemies, mechanical control and biological pesticides to control pests. Agricultural pesticides may be inevitably required to achieve the project's objectives but this will be used only as a last resort or only when other means of pest control has failed. Where the use of chemical pesticides is inevitable, the most environmentally friendly products will be used. Only pesticides that are approved for use by the World Bank will be procured and use in the project.

The Project will provide the necessary resources to ensure that all the applicable stakeholders along the value chain receive adequate training in all the areas that will promote IPM and sustainable use of pesticides. A holistic and all-encompassing approach will be adopted to ensure farmers and other stakeholders are capable of managing pests and diseases throughout all the stages of the production cycle. Farmers and operators will be trained and encouraged to make detailed observations in their fields, storage areas and processing facilities to ensure the detection of early infestations and make the appropriate management decisions.

The project will maintain a robust means of communication between project beneficiaries and other stakeholders to ensure that they are always in the know regarding any developments in pest management with regards to IPM strategies, new and improved pesticides, pest outbreaks and any other pertinent information.

8.0 INTEGRATED PEST MANAGEMENT (IPM)

Integrated pest management (IPM) will be applied as the first resort to managing pest on the REDI II project. IPM is a comprehensive method or approach for managing pests that combines cultural, biological, and chemical control strategies into a single complimentary management strategy that maintains long-term control of pest populations with minimal environmental impact and economic loss. This is considered the best approach to control pests and will be applied under the JSIF pest

management plan. This plan will minimize pesticide use and protect the environment since it embodies the:

- Tolerance of some pest numbers;
- Setting of pest threshold levels;
- Protection of beneficial insects if present;
- Use of chemical spray as the last resort;
- Selective application of pesticides; and
- Provision of proper plant care to improve crop resistance to pest.

The IPM approach is describes under the subsequent subsections. The mechanism of implementation is outlined in the REDI II Operations Manual.

8.1 Characterization of Pests

Pests are any organisms that:

- Are noxious, destructive, or troublesome;
- Competes with desirable organisms for resources;
- Threatens the health and appearance or value of desirable plants; and
- Are harmful to human.
- Pests include pathogens, nuisance wild animals, annoying insects, molds, weeds, etc.
- Agricultural pests are organisms that feed on ornamental plants, agricultural crops and animals.
- Agricultural pests include various insects, weeds, fungi, viruses, bacteria, worms, snails, slugs, rats, mice, and birds.

8.2 Characterization of the Pest Problem and Set Action Threshold Levels

Having pests onsite **Do Not** necessarily mean a pest problem exists. Therefore, under this plan, the agricultural specialists should set **Action Threshold** which will trigger the need for intervention. An Action Threshold is defined as the pest population or plant damage level that requires action to prevent irreversible damage or economic losses. If the pest presence or plant damage for example is greater than the action threshold then a pest problem exist which needs intervention.

The agricultural specialists will be required to consider several factors including but not limited to the following when trying to determine action threshold levels:

- Level of loss that can be tolerated;
- Plant tolerance or resistance to the pests;
- Weather and site conditions;
- Time of the year;
- Pest damage potential;
- Presence and adequacy of natural pest enemies; and
- Pest reproductive characteristics.

8.3 Knowing what is Involved in IPM

The agricultural specialists will ensure that the farmers:

- Monitor crops regularly
- Become familiar with pests and beneficial insects of each crop;
- Correctly identify the type of pests;
- Understand the life cycles and seasonal occurrences of the pests; and
- Take the appropriate measures.

8.4 Knowing the Key Features of IPM

The following features will form the basis of the IPM plan. The agricultural specialist will be required to:

- Perform regular monitoring;
- Use a combination of control methods to curtail pest problems;
- Minimizing harm to beneficial organisms and the environment; and
- Decide whether treatment is necessary after assessing the pest populations.

9.5. Monitoring

The project sites will be inspected on a regular basis to collect information about the pests and to make pest management decisions. Information such as pest identity, population level, life stages, and potential for natural control will be observed. The key pests will be identified based on population size and level of

plant damage. Once the key pests are identified, a combination of measures will be implemented to control the pest population to a desired level.

9.6. Apply the Necessary Combination of Control Measures

As mentioned earlier, IPM involves a combination of control measures both chemical and non-chemical. Like other IPM plans, the JSIF IPM plan is aimed at using chemicals minimally and as a last resort. Cultural, physical, and biological controls will take precedence to chemical control where practical.

Cultural Control – The agricultural specialist will help farmers to adopt the correct farming practices such as crop selection, proper fertilizing, irrigation, field sanitation, time of planting, crop rotation, and intercropping that either reduce pest population or reduce the crop susceptibility to pest population. This method will include:

- Selecting crops that are tolerant to the environment and are resistant or tolerant to the pests of concern;
- Providing the required fertilizers based on crop requirement and soil type – Healthy plants are more resistant to pests;
- Adequately irrigate crops to improve health and resistance to pests;
- Cleaning up field after harvesting to reduce the quantity of food available for pest growth;
- Time crop planting so that harvesting coincides with the period when pest population is the lowest;
- Rotating crops from different family to minimize built up of pest. For example, rotating tomatoes, cabbage, carrots, and pumpkin instead of using cabbage, broccoli, and cauliflower which belong to the same family.
- Intercropping susceptible crops with plants that are more tolerant or resistant tend to reduce pest population. For example, intercropping cabbage with tomato tend to reduce Diamond Back Moth infestation.

Physical Control – This control method involves the use of operational equipment and staff to physically controlling the pests. In this approach, farmers will be required to:

- Identify and physically remove insect pests from the plants;

- Manually or mechanically control weed;
- Tilling soils to kill mature insects, larva, and eggs
- Ploughing of soil kill grown weed or weed seeds; and
- Trapping of insects in pits in the ground.

Biological Control – Where practical, the agricultural specialist shall use or promote the use of natural pest control agents to effect pest management. This can be done by either introducing natural enemies or create a suitable environment for the growth of existing species. Depending on the type of crop being produced and the pest problem the following can be done:

- Introduction of predatory insects or natural enemies such as lacewings, ladybirds, Assassin bugs, predatory caterpillar, praying mantises, and spiders;
- Introduction of parasites such as Encarsia Wasp;
- Use of pathogenic insecticides with fungi, bacteria, or viruses as active ingredient. Baccillus thuringiensis is a common microbial pathogen used for caterpillar control; and
- Protection of natural enemies by not spraying non-targeted areas and maintaining habitats.

Chemical Control – Pesticide is the most common method of pest control because of its effectiveness, however chemicals have adverse impact on the environment and human health consequently this programme intends to use chemical control as a compliment to other control measures in effecting pest control. The following are chemical use guidelines that will be followed under this Plan:

- Pesticides will be used only on a minimal basis and as a last resort
- Selective pesticides will be used when the problem is caused by a single pests;
- Pesticides will be used only on an as need basis and Not for preventative pest control treatment;
- Pesticides will be used in conjunction with trap cropping technique when necessary;
- The habitats of natural enemies and predators will be avoided when applying pesticides;
- Pesticides will be carefully selected to match the pest problems;

- Low toxicity and low persistence pesticides such as biological insecticides will be selected over more toxic and persistent chemicals; and
- Proper chemical mixing and application procedures will be followed to reduce the need for excessive or repeated treatment.

9.7. Major Pests and Diseases of Cabbage

This section describes the major pests and diseases associated with selected vegetables that are likely to be supported under REDI II.

9.7.1 Major Pest and Diseases of crucifers (Cabbage, pack choy, Broccoli, cauliflower)

No.	Major pests and Diseases	Comments
1	Diamond-back moth (DBM) (*Plutella xylostella)*	It is the most serious pest of cabbage. DBM female moth lays its eggs singly. Eggs are glued to the underside of leaves and hatch after 3-5 days into green larvae. Larvae creep to underside of leaf, pierce the epidermis and tunnel or bore through the leaf tissue. Progressively eat leaf from underneath leaving the upper cuticle intact creating a bizarre window, which later disintegrates.
2	Webworms or cabbage borer (*Hellula undulalis)*	The light brown larvae or caterpillars of the cabbage webworm bore into the main veins of the leaves of cabbages and later into the centre of the stems, where they then feed. This makes these pests very difficult to control with pesticides.
3	Cabbage aphids (*Brevicoryne brassicae)*	Usually occur in large numbers, mainly during dry spells. Sucking pests, grey or green with soft pear shaped bodies often in colonies on lower side of leaves. Suck sap causing stunting growth and honeydew excretes on leaves
4	Cutworm (*Agrotis sp)*	Dull coloured moths lay eggs in soil surface or on stems. Mature larvae hide during day and emerge at night to feed on crop causing damage by cutting young plant stems at the base and feeding on foliage. Larvae bend characteristically in an o-shaped when disturbed

5	Bacteria soft rot (*Erwinia carotovora)*	Is a major disease of cabbage. Attacks the leaves of cabbage and affected areas take on a water-soaked appearance and start to decay, emitting an unpleasant smell. Cabbage heads decay rapidly and turn dark.
6	Root knot nematode (*Meloidogyne spp.)*	Nematodes invade roots causing swelling and deformation of roots (galls on roots). Stunted growth and chlorosis are above-ground symptoms
7	Black rot	Chlorotic discoloration on leaves, which turn to dark brown or black. Black discoloration of the vascular bundles and internal tissue break down.

9.7.2 **Major Pests and Diseases of Cucurbits (cucumber, melon, pumpkin and squash)**

No.	Major pests and Diseases	Comments
1	Aphids *(Aphis gossypii)*	Are common on cucurbits. Occur in colonies of green to blackish aphids under leaves, where they suck the sap. Move from plant to plant in their winged form and transmit virus diseases.
2	Melon flies	Very small black fly that pierces fruits of plants of cucurbit family and lay eggs in them. Eggs hatch into white maggots which feed inside fruits, causing sunken, discoloured patches and distortions and open cracks.
3	White flies *(Bemisia tabaci)*	White fly adults are small, winged insects that fly off readily when disturbed. Attack cucurbits, sucking sap and secreting sticky honey dew on which black mould develops. Adult transmits various virus diseases which damage cucurbits
4	Cucumber mosaic virus disease (CMV)	Major disease of cucumber transmitted by aphids. Attacked plant leaves become mottled, distorted and stunted, and the leaf edges curl downwards. Fruits produced by these plants show pale green areas mixed with dark green spots
5	Powdery mildew (*Erysiphe cichoracearum)*	Is a very serious fungus disease that affects leaves of cucurbits, causing them to dry up and die. Can be recognized by white powdery spots on upper and lower leaf surfaces and spread from older to younger leaves.
6	Angular leaf spot (*Pseudomonas lachrymans)*	Is a major cucumber pest that attacks leaves, stems and fruits
7	Downy mildew *(Pseudoperonospora cubensis)*	Is a major cucumber pest that attacks leaves

9.7.3 Major Pests and Diseases of Eggplant (Aubergine)

No.	Major pests and Diseases	Comments
1	Budworms (*Scrobipalpa blasigona)*	Small brown caterpillars of budworms bore into flower buds to feed inside flowers causing them to drop off and plant cannot produce any fruits
2	Epilachna beetles (*Epilachna chrysomelina)*	Is a major pest that feed on leaves of egg plants by scraping surface and reducing leaves to skeletons
3	Jassis (*Jacobiasca spp./Empoasca spp.)*	Are small, green and very mobile insects that live on lower and upper side of plant leaves. Suck juice from leaves and inject poisonous substances that cause leaves to first turn yellow, then brown and dry, a condition known as 'hopper burn'
4	Mole crickets (*Brachytrupes spp)*	Live in soil, and attach and feed on roots of many vegetables. Attack seedlings or young transplants especially at night. Are large brown insects found mainly in sandy areas
5	Root-knot nematodes (*Meloidogyne spp)*	Are microscopically small, round worms that live in soil and in the roots of egg plants. Affected roots swell (gall) become malformed inhibiting plant growth.
6	Stem and fruit borers *(Leucinodes orbonalis)*	White larvae or caterpillars of the pest bore into top sections of fruits and stems of fruits and stem of eggplants. Tunnel causing plants to grow poorly and prematurely. Fruits change colour and taste through stems sometimes die
7	Damping-off disease (*Pythium spp)*	Major disease that affects young seedlings in the nursery. Seedlings become constricted near ground surface and then collapse and many die.
8	Wilt disease (*Fusarium semisectum)*	Soil fungus disease that causes egg plants to wilt. Leaves turn yellow and plant dies.

9.7.4 Major Pests and Diseases of Lettuce

No.	Major pests and Diseases	Comments
1	Cutworms (*Agrotis spp.)*	Large, brownish-black caterpillars of cutworms damage young lettuces by cutting through stems at ground level at night, causing plant to collapse and die. Hide in soil during daytime and emerge at night to feed on lettuce
2	Damping-off disease *(Pythium spp.)*	Fungus disease that is present in soil. It infects stems and roots of lettuce seedlings in the nursery or when just planted in the field.

9.7.5 Major Pests and Diseases of Okra

No.	Major pests and Diseases	Comments
1	Aphids *(Aphis gossypii, Myzus persicae)*	Several species of aphids affect okra leaves and young fruits. Are very small, light to dark green, round insects that suck sap from okra leaves, causing leaves to turn yellow and become twisted; later plants may wilt and die
2	Cotton strainers (*Dysdercus spp.)* and other sucking bugs (*Nezara viridula)*	Cotton stainer adults and nymphs are very common on okra plants at fruiting stage and abundant during dry season. When strainers attack mature fruits, they damage the seeds. The bugs are conspicuously red, with black bands. They pierce through both young and mature fruits and suck the seeds inside. Attacked fruits shrivel and then fall. Other bugs that attack okra plants are stink bugs and shield bugs. These bugs make feeding holes in okra fruits causing necrosis and these results in spotting, deformation and shedding of fruits.

3	Flea beetles (*Nisotra spp., Podagrica spp.)*	Very common pest that occur on almost all okra plants. Feed on okra leaves and make many small holes in the leaves
4	Root-knot nematodes (*Meloidogyne spp.)*	Several species of soil-living root-not nematodes are major pests of okra plants. These same species also attack eggplant, tomato, pepper, cabbage, carrot and other vegetables. Form swellings known as galls and other malformations on okra roots. Plant become stunted and may die
5	Anthracnose disease *(Colletotrichum spp.)*	Disease affects leaves of okra, on which dark necrotic spots will begin to appear; later leaves become badly wrinkled and are then completely destroyed. Sometimes affects petioles of okra flowers and fruits causing many to drop off.
6	Leaf curl virus and mosaic virus	Okra suffers from these two major virus diseases. In affected plants, leaves become small, cup-shaped and/ or yellow (chlorotic), mottled and distorted; plants become stunted. Viruses transmitted by flea beetles, aphids and white flies.
7	Wilt disease (*Fusarium pallidoroseum)*	This soil-borne disease is caused by two species of fungi that infect the roots, stems, leaves and fruiting stalks. Leaves initially show dark patches of mould on lower surface, then roll, wilt and drop off

9.7.6 Major Pests and Diseases of Onions

No.	Major pests and Diseases	Comments
1	Onion flies (*Delia antique)*	A major pest of onions. Small, white, headless larvae (maggots) feed just above base of seedlings. Attacked plants die. Larvae are also found in developing onion bulbs.
2	Onion thrips (*Thrips tabaci)*	Are major pests of onions throughout the Tropics. In attacked onion plants, leaves show white and silvery patches, become distorted and may later wilt and die. Adult thrips are tiny, long, brownish-black insects that are very mobile and collect in large numbers at base of onion leaves, sucking the cells of leaves.
3	Bacterial soft rot (*Erwinia carotovora)*	In attacked plants, leaves rot and also the entire bulb rots. It is also a very serious disease in stored onions, if onions are not mature, mechanically damaged during harvest and there is poor aeration and high humidity in the store room.
4	Downy mildew disease (*Peronospora destructor)*	Caused by a fungus that attacks onion leaves. Fungus bodies develop as purple areas on fully mature leaves. Affected leaves drop off and die
5	Mould *(Aspergillus niger)*	Unlike bacterial rot, mould cause dry rot. Immature onions when harvested (still moist, and neck intact) and then stored without curing (sun drying) under poor conditions (without aeration and in humid conditions), black mould develops and onions become unfit for human consumption
6	Purple blotch (*Alternaria porri)*	Disease affects all parts of onion plant. Infected leaves and flowers show small, sunken, white areas with purple centres which become enlarged and encircle entire leaves. Tips of leaves become dry and collapse

9.7.7 Major Pests and Diseases of Pepper (hot and sweet pepper attacked by same pests and diseases)

No.	Major pests and Diseases	Comments
1	Root-knot nematodes (*Meloidogyne spp)*	Are same nematodes that attack eggplant and okra. Affected roots develops gall become malformed inhibiting plant growth; leaves become yellow, then curl and drop off before they mature. Pepper plants attacked by nematodes are also easily infected by wilt diseases and attacked by termites
2	White flies *(Bemisia tabaci)* and Aphids *(Ahis gossypii)*	White flies and aphids are important as vectors of virus diseases. Same aphids attack cabbage and same white flies attack tomatoes
3	Leaf spot *(Cercospora capsicii)*	Disease affects mainly leaves of pepper seedlings. Initial symptoms are small dark spots on leaves and these spots later enlarge to cover whole leaf, causing leaf to turn yellow and drop off.
4	Pepper leaf curl mosaic virus	Virus disease infects pepper leaves, stems and fruits and is transmitted by white flies. Leaves become yellow, mottled, distorted, small and cup- shaped. Plants become stunted and fruits are malformed.
5	Pepper mottle virus	Is transmitted by aphids. Leaves and fruits of infected plants are badly formed; become mottled, twisted and curled. Plants are stunted, turn yellow, and finally die.
6	Pepper wilt disease *(Fusarium oxysporum)*	Soil-borne disease caused by two species of fungi that infect roots, stems and leaves of pepper. Seedlings wilt and die and old leaves turn yellow

9.7.8 Major Pests and Diseases of Tomato

No.	Major pests and Diseases	Comments
1	Aphids *(Aphis gossypii)*	Occasionally attack tomato heavily. Feed on the soft terminal shoots and on the underside of leaves. May also transmit virus disease during feeding. Honeydew produced by aphids causes unsightly black moulds on tomatoes which reduces their market value. Attacked plants may wilt and die
2	Fruit borers (American bollworms [Helicoverpa armigera] and leaf-eating caterpillars (cotton leafworms [Spodoptera littoralis])	Different kinds of caterpillars attack developing and mature fruits of tomato. The American bollworm comes in various colours. A single caterpillar can bore into m ay tomato fruits in one night. Fungi and bacteria enter these fruits through the holes and cause the fruits to rot and become worthless. The cotton leaf worm feeds on leaves of tomato and bores into the fruits, especially those lower down the plant
3	Fruit fly (Rhagoletis ochraspis)	It is an important pest of tomato at the fruiting stage. It pierces fruits and leaves rotten spots. Adult fly pierces fruit to lay eggs inside. The small white maggots or larvae develop in the fruit and pupation occurs in the soil below the host plant.
4	Root-knot nematodes (*Meloidogyne spp.)*	Nematodes are one of the most important pests of tomato. These same species also attack eggplant, pepper, cabbage, carrot and other vegetables. They are microscopically small worms that live in the roots of their host and cause galls or root-knots. Some affected plants may show yellow leaves, poor growth and even wilting. Affected roots are short and have many swellings or galls. Plant become stunted and may die

5	Tomato mirid bugs *(Cyrtopeltis teriuis)*	Adults and nymphs of slender, dark green mired bugs feed on tender terminal stems and flower stalks of tomato plants. Inject a toxic substance/saliva into the tissues, causing small, brown necrotic spots to develop. Adult female mirids pierce tomato stems to lay eggs resulting in major damage to stems.
6	White flies (Bemisia tabaci)	White fly adults are small, white, winged insects that fly off readily when disturbed. They attack tomatoes from seedling stage to maturity. White fly adults and nymphs occur under tomato leaves, sucking the sap and secreting a sticky honeydew on which black mould develops. The adult transmit the leaf curl virus disease, which causes considerable damage to tomatoes
7	Dumping-off disease *(Pythium spp.)*	Is a major disease that attacks tomato seedlings. Water-logging creates conditions that favour development and spread of disease. Is a soil fungus and attack causes young stems to rot. Affected seedlings wither and die.
8	Early (or dry) tomato blight *(Alternaria solani)*	Is a major disease during the rainy season. It is caused by a soil-borne and air borne fungus. Symptoms are brownish-black angular spots with concentric circles on the leaflets. Black or brown sunken lesions develop on stems and fruits
9	Late blight *(Phytophtora infestans)*	Symptoms show as necrotic spots on leaves which enlarge rapidly to become water-soaked areas on leaves and fruits. Infestation leads to defoliation and fruit blotches.
10	Rots and cankers *(Phoma spp., Phomopsis spp.)*	Rots and cankers are caused by fungi and bacteria that infect tomato stems and roots. Root and stem rot fungus is present in soil and attacks roots, causing collars to rot. The bacteria that attack

		plants cause blight and cankers of stems, leaves and fruits.
11	Tomato yellow leave curl virus (TYLCV)	It is the most serious disease of tomatoes. Transmitted by white flies feeding on tomato leaves. Plants infected by disease are stunted and turn yellow, and leaves curl. Affected flowers and fruits drop off.
12	Wilts *(Fusarium oxysporum)*	Caused by a soil-borne fungus that attacks roots through small wounds (made during transplanting or resulting from nematode attack). Plant wilt from lower leaves and leaves turn yellow and die; later whole plant wilts and dies.

10.0 RECOMMENDED IPM PRACTICES FOR SELECTED VEGETABLE CROPS PEST/DISEASES

A. Crucifers (Cabbage, Pack Choy, Broccoli and Cauliflower)

No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
	Diamond-back moth (DBM) (*Plutella xylostella)* (Pre-harvest stage: Vegetative to head formation)	▪ Embark on field sanitation (uproot and compost stalks or feed to animals) ▪ Plant during rainy season to wash off young larvae ▪ Intercrop with repellent plants such as tomato or chilly pepper between rows 30 days before planting cabbage ▪ Do no leave overgrown cabbage in the field ▪ Scout weekly when plants are young and destroy eggs and caterpillars ▪ Conserve and encourage natural enemies such as Trichogramma and Diadegma insulare. ▪ Use microbial insecticides such as Bacillus thuringiensis (Bt) Biobit to control young larvae ▪ Spray neem pesticide in the evenings – light sensitive ▪ When Diamondback moth population builds up and natural control proves not to be sufficient, switch on to pesticides ▪ Prevent pesticide resistance build up in DBM by rotating the pesticides ▪ Observe the pre harvesting intervals of synthetic pesticides
	Webworms or cabbage borer *(Hellula undulalis)* (Pre-harvest seedling to head formation)	▪ Embark on field sanitation (uproot and burn stalks or feed to animals) ▪ Use bio pesticides, such as Bt and neem based insecticides ▪ Use insect growth regulators (IGR) or other recommended pesticides

	Cabbage aphids (*Brevicoryne brassicae)* (Pre-harvest vegetative phase to head formation)	▪ Avoid planting cabbage near an aphid infested crop or on land, which a recent infested crop has been removed ▪ Conserve and encourage natural enemies (ladybird beetles, hoverfly maggots, lacewing larvae, parasitic wasps) by enhancing diversity and avoiding broad spectrum pesticides ▪ Avoid application of too much nitrogen fertilizer as this makes the plant very soft, juicy and attractive to aphids but apply organic manures liberally ▪ Rainfall and overhead irrigation washes aphids off. ▪ Scout and monitor aphid infestation for early detection and control. ▪ Control ants that protect aphids against attack to ensure the supply of honeydew, which they also feed on either with pesticide or by removing nesting sites such as old tree trunks, rock heaps, debris and weeds. ▪ Prune/remove basal (lower) old leaves of head forming cabbages as may be a source of aphid infestation ▪ Use water jet spray for the lower leaves to wash off aphids. ▪ Plant solutions such as chilli, neem and garlic can also be applied on the crop. Spray with a soapy solution to wash off aphids and disturb their breathing. Use soap solution as a spray by mixing together and stir well 30 ml liquid soap in 5 litres of water. Test a small area first to ensure that the soap preparation does not damage the crop plant. ▪ Use chemical spray with recommended and approved insecticide only when heavy infestation occurs ▪ Timely weed control. ▪ Plough to expose larvae (specially Egret birds) and to bury others and prevent them from reaching the surface

	Cutworm (*Agrotis sp)* (Pre-harvest –Seedling stage)	▪ Replant severe losses ▪ In severe cases, dust around the plant with a recommended insecticide such as an Organophosphate (OP). ▪ Dried grounded red pepper sprinkled on dampened plants deters insect attacks. Spreading red pepper powder around the base of plants can repel cutworm such as Braconid wasp larvae (Meteorus communis),Ichneumonid wasp larvae (Nepiera spp), Green Lacewing larvae (Chrysopidae).
	Bacteria soft rot (*Erwinia carotovora)* (Pre- and post- harvest – heading stage, leaves)	▪ Practice three years rotation with non-host crops such as cereals and pulses ▪ Avoid water logged or heavy soils; do ridging ▪ Avoid injury to plants near soil level ▪ Avoid practices that transfer infested soil to non-infested areas (clean hoes and ploughs from soil) ▪ Strict hygiene/ sanitation ▪ Use resistant varies where available ▪ Avoid planting in shaded area that keep plants wet from dews or rains ▪ Space rows and plants adequately so that soil dries easily ▪ Undertake early harvesting ▪ Store only sound cabbages without blemish and not wet cabbages (no water on them)
	Root knot nematode (*Meloidogyne spp.)* (Pre-harvest –	▪ Practice plant rotation with non-host e.g. cereals, cassava, etc. ▪ Avoid infected soils, grown with host crops before e.g. tomato, garden eggs, okra, carrots, etc. ▪ Use resistant variety if available ▪ Improve soil fertility by increasing levels of organic matter to alleviate and suppress nematode of damage. ▪ Uproot plants after harvesting and compost them away from soil you are using ▪ Flooding the soil for a few weeks will reduce nematode population ▪ Solarise (4-6 weeks) nursery soil before sowing
	Black rot	▪ Deep plough

	(*Xanthomonas campestris)* (Pre- and post-harvest –heading stage, leaves)	▪ Practice seed bed/crop rotation at least for three years or more with non-crucifers e.g. cereals and pulses. ▪ Use resistant varieties where available ▪ Ensure good sanitation practices (removal and disposal of diseased plants) ▪ Overhead irrigation may increase the rate of infection if other conditions are favourable for the disease. ▪ Undertake early harvesting ▪ Store only sound cabbages without blemish and not wet ▪ Avoid practices that transfer infested areas
		• Flooding the soil before planting will expose caterpillars to predators

2. Cucurbits (cucumber, melon, pumpkin and canteloupe)

No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
1	Aphids *(Aphis gossypii)* (Pre-harvest stage-vegetative stage)	▪ Observe buildup of predators (ladybird beetles, lacewings, hoverflies) • Use appropriate pesticide or ▪ Use neem tree extracts if need arises (check for ▪ winged aphids as transmitters) ▪ Observe buildup of aphid populations and of natural enemies
2	Melon flies (Pre- an harvest d post harvest – fruit stage before and after harvest)	▪ Good sanitation practices are of paramount importance: frequent picking, destruction of infested fruits ▪ Do not dispose of cullied fruit with live melon fly larvae in areas close to the field ▪ Pick all infested fruits and bury them deep to break their life cycle and prevent them from serving as field reservoirs. ▪ Eliminate all alternate hosts that serve as reservoirs. ▪ Periodically monitor melon fly populations through trapping ▪ Bag fruits ▪ Spray around the plants as bait ▪ As a preventive measure in known high infestation areas spray with appropriate pesticides starting from flowering

3	Cucumber mosaic virus disease (CMV) (Pre-harvest – vegetative to fruiting stages)	▪ Eradicate infected plants in vegetative stage. ▪ Select tolerant varieties where applicable ▪ Control aphids (vectors) with insecticides before disease spreads ▪ Try spraying with emulgated oil (e.g. milk powder) to keep winged aphids from flying. ▪ Avoid transmission by tools and cultivation practices. ▪ Plant during wet season when least likely to occur. ▪ Wash and clean farm tools thoroughly. ▪ Destroy alternate weedy host aphids from flying. ▪ Avoid transmission by tools and cultivation practices. ▪ Plant during wet season when least likely to occur. ▪ Wash and clean farm tools thoroughly. ▪ Destroy alternate weedy hosts
4	Powdery mildew (*Erysiphe cichoracearum)* (Pre-harvest stage)	▪ Control weeds and eliminate volunteer cucurbit crops around the field or in the field ▪ Practice good sanitation ▪ Try to spray with sodium bicarbonate and potassium silicate ▪ Plant resistant varieties where applicable ▪ Use WHO approved pesticides and strictly observe pre-harvesting intervals.
5	Angular leaf spot (*Pseudomonas lachrymans)* (Pre-harvest – vegetative stage)	▪ Practice a three-year crop rotation. ▪ Plant disease free seed (certified or selected) from selected disease free, ripe fruits ▪ Plant resistant varieties where available ▪ Eradicate all affected plants (uproot and burn or feed to animals). ▪ Do not work in the field when foliage is wet. ▪ Monitor disease ▪ At first sight of disease in wet season, spray with copper or other registered and recommended fungicides and then repeat at 8-10 days interval and thereafter with copper fungicide, if there is a history of heavy attacks and favourable weather.

	Downy mildew *(Pseudoperonospora cubensis)* (Pre-harvest – vegetative to generative stage)	▪ Ensure adequate spacing to lower humidity ▪ Avoid overhead irrigation ▪ Eradicate diseased plants ▪ Monitor disease ▪ At first sight of disease in wet season, spray with copper or other registered and recommended fungicides and then repeat at 8-10 days interval and thereafter with copper fungicide, if there is a history of heavy attacks and favourable weather
6		• Grow young plants away from older plants

C. Okra

No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
	Aphids *(Aphis gossypii, Myzus persicae)* (Pre-harvest – all stages)	▪ Conserve natural enemies such as lady bird beetles, hoverfly, lacewings, parasitic wasps like Aphidius spp (mummified-brown, dry and inflated as a result of having been parasitized by a small wasp). ▪ Rain and overhead irrigation discourages aphides. ▪ Spray with soap solution or neem
	Cotton stainers (*Dysdercus spp.)* and other sucking bugs (*Nezara viridula)* (Pre-harvest reproductive stage)	▪ Usually no control ▪ May be controlled biologically by chickens or birds ▪ Neem seed extracts can be used in severe infestation ▪ After AESA, use fast acting pesticide in case of heavy infestations. ▪ Trap nymphs with split kapok or baobab seeds then destroy mechanically nymphs and reduce number
	Flea beetles (*Nisotra spp., Podagrica spp.)* (Pre-harvest early vegetative stage)	▪ Ensure good agricultural practices (fertilization, irrigation, soil management) to allow okra to out-grow damage ▪ Stir around plants to expose eggs and grubs in the soil to predators, e.g. ants, birds. ▪ Control only if it is damaging seedlings and young plants severely with soil treatment recommended systematic organophosphorus insecticide
	Root-knot nematodes (*Meloidogyne spp.)* (Pre-harvest – seedling to reproductive stage)	▪ Use crop rotation with maize, groundnut, millet, cassava and other small grains. ▪ Avoid planting on fields previously planted to nematode susceptible crops such as solanaceous plants, sweet potato, carrots, etc. ▪ Undertake alternative planting or intercrop with Tagetes spp (African/French marigolds) or crotolaria and Indian mustard as trap crop. ▪ Use indicator plants to monitor presence of nematodes.

		▪ Deep plough, expose nematode infected roots ▪ Try solarization to reduce nematode numbers (4-6 weeks). ▪ Incorporate neem cake into the soil during land preparation ▪ Fallow field for 3-4 years ▪ Apply recommended nematicide in extreme case or if monitoring confirms necessary
	Leaf curl virus and mosaic virus (Pre-harvest vegetative to reproductive stage)	▪ Ensure strict sanitation by removal and destruction of disease plants. ▪ Remove possible weed host plants. ▪ Control vectors with recommended insecticide before disease spreads. ▪ Avoid smoking when working in the field or handling seedlings
	Wilt disease (*Fusarium pallidoroseum)* (Pre-harvest – vegetative stage)	▪ Use certified disease free seeds. ▪ Take seeds only from disease free plants. ▪ Grow plants in well drained soils ▪ Practice long rotation with non-susceptible hosts (more than 5 years in severe infestations; rotate with cereals, pulses, root and tubers, etc.). ▪ Destroy diseased plants. ▪ Plant on ridges. ▪ Increase pH level by liming where soil pH is below the recommended level of 6.0-6.8. ▪ Treat seeds with recommended fungicide before planting. ▪ Plant in balanced fertile soils neither too acidic nor too alkaline. ▪ Irrigate at regular intervals with potable water

D. Onion

No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
	Onion flies (*Delia antique)* (Pre-harvest – vegetative stage)	▪ Practice crop rotation with non-host crop (not from onion family). Infested plants should be carefully uprooted and burnt or buried deeply. ▪ Destroy crop debris after harvesting.
	Onion thrips (*Thrips tabaci)* (Pre-harvest – all stages, from seedling)	▪ Grow tolerant varieties. ▪ Plant early to avoid pest attack or organize closed season. ▪ Irrigate regularly (twice daily). ▪ Apply appropriate insecticides approved by EPA as a last resort (>30 thrips scouted) after AESA. ▪ Maintain weed free field and borders
	Bacterial soft rot (*Erwinia carotovora)* (Post-harvest – storage)	▪ Clean store before use ▪ Create well aerated storage conditions ▪ Check store regularly for rotting onions (weekly) and remove them ▪ Remove infested bulbs ▪ Store only onions that are fully mature with collapsed necks ▪ Avoid harvesting onions during rainy day
	Dowy mildew disease (*Peronospora destructor)* (Pre-harvest – vegetative stage)	▪ Burn plant debris ▪ Plant only healthy disease free seeds ▪ Keep field free from weeds ▪ Plant in fields with well drained soils ▪ Avoid over irrigation

		▪ Practice a four year rotation ▪ Excess nitrogen should be avoided ▪ Rogue out affected plants ▪ Plants that are to be used for seed production should be isolated from the main crop ▪ Use resistant varieties ▪ Spray with an appropriate fungicide approved by EPA every 7-10 days (add sticker spreader) after AESA ▪ Select field with well-drained soil
	Mould *(Aspergillus niger)* (Post-harvest – storage)	▪ Cure onion bulbs before storage ▪ Clean store before use ▪ Create well aerated storage conditions ▪ Check store regularly for mouldy onions (weekly) and remove them ▪ Store only onions that are fully mature with collapsed necks
	Purple blotch (*Alternaria porri)* (Pre-harvest from seedling stage on)	▪ Organism persists in crop residue so gather and burn all plant residues in the field ▪ Use seeds only from disease free plots. ▪ Practice long rotation (>5 years) with unrelated crops such as cabbage, tomato, maize or beans. ▪ Treat seeds with appropriate chemical. ▪ Use resistant varieties when available. ▪ Spray with appropriate EPA approved fungicide during rainy season and strictly observe pre-harvest intervals

E. Pepper (hot and sweet pepper attacked by same pests and diseases)

No.	**Major pests and Diseases/ Stage**	**Recommended cultural practice and direct interventions**
	Root-knot nematodes (*Meloidogyne spp)* (Pre-harvest – all stages starting at nursery)	▪ Practice plant rotation with non-host (e.g. cereals, cassava, pulses etc. ▪ Avoid infected soils, grown with host crops before (e.g. tomato, garden eggs, okra, carrots, etc.) ▪ Rotate one season with marigold (Tagetes spp.) or plant marigold alongside peppers (Tagetes patula or Tagetes erecta) ▪ Solarise (4-6 weeks) nursery soil before sowing ▪ Use resistant variety if available ▪ Improve soil fertility by increasing levels of organic matter to alleviate and suppress nematode damage ▪ Uproot plants after harvesting and burn them ▪ Flooding the soil for a few weeks will reduce nematode population
	White flies *(Bemisia tabaci)* and Aphids *(Ahis gossypii)* (Pre-harvest – all stages)	▪ Encourage the presence of natural enemies (predators or parasites) by promotion of vegetation along field edges. ▪ Moderate use of nitrogen fertilizer. ▪ Use resistant varieties where available. ▪ Controlled in nature by hymenopteran parasitoids Encarsia spp and Eretmocerus spp, by phytoseiid mites, Amblyseius spp and by Chrysopa spp (lace wings). ▪ Use of repellents such as botanicals ▪ Spray with soap solution or neem extract ▪ Use yellow sticky traps ▪ Use trap crops and use sprinkler or over-head irrigation.

		▪ African marigolds and masturtiums intercropped with pepper discourage whiteflies ▪ Chemical spray is not necessary
	Leaf spot *Cercospora capsicii)* (Pre-harvest – vegetative stage)	▪ Use only certified disease free seeds ▪ Practice a three year rotation with non-host plants like cereals and pulses ▪ Burn or plough deep crop debris after harvest ▪ Hot water treatment of seed Spray with a recommended fungicide after AESA
	Pepper leaf curl mosaic virus (Pre-harvest – all stages from vegetative stage)	▪ Strict sanitation by removal and destruction of diseased plants, especially before fruit set ▪ Remove weed from within and around the field (solanaceous), which are alternate host ▪ Ensure balance nutrition ▪ Use sticky yellow traps to trap vector (white fly) ▪ Use repellents such as botanicals ▪ Spray with soap solution or neem extract or apply a fast acting chemical as soon as flying vectors are seen on young plants ▪ Use resistant varieties where available ▪ Do not smoke while working on the field
	Pepper mottle virus (Pre-harvest –vegetative stage)	▪ Plant only healthy virus free seed from a reliable source ▪ Remove all weeds, which may act as host for aphids, particularly solanaceae
	Pepper wilt disease/stem and root rot *(Fusarium oxysporum, Fusarium solani)* (Pre-harvest stage)	▪ Use certified seeds (disease free seeds) ▪ Practice crop rotation for at least three years with non-host crops

F. Tomato

No.	Major pests and Diseases	Recommended cultural practice and direct interventions
	Aphids *(Aphis gossypii)* (Pre-harvest – vegetative to reproductive stages)	▪ Neem extract sprays recommended if populations are high, following AESA ▪ When attacked in early growth, spray with quick acting, short persistent Organo-Phosphate insecticide following AESA ▪ Spray solution of local soap (1-2%) if infestation is heavy)
	Fruit borers (American Bollworms [Helicoverpa armigera] and (Pre-harvest – fruiting stage) leaf-eating caterpillars (cotton leafworms [Spodoptera littoralis]) (Pre-harvest vegetative to reproductive stage	▪ Grow trap crops such as pigeon pea (Cajanus cajan) and Crotalaria in and around tomato fields ▪ As soon as young caterpillars are seen, spray with Bacillus thuringiensis based bio-pesticides, neem seed extracts or short residual pyrethroid, after AESA ▪ Predators and parasitoids usually control the pest Use Bacillus thuringiensis products or neem extracts following AESA
	Fruit fly (Rhagoletis ochraspis) (Pre-harvest – fruiting stage)	▪ All infected fruits should be gathered and destroyed ▪ Destroy wild host plants, e.g cherry tomatoes
	Root-knot nematodes (*Meloidogyne spp.)* (Pre-harvest – all stages, from seedling to fruiting)	▪ Crop rotation (at least 3 years) with non-host crops (e.g. cereals, pulses, cassava etc) ▪ Plant Tagetes spp. (marigold) in alternate rows or as intercrop ▪ Plant Tagetes spp. Or Crotalaria as fallow crop ▪ Add organic matter to stimulate and encourage antagonistic organisms in soil

		▪ Flood field if water can be controlled
	Tomato mirid bugs *(Cyrtopeltis teriuis)* (Preharvest –vegetative stage)	▪ Usually no control necessary ▪ Spray with a quick acting but ephemeral carbamate or organo-phosphate insecticide if damage is likely to be substantial after AESA
	White flies (Bemisia tabaci) (Pre-harvest – seedling to reproductive stages)	▪ Use yellow sticky traps to reduce populations but cannot prevent the spread of TYLCV ▪ Spray solution of local soap (1-2%) if infestation is heavy
	Dumping-off disease *(Pythium spp.)* (Pre-harvest –seedling stage)	▪ Use clean, hot water treated seeds ▪ Use subsoil for nursery seedbed. Also apply solarization ▪ Sterilize soil for seed boxes. ▪ Drain off excess water ▪ Avoid overcrowding in nursery ▪ Drench soil with copper fungicide.
	Early (or dry) tomato blight *(Alternaria solani)* (Pre-harvest – vegetative to fruiting stages)	▪ Remove and burn affected leaves ▪ Rotate crops and observe strict sanitation (no new plots alongside old ones) ▪ Use clean, disinfected seeds ▪ Practice staking and mulching ▪ Spray with fungicides when environmental conditions are favourable for infection (cool and humid, for several days after rains), or at first sign of disease and every 7-10 days there after
	Late blight *(Phytophtora*	▪ See early blight above ▪ Grow resistant cultivars where available ▪ Use copper fungicides after AESA in disease favoring weather

	infestans) (Pre-harvest – vegetative to fruiting stages)	▪ Remove and destroy infected plants detected early ▪ Avoid wetting plants for protracted periods
	Rots and cankers *(Phoma spp., Phomopsis spp.)* (Pre-harvest – vegetative to reproductive stages)	▪ Remove and destroy infected debris ▪ Avoid planting in infested fields for 3 years ▪ Adequate spacing between rows and plants ▪ Practice staking ▪ Use seed from uninfected fields ▪ Hot water treated seeds 30mins at 122^{o}F ▪ Spray with a copper fungicide after AESA
	Tomato yellow leave curl virus (TYLCV) (Pre-harvest seedling to reproductive stages)	▪ Rotate crops (minimum 2 years) ▪ Destroy weeds ▪ Use resistant varieties ▪ Control vector chemically with contact insecticide or 1-2% solution of local soap (alata samina) ▪ Rogue infested plants early, from seedbed on, and destroy ▪ Enhance nutrition to help plants recover
	Wilts *(Fusarium oxysporum)* (Pre-harvest – vegetative to reproductive stages)	▪ Destroy whole plant and roots after harvest ▪ Use resistant varieties (e.g. Roma VF) ▪ Follow strict field sanitation ▪ Remove solanaceous weeds ▪ Avoid infected fields ▪ Use health seedlings ▪ Controlled burning on fields ▪ Use clean seed-beds (subsoil nurseries, solarization)

11.0 PESTICIDE BEST MANAGEMENT PRACTICES

As indicated earlier, the use of pesticide on REDI II projects will be a last resort and when these are used to effect pest control, the most appropriate practices and procedures will be followed to protect human health and the environment. One of the primary focus of the JSIF as an **ISO 14001:2015 certified** organization, is the protection of the nation's surface and groundwater resources from all project impacts including pesticide pollution. JSIF makes it the responsibility of all its stakeholders to manage pesticides sustainably. Pesticide users can significantly reduce the risk of environmental pollution by adapting Best Management Practices (BMP's). These are effective, common sense approaches that emphasize proper decision making from procurement to application and subsequent disposal of waste. The following are some of the BMPs that this plan proposes users to adopt at JSIF's project sites.

12.0 PESTICIDE MANAGEMENT PROGRAMME GOALS

The goal of this pesticide management programme is to provide users the tools and knowhow required to sustainably control pests when IPM alone is not effective or practical. The Plan incorporates practical pesticide best management practices that are aimed at:

- Minimizing pest population and associated effects;
- Protecting the natural environment and human health;
- Promoting sustainable and cost-effective pest management.
- Ensuring compliance with all pertinent laws, regulations, and policies;
- Ensuring that ecologically-sound vegetation and pest management principles, concepts, and techniques are promoted in the design and implementation of development projects.

13.0 TRAINING

Prior to handling of any pesticides, farmers will be trained in pesticide management and application through JSIF and the Rural Agricultural Development Authority (RADA).

Training will be done frequently to ensure that the farmers are comfortable in managing pesticides without constant supervision and monitoring. Training will take the form of both theory and practical application in the field. Farmers will be trained in multiple areas of pesticide use including but not limited to types of pesticides and their uses; pesticide impacts; transportation, storage and handling of pesticides; pesticide application techniques; when to use pesticides; mixing procedures for pesticides; health and safety protection; emergency response; record keeping; and disposal of pesticides and pesticide containers.

13.1 ASSESSMENT OF THE SITE CHARACTHERISTICS

The area selected for pesticide treatment will be scouted to:

- Evaluate the extent of the pest problem in order to select the appropriate control method(s);
- Identify environmentally sensitive areas; and
- Learn how the soil types and the layout of each application site affect the movement of water, both through and across the soil.

Soil properties that significantly affect pesticide movement in the soil are:

- Organic matter (OM) content – Pesticides are usually strongly adsorbed to soil OM and are less likely to leach in soils with high OM content. Applicators should be mindful when applying pesticides to soil with less than 1% OM content due to the potential for leaching into groundwater.
- Texture – Soils with clayey texture are more resistant to pesticide leaching due to its fine texture and high adsorption potential when compared to sandy soils. The loose nature of sandy soils increased the potential for pesticide leaching into the groundwater. Do not use very persistent pesticides (some chlorinated materials) on sandy soils.
- Structure and macropores – Soils with loose structure and large quantities of macropores will facilitate rapid movement of pesticides into the groundwater. Like sandy soils, do not apply persistent pesticides in soils with high concentration of macropores.

- Moisture Content – Soil moisture content is one of the major factors that determine the rate of leaching or runoff of pesticides. Soils with high moisture content are susceptible to runoff. Saturated course textured soils also increased leaching of pesticides. Do not apply pesticides with high or medium mobility to soils with high moisture content.

13.2 Read Pesticide Label And Follow Directions

Pesticide manufacturers usually provide important information on the label about the pesticide, applicator and environmental safety, including water quality protection. Every pesticide label specifies the application rates. The following are some of the tips:

- Always follow label directions particularly precautionary statements;
- Apply pesticides according to the specified application rates; and
- Use the specified mixing procedures and equipment.

13.3 Select the Appropriate Pesticide for the Pest Problem

Pesticides are designed for specific pests. Carefully consider all aspects of the pest problem, such as the type of pest, level of infestation, and location. All pesticide must be applied only to the crops for which the product is registered for use. Herbicides, insecticides, rodenticides, and fungicides, etc. must be used to control the specific type of pest. For example, herbicides/weedicides are used to control weeds, therefore**:**

- Do not use an insecticide for weed problem;
- Do not use contact insecticide to control sucking insects (use a systemic insecticide;
- Do not use systemic insecticides to control biting and chewing insects (e.g. caterpillars) - use a contact insecticide;
- Use a broad spectrum herbicide to control weeds on areas with both broadleaf and grass weeds;
- Use broadleaf herbicides for broadleaf weeds;
- Do not use foliage herbicides for weed seeds and pre-plant treatment;

- Do not overuse preventive pesticides. Apply pesticides only to those areas where pest problem exists or located; and
- Do not use pesticide if other method of control is equally effective and practical.
- Select the least toxic and less persistent pesticides when feasible.
- Avoid overuse of herbicides with similar modes of action. Chemicals within the same family have similar modes of action and should be rotated to avoid weed resistance particularly with herbicide tolerant cultivars.

13.4 Consider Safety When Purchasing Pesticides

Some pesticides are extremely hazardous to the environment and human health due to their chemical constituents and persistence. Consequently, some pesticides are highly regulated or banned for use. It is illegal to use banned substances including pesticides therefore, when purchasing pesticides for use on JSIF's projects, with the help of the agricultural specialist, the procurement officer should ensure that:

- The chemical is certified by the Jamaica Pesticide Control Authority (PCA)for sale in Jamaica;
- The pesticide is not listed as a banned substance;
- The place of business or pesticide dealer is certified by the PCA;
- Only the required quantity of pesticide is purchased; and
- Pesticides are delivered to the designated place of storage.
- Purchase Pesticides only approved by the World Health Organization (WHO)

13.5 Prevent Pollution of Water and Non-Targeted Areas

Pesticides can leach into groundwater and runoff to surface water as a result of discharges or spills that occur during storage, mixing, and loading operations. Consequently, the effects of pest control measures on the environment and non-target organisms must be considered when using pesticides. The following precautions must be taken to avoid pollution.

- Do Not store, mix and load pesticides near water bodies

- Mix, load and wash pesticides containers at least 50 feet from wells, lakes, streams, rivers and storm drains
- When possible, mix and load the pesticides at the site of application
- Mix pesticides on plastic sheeting to contain any spills
- Properly secure all pesticide containers during transportation
- Cleanup spills as early as possible if it is safe to do so
- Immediately call the appropriate agency such as NEPA, Fire Service, and PCA in case of a large spill.

13.6 Apply Pesticide Appropriately

Pesticide application best management practices (BMP's) means using proper equipment, following recommended application rates, adopting safety procedures, and choosing the right timing in an effort to protect the environment while effectively controlling the pests.

The pesticide application notices will be posted in the vicinity of the area to be treated at least one day prior to treatment. These signs will include the name of the pesticide to be used; date and time of application; warning or precautionary statements from the product label (including restrictions on entering the treated areas or special cautions for certain individuals); information about availability of product labels and MSDS; and a contact phone number for emergency services. Signs shall remain in place for one day after the manufacturer's specified re-entry period. **BMPs for pesticide application include**:

- Post warning signs around fields that have been treated, in accordance with local, state, and federal laws.
- WEAR PERSONAL PROTECTIVE EQUIPMENT (PPEs) – avoid all contacts with pesticides.
- Check application equipment before and during use for functionality;
- Calibrate equipment frequently to ensure that pesticides are applied at recommended rates

- Calibrate Application Equipment Properly - Frequently check and maintain spray nozzles, hoses, gauges and tanks. Proper application rate is highly dependent on the accuracy of calibration.
- Ensure spray is coming out of the nozzle evenly;
- Apply pesticides only in the location where the pest problem exists; Use the minimum quantity of pesticide required to control the pests;
- Do Not apply pesticides before, during or immediately after heavy rain - susceptible to runoff;
- Do not apply pesticides when it is windy, hot and dry
- Avoid overspray and chemical drift, especially when surface water is in close proximity to treatment area;
- Adjust nozzle or use nozzles that produce large droplet sizes to reduce pesticide drift;
- Avoid pesticide application when soil moisture status or scheduled irrigation increases the possibility of runoff or deep percolation;
- Apply herbicides directly to the targeted weeds; Apply pesticides when the pests are most vulnerable;
- Avoid repetitive use of the same pesticide or pesticides of similar chemistry and modes of action to reduce the potential for pesticide resistance;
- Have an emergency response kit available when handling pesticides
- Check the product label for instructions and call the nearest hospital in the event a pesticide is ingested or when exposure has occurred;
- Take the pesticide label to the attending physician if you need treatment; and
- Do not re-enter field before the re-entry period stipulated by the pesticide manufacture has expired. This is especially critical for greenhouse and other indoor farming ventures.
- WEAR PERSONAL PROTECTIVE EQUIPMENT (PPEs)
    - ✓ Water proof raincoat with a hood
    - ✓ Respirator
    - ✓ Goggles
    - ✓ Chemical resistant boots and gloves

13.7 Store Pesticides In A Safe Place

Pesticides can be harmful to the environment if they are not stored properly. The following are some pesticides storage tips:

- Store pesticides in a secure place out of the reach of children;
- Stored pesticides in their original containers with the labels clearly visible.
- Inspect containers for leaks and damages.

- Pesticides must be stored at least 50 feet from any well unless they are stored in secondary containment.
- Dispose of chemicals if their shelf-life has expired.
- Keep containers closed at all times.
- Store granules above liquids if necessary.
- Store volatile products separately.
- Prevent water from contacting the chemicals.
- Provide ventilation
- Lock storage door when leaving the facility.

13.8 Properly Dispose Of Pesticide and Containers

Improper disposal of pesticides and pesticide containers can cause adverse environmental issues such as soil and water contamination. Usually, the label on pesticide containers contains information about proper disposal procedures. The following guidelines are recommended for pesticide/container disposal.

- Dispose of banned or expired pesticides according to manufacturer's specifications.
- Containers should be triple or pressured-rinsed thoroughly after use, punctured and disposed of in accordance with label directions.
- Cleaned containers can be disposed of at an approved dumpsite.
- Some containers cab be recycled or reused.
- Plastic materials can be incinerated

- Sprayers should be cleaned at the application site whenever possible and at a safe distance from wells, lakes, streams and storm drains.
- The rinsate should be sprayed on a site that is listed on the pesticide label or used as makeup water in the next tank mix.
- Do not dump pesticides in the soil or water bodies.

13.9 Follow Proper Safety Procedures

Pesticides are hazardous to human health therefore proper safety procedures must be followed in order to minimize exposure. The REDI II agricultural specialist and the environmental officers will be responsible for monitoring the projects to ensure that proper pesticide management procedures are being followed (**see Appendix 3** for monitoring sheet). The following safety guidelines **MUST** be followed when dealing with pesticides:

- Wear protective gears when removing pesticides;
- Check containers for leaks;
- Read and follow label safety directions;
- Keep a Material Safety Data Sheets (MSDS) for each pesticide on site;
- Pesticide users must receive the appropriate training;
- Post warning signs around fields that have been treated;
- Do Not re-enter treated areas before the established re-entry interval as stated on the pesticide label;
- Wear the appropriate protective equipment specified on the pesticide label to minimize unnecessary exposure to pesticide;
- Wear safety gears especially respirator if rescuing a sick person in a closed environment like a greenhouse;
- Clean protective gear after each day's use;
- Do not eat, drink, or smoke during pesticide application;
- Keep face or eyes above pesticide containers when opening;
- Do not open pesticide containers with your teeth;
- Do not take home empty pesticide containers;

- Avoid splashing on chemicals on the skin during mixing;
- Provide emergency hand and eye wash facilities for personnel working in chemical storage, mixing, and treatment areas.
- Follow the emergency response plan that includes information about poison centers and emergency treatment centers.
- Post emergency response phone numbers in highly visible places near areas where chemical handling occurs.
- Store emergency response numbers into your cell phone when involved with pesticide handling.
- Check the product label for instructions and call the nearest poison center in the event a pesticide is swallowed or when pesticide exposure has occurred. Product labels often include a telephone number where expert information is also available.
- Take the pesticide label to the attending physician if you need treatment.
- Develop An Emergency Response Plan - Anyone who stores, handles or uses pesticides should have an emergency response plan in case an accident occurs.

13.10 Equipment Maintenance

- Check if respirator fits or leaks at the sides.
- Check and change respirator filters when it becomes difficult to breathe. Change respirators when you can smell or taste pesticides or when nose or throat burns;
- Replace all worn components of pesticide application equipment, especially nozzles, prior to application.
- Repair or discard defective equipment; Report issues to manager;

13.11 Material Safety Data Sheet (MSDS)

A MSDS is a document containing important information about a hazardous chemical and must state:

- The hazardous substance's product name
- The chemical and generic name of certain ingredients
- The chemical and physical properties of the hazardous substance
- Health hazard information

- Precautions for safe use and handling
- The manufacturer's or importer's name, address and telephone number.
- The MSDS provides employers, self-employed persons, workers and other health and safety representatives with the necessary information to safely manage the risk from hazardous substance exposure. It is important that everyone in the workplace knows how to read and interpret a MSDS. **A folder containing the**

MSDS for all chemicals used onsite must be kept in a safe place accessible to all workers on the project site.

13.12 Emergency Response Plan

Some of REDI agricultural projects may require the storage and use of large quantities of pesticides therefore an emergency response plan or procedures must be in place. The plan provides the list of equipment and information required by pesticide users to respond appropriately to any accidental or inadvertent discharge of chemicals onsite. The JSIF emergency response plan includes:

- The provision of professional pesticide handling training for all pesticide users on the project site.
- The provision onsite of personal protective equipment –
- Chemical-resistant gloves,
- A chemical-resistant apron as required for the pesticides being handled;
- Coveralls;
- Chemical-resistant boots;
- Eye protection;
- Respiratory protection, when indicated on the MSDS;
- A first aid kit that meets; and
- An emergency eyewash or emergency shower.

Ensuring that the following information are available onsite:

- Current and readily available MSDS and pesticide labels for all pesticides being used or stored;

- Emergency telephone numbers:
  - ✓ NEPA - 876-754-7540,
  - ✓ Ambulance Service - 110.
  - ✓ **Fire Service – 110**

An understandable contingency plan for containment and cleanup of pesticide spills should be available to personnel handling pesticides.

Ensuring spill clean-up materials, including, but not limited to the following are kept onsite in a safe and accessible location:

- Absorbent materials, as specified on MSDS or by the pesticide product label or manufacturer;
- Neutralizing materials as specified on MSDS or by the pesticide product label or manufacturer;
- Brooms and shovels;
- Containers with lids for waste material or leaking containers; and
- Labeling materials to identify contents of waste containers.

Cleanup of small spills – Put on safety gears and mop up the spill using the available absorbent materials. Use a shovel to remove impacted soil. Store the contaminated materials in the appropriate container for disposal at an approved waste management site. Report the incident to the project manager and environmental officer.

Cleanup of Large spills – Put on safety gears. Ask someone to call for assistance from designated environmental and emergency response agencies such NEPA and the fire service. Clear the area of all non-essential persons and stop the leak if it can be done safely. Create a berm or trench around the spill to help minimize spread. Clean-up the spill with the available equipment and dispose of the waste appropriately. Report the incident.

13.13 Record Keeping

The farmers must give account for pesticide use by keeping accurate and timely pesticide use records. **Appendix 1** table below is a sample of the records that workers will be required to complete after each pesticide application.

13.14 First Aid

Exposure to pesticides may cause acute or chronic responses. The following are some of the symptoms experienced when exposed:

- Fatique;
- Shortness of breath;
- Dizziness;
- Headache;
- Vomitting;
- Chest pain and stomach cramps;
- Rash and skin burn;
- Itchy runny eyes; and
- Slurred speech;

Report any exposure to pesticides to the necessary authorities whether or not you feel ill.

Removing Pesticides from your eyes – Immediately flush eyes with clean water for about 15 minutes. Report the incident.

Removing Pesticide From the Skin – If the skin does not burn, remove clothes that contacted the pesticide. Wash area with soap and clean water. If the skill is burnt, leave the clothing on for a while. Brush off the pesticide if it is a powder. Wash the contacted skin thoroughly with water and soap if exposed to a liquid pesticide.

Pesticide Burn – Pour clean water on area while removing clothing. Cover the burn slightly with clean cloth. Report the issue. **Don't use** soap, burst blisters, touch the area or put ointment or lotion on the area if burn.

Swallow pesticides – Call for help immediately. Do not induce vomiting. Call the hospital or ambulance service. Take pesticide label and MSDS to the doctor.

14.0 ROLES AND RESPONSIBILTIES

Project Manager will coordinate pesticide training programmes with the relevant authorities such as RADA for the relevant JSIF's field staffs and project site workers.

Technical Officers or Agricultural Specialists will be responsible for:

i. Evaluation of pest problems
ii. Selection of the appropriate pesticides;
iii. supervision of pesticide distribution, mixing, treatment, and application;
iv. Appointing or assigning an assistant pesticide manager;
v. Evaluation of treatment effectiveness;
vi. Compiling of MSDS folder;
vii. Monitoring of emergency response plan; and
viii. Supervision of pesticide use records.
ix. Monitoring of regulatory compliance
x. E valuation and revision of the plan

IPM leader is a trained farmer whom in the absence of the agricultural specialist will be responsible for:

i. Distribution of pesticides and equipment;
ii. Monitoring of storage facilities;
iii. Communicating with agricultural specialist;
iv. Emergency response;
v. Recordkeeping;
vi. Supervision of pesticide application; and

vii. Preparing reports.

Farmers will be responsible for:

i. Handling, storage, and application of pesticides;

ii. Maintenance of application and emergency response equipment;

iii. Recordkeeping;

iv. Posting of pesticide treatment notices and emergency signs; and

15.0 EMERGENCY CONTACT INFORMATION

PERSONNEL	ADDRESS	TELEPHONE
NEPA	10 & 11 Caledonia Avenue, Kingston 5	Office: 876-754-7540 Hotline: 888-991-5005
Fire Service	Multiple	110
Police		119
Ambulance		110

APPENDIX 1: PESTICIDE RECORD KEEPING FORM

NAME OF APPLICATOR:_____ **SUPERVISOR:**_____

Date	Location of treated area	Type and size of area	Product Brand Name	Total Amt. of Each Product Used	Total Volume	Equip. Used	Start Time/ End Time	Climatic conditions	Spillage

APPENDIX 2: WHO Pesticide Classification List

Table 1. Extremely hazardous (Class l a): Active Ingredients of Pesticides (Common name):

Aldicarb	Difethialone	Parathion-methyl
Brodifacoum	Diphacinone	Phenylmercury acetate
Bromadiolone	Disulfoton	Phorate
Bromethalin	Ethoprophos	Phosphamidon
Calcium cyanide	Flocoumafen	Sodium fluoroacetate
Captafol	Fonofos	Sulfotep
Chlorethoxyfos	Hexachlorobenzene	Tebupirimfos
Chlormephos	Mercuric chloride	Terbufos
	Mevinphos	
Chlorophacinone	Difenacoum	Parathion

Table 2 Highly hazardous (Class l b) technical grade active ingredients of pesticides (common name)

Acrolein	Ethiofencarb	Omethoate
Allyl alcohol	Famphur	Oxamyl
Azinphos-ethyl	Fenamiphos	Oxydemeton-methyl
Azinphos-methyl	Flucythrinate	Paris green {C}
Blasticidin-S	Fluoroacetamide	Pentachlorophenol
Butocarboxim	Formetanate	Pindone
Butoxycarboxim	Furathiocarb	Pirimiphos-ethyl
Cadusafos	Heptenophos	Propaphos
Calcium arsenate	Isazofos	Propetamphos
Carbofuran	Isofenphos	Sodium arsenite
Chlorfenvinphos	Isoxathion	Sodium cyanide
3-Chloro-1,2-propanediol	Lead arsenate	Strychnine
Coumaphos	Mecarbam	Tefluthrin

Coumatetralyl	Mercuric oxide	Thallium sulfate
Zeta-cypermethrin	Methamidophos	Thiofanox
Demeton-S-methyl	Methidathion	Thiometon
Dichlorvos	Methiocarb	Triazophos
Dicrotophos	Methomyl	Vamidothion
Dinoterb	Monocrotophos	Warfarin
Edinofenphos	Nicotine	Zinc phosphide

Table 3. Moderately hazardous (Class II) Technical Grade Active Ingredients of Pesticides (Common name)

Alanycarb	Endosulfan	Paraquat
Anilofos	Endothal-sodium	Pebulate
Azaconazole	Esfenvalerate	Permethrin
Azocyclotin	Ethion	Phenthoate
Bendiocarb	Etrimfos	Phosalone
Bensulide	Fenitrothion	Phoxim
Bifenthrin	Fenobucarb	Piperophos
Bilanafos	Fenpropidin	Pirimicarb
Bioallethrin	Fenpropathrin	Prallethrin
Bromoxynil	Fenthion	Profenofos
Brobuconazole	Fentin acetate	Propiconazole
Bronopol	Ferntin hydroxide	Propoxur
Butamifos	Fenvalerate	Prosulfocarb
Butylamine	Fipronil	Prothiofos
Carbaryl	Fluxofenim	Pyraclofos
Carbosulfan	Formothion	Pyrazophos
Cartap	Fuberidazole	Pyrethrins
Chloralose	Gamma-HCH	Pyroquilon
Chlordane	Guazatine	Quinalphos
Chlorfenapyr	Haloxyfop	Quizalofop-p-tefuryl
Chlorphonium chloride	Heptachlor	Rotenone
Chlorpyrifos	Imazalil	Sodium fluoride
Clomazone	Imidacloprid Sodium	Hexafluorosilicate
Copper sulfate	Iminoctadine	Spiroxamine
Cuprous oxide	loxynil	Suiprofos
Cyanazine	loxynil octanoate	Terbumeton
Cyanophos	Isoprocarb	Tetraconazole
Cyfluthrin	Lambda-cynalothrin	Thiacloprid

Beta-cyfluthrin
Cynalothrin
Cypermethrin
Alpha-cypermethrin
Cyphenothrin
Deltamethrin
Diazinon
Difenzoquat
Dimethoate
Dinobuton Nabam
Diquat Naled
Mercurous chloride
Metaldehyde
Metam-sodium
Methacrifos
Methasulfocarb
Methyl isothiocyanate
Metolcarb
Metribuzin
Molinate
Thiobencarb
Thiocyclam
Thiodicarb
Triazamate
Trichlorfon
Tricyclazole
Tridemorph
Vernolate
Xylylcarb

Acephate
Acetochlor
Acifluorfen
Alachlor
Allethrin
Ametryn
Amitraz
Azamethiphos
Bensultap
Bentazone
Bromofenoxim
Butroxydim
Chinomethionat
Chlormequat (chloride)
Chloracetic acid
Chlorthiamid
Copper hydrixide
Copper oxychloride
Cucloate
Cyhexatin
Cymoxanil
Cyproconazole
Dazomet
Desmethryn
Dicamba
Dichlormid
Dichlorbenzene
Dichlorophen
Dichlorprop
Diclofop
Dienochlor
Diethyltoluamide
Difenoconazole
Dimepiperate
Dimethachlor
Dimethamethryn
Dimethipin
Dimethylarsinic acid
Diniconazole

Table 4: Technical Grade Active Ingredients of Pesticides Unlikely to Present Acute Hazard in Normal Use (Common name):

Acephate
Acetochlor
Acifluorfen
Alachlor
Allethrin
Dinocap
Diphenamid
Dithianon
Dodine
Mecoprop
Mecoprop-P
Mefluidide
Mepiquat
Metalaxyl
Metamitron
Metconazole
Methylarsonic acid
Metolachlor
Bentazone
Bromofenoxim
Butroxydim
Chinomethionat
Chlormequat (chloride)
Chloracetic acid
Chlorthiamid
Copper hydrixide
Copper oxychloride

Empenthrin	Myclobutanil	Nuarimole
Esrocarb	2-Napthyloxyacetic acid	Octhilinone
Etridiazole	Nitrapyrin	N-octylbicycloheptene
Fenothiocarb	Ametryn	Dicarboximide
Ferimzone	Amitraz	Oxadixyl
Fluazifop-p-butyl	Azamethiphos	Paclobutrazol
Fluchloralin	Bensultap	Pendimethalin
Flufenacet	Mecoprop	Pimaricin
Fluoroglycofen	Mecoprop-P	Pirimiphos-methyl
Flurprimidol	Mefluidide	Prochloraz
Flusilazole	Mepiquat	Propachlor
Flutriafol	Metalaxyl	Propanil
Fomesafen	Metamitron	Propargite
Furalaxyl	Metconazole	Pyrazoxyfen
Glufosinate	Methylarsonic acid	Pyridaben
Hexazinone	Metolachlor	Pyridaphenthion
Hydramethylnon	Myclobutanil	Pyridate
Iprobenfos	2-Napthyloxyacetic acid	Pyrifenox
Isoprothiolane	Nitrapyrin	Quinoclamine
Isoproturon	Ametryn	Quizalofop
Isouron	Amitraz	Resmethrin
Malathion	Azamethiphos	Sethoxydim
MCPA-thioethyl	Bensultap	Simetryn

APPENDIX 3: PESTICIDE USE MONITORING CHECKLIST

JAMAICA SOCIAL INVESTMENT FUND

11 OXFORD ROAD
KINGSTON 5

PESTICIDE USE MONITORING CHECKLIST

THIS CHECKLIST MUST BE COMPLETED BY THE AGRICULTURAL OFFICER OR SITE SUPERVISOR DURING EACH SITE VISIT AND WHENEVER PESTICIDES ARE BEING USED ONSITE.			
OFFICER'S NAME:	**DATE:**		
PROJECT NAME:	**PARISH:**		
	YES	**NO**	**N/A**
PESTICIDES USED			
Insecticide			
Herbicide/weedicide			
Fungicide			
Other			
PESTICIDE HANDLING AND APPLICATION			
Is storage facility adequate for the pesticides?			
Is the storage area well ventilated?			
Are pesticide containers properly secured and lids fastened?			
Were pesticide containers in storage checked for leakage?			
Were pesticide leaks controlled?			
Were food items kept clear of the pesticide storage area?			
Are pesticides stored in their original containers?			
Are pesticide types segregated in the storage?			
Were pesticides properly secured during transportation?			
Is there a Material Safety Data Sheet (MSDS) folder for all pesticides present onsite in an accessible location?			

Were pesticide application notices posted one day before treatment?			
Is emergency response contact information posted onsite?			
Is the label for all pesticides used intact and readable?			
Were pesticide labels reviewed and followed during application?			
Was the correct pesticide used for the specified pest problem?			
Did workers wear the appropriate safety gears?			
Were equipment functioning properly during application?			
Were pesticide drifts avoided during application?			
Was migration of pesticide by runoff water avoided?			
Was non-chemical measures used prior to pesticide application?			
Was natural enemy's habitat protected?			
Only infected areas were treated with pesticide?			
Only authorized persons were onsite during application?			
Were unauthorized persons prevented from visiting site during or immediately after pesticide application?			
Did the pesticide applicator receive the appropriate training?			
Are pesticide use being monitored and recorded?			
Was surface water contamination prevented during application?			
Were pesticide spills avoided?			
Is a charcoal pit available for pesticide disposal?			
Are emergency or spill response equipment onsite?			
COMMENTS:			

POST APPLICATION			
Were illnesses or signs of pesticide exposure avoided?			
Was surface water impact avoided?			
Wildlife in the area appears health after pesticide application.			
Excess pesticide solution was disposed on in charcoal pit?			
Were pesticide containers cleaned according to specifications?			
Were waste containers disposed of in an environmentally friendly manner or as specified on the label or MSDS?			
Did pesticide applicators change clothing before leaving project site?			
Did workers wash hands prior to eating, drinking, or smoking?			

COMMENTS: