Pest Management Plan

Submitted by

World Vision International, Ghana

for

Improved Feeding Practices for first 1,000 Days (P159735)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Project Background

World Vision International, Ghana is seeking financial support from the World Bank to implement Improved Feeding Practices for first 1,000 Days project. The Project Development Objective (PDO) is to improve the feeding practices among targeted women of reproductive age (including pregnant and lactating women) and children under two (the so-called "first 1,000 days of life"). The overall implementation of the project is the responsibility of world vision Ghana.

The proposed project has four components as stated below.

- Access to Innovative Nutritional Supplements
- Household-level Agriculture
- Nutrition Messaging
- Program Management and Administration, Monitoring and Evaluation and Knowledge Dissemination

The World Bank safeguard policy on Pest Management (OP 4.09) has been triggered and as a result, World Vision International, Ghana is required to prepare Pest Management Plan as a standalone document.

Pest Management Plan (PMP) Objectives

The objective of the Pest Management Plan is to:

• Promote the use of environmentally friendly practices (hygienic, cultural, biological or natural control mechanisms and the judicious use of chemicals) in pest control;
• Effectively monitor pesticide use and pest issues amongst participating farmers;
• Provide for implementation of an IPM action plan in the event that serious pest management issues are encountered, and/or the introduction of technologies is seen to lead to a significant decrease in the application of pesticides;
• Assess the capacity of the country's regulatory framework and institutions to promote and support safe, effective, socially and environmentally sound pest management and to provide for appropriate institutional capacity support recommendations;
• Ensure compliance with regional standards, laws and regulations;
• Ensure compliance with World Bank safeguard policy OP 4.09

Policy and Regulatory Framework

The major policy and regulatory framework include:

• Food and Agriculture Sector Development Policy (FASDEP)
• Ghana's Medium Term Agriculture Sector Investment Plan (METASIP)
• Guidelines for the National Plant Protection Policy, June 2004
• National Land Policy

• National Water Policy, June 2007
• National Environment Policy
• Environmental Protection Agency Act, 1994, Act 490
• Environmental Assessment Regulations, 1999, LI 1652 and its Amendment
• Plants and Fertilizer Act, 2010, Act 803
• Water Resources Commission Act, 1996, Act 522
• Food and Drugs Act 1992, PNDCL 3058
• World Bank Safeguard Policy on Pest Management, OP 4.09

Challenges and Potential Impact on the Project

The impacts and challenges identified include:

• Lack of IPM sustenance measures even though national pest control strategy is IPM;
• Likely pollution of water resources and aquatic life from pesticide usage;
• Public health concerns from water-borne and water-related diseases can trigger the use of pesticides in controlling their vectors;
• Mycotoxin poisoning from poor maize drying;
• Poisoning from improper use of pesticides by farmers
• Impact from improper disposal of pesticide containers;
• Large scale production losses from fruit fly and armyworm outbreaks;
• Production losses from threats from other crop pests and diseases;
• Abuses associated with pesticide supply and sales; and
• General health and safety of farmers and environmental hazards.

Action Plans

The action plans are provided in the project document

Programme to meet PMP requirements

World Vision International Ghana will adopt the following strategies to achieve an effective pest and pesticide management process:

• Formation of a Safeguard Team
• Registration and training of all pesticide distributors/resellers under the Project
• PMP Communication and IPM/PMP Orientation workshop for project actors such as the EPA, PPRSD, MoFA at the national and relevant regional levels (i.e. within project beneficiary regions)
• Education and awareness creation among downstream project actors (pesticide distributors/resellers, farmers, farm assistants) of the importance of pest and pesticide management in the framework of this PMP
• Pests Inventory and Monitoring Measures
• Stakeholder and Interest Group consultation and Involvement
• Prevention of new Pest Infestations and management of established Pests
• IPM Capacity Building
• Institutional Arrangements and Training Responsibilities
• Participatory Monitoring and Evaluation

• Ensuring Sustainability
• Annual Reporting and Management Reviews

PMP Budget

The estimated budget for the implementation of the PMP is USD 63,000.

1.0 Introduction

1.1 Project Background (Improved Feeding Practices for first 1,000 Days Project)

Improved Feeding Practices for first 1,000 Days is a project World Vision Ghana (WVG) is proposing to implement to address the problem of nutritional deficiencies among the rural poor. The project envisages using a holistic approach that integrates the deployment of innovative nutrition specific and nutrition sensitive interventions reaching the poorest populations in Northern, Middle Belt, and Southern Ghana. This will increase and sustain the intake of micronutrients and amino acids / protein, in particular during fetal and early childhood development by targeting pregnant and lactating women and children aged 6 to 23 months with proven, cost-effective interventions, including improved diet. Thus, the utilization of nutritional supplements, a market-based distribution model (sales through Village Based Entrepreneurs), bio-fortification, household backyard gardens, small animal rearing, social behaviour change communication (SBCC) and capacity building at the community level, will be pursued. The proposed grant activities will build on the lessons learned from other projects.

The project has the following as objectives;

Project objectives

The Project Development Objective (PDO) is to improve the feeding practices among targeted women of reproductive age (including pregnant and lactating women) and children under two (the so-called "first 1,000 days of life") in targeted project areas.

The project has four outcome indicators which are indicated below:

(i) increase access to effective complementary feeding practices,
(ii) increase knowledge of good nutrition practices,
(iii) increase income of Village-Based Entrepreneurs (VBEs)
(iv) improve dietary diversity at the household level.

Project interventions

The project consists of 4 main components:
(i) Component 1. Improve Access to Innovative Nutritional Supplements
(ii) Component 2. Household-level agriculture
(iii) Component 3. Nutrition Messaging

(iv) Component 4. Program Management and Administration, Monitoring and Evaluation and Knowledge Dissemination

1.2 Background on Pest Management Plan

World Vision Ghana (WVG) is seeking financial assistance from the World Bank to finance the implementation of Improved Feeding Practices for first 1,000 Days to address nutrient deficiencies. The project implementation will be under the overall responsibility of World Vision International, Ghana and its partners the Ministry of Health (MoH) and Ministry of Agriculture. The development objective of the project is to improve the feeding practices among targeted women of reproductive age (including pregnant and lactating women) and children under two (the so-called "first 1,000 days of life") in targeted project areas. The project will promote planting of Orange Fleshed Sweet Potato, vegetables (spinach, carrot, cabbage, pepper), pawpaw, cashew, moringa for household consumption and sales. The pest management plan in place will develop capacity and provide support to enable resource poor farmers improve productivity and the quality of their produce. It will further reduce post-harvest losses through the institution of efficient post-harvest handling mechanisms and the facilitation of access to high value markets to ensure appreciable income levels for the farmers. The intervention is expected to result in increased productivity coupled with reduced post-harvest losses, improved product range and quality, more efficient processing and improved marketing, thereby generating additional incomes for producers and other operators in the targeted vegetable value chains.

Pest Management Plan Objectives

The objective of the Pest Management Plan is to promote the use of a combination of environmentally and socially friendly practices (hygienic, cultural, biological or natural control mechanisms and the judicious use of chemicals) and reduce reliance on synthetic chemical pesticides and ensure that health, social and environmental hazards associated with pesticides are minimized under the Project and within acceptable limit requirements of key stakeholders (i.e. primary users among farmers and their immediate dependants/families).

The specific objectives of the PMP are to:

i. Promote the use of Integrated Pest Management options (hygienic, cultural, biological or natural control mechanisms and the use of agro chemicals as a last resort) in pest control;
ii Effectively manage and strengthen capacity amongst participating farmers in safe handling and use of pesticides;
iii. Provide for implementation of an IPM action plan in the event that serious pest management issues are encountered, and/or the introduction of technologies is seen to lead to a significant decrease in the application of pesticides;
iv. Effectively monitor pesticide use and pest issues amongst participating farmers;
v. Assess the capacity of the country's regulatory framework and institutions to promote and support safe, effective, socially and environmentally sound pest management and to provide for appropriate institutional capacity support recommendations

vi. Ensure compliance with regional standards, laws and regulations;
vii Ensure compliance with World Bank safeguard policy OP 4.09

1.3 Rationale

The Pest Management Plan (PMP) addresses relevant stakeholder concerns about pests and pesticides. It stresses the need to monitor and mitigate negative environmental and social impacts of the Project (which includes the use of pesticides) and promote ecosystem management with the human health risk being the underlying principle from seed usage, through planting and growth stage and post-harvest issues including safe crops for consumption.
It emphasizes the need for an integrated approach to the management of pests in line with the nation's policy on IPM as well as funding agencies requirements on pest management. In addition, the PMP provisions for adequate measures to enable the project sustain the adoption of IPM techniques.

1.4 General approach

With agriculture being key component of the Project, pesticide use in the project area will be an element in project activity. The design and environmental impact screening of specific project options or interventions will consider on each case the likely pesticides to be used. An appropriate IPM technique will be incorporated into the project option or intervention to mitigate the need or demand for the use of chemical pesticides.

The Project will collaborate with MoFA-PPRSD to train farmers to use already existing knowledge in IPM for the selected crops to management of pests and diseases. This will be done holistically from seed selection, land preparation, through planting and farm maintenance to harvesting and post harvesting issues. Farmers will be trained and encouraged to make detailed observations in their fields regularly so that they can detect early infestations and make the appropriate management decisions using agro-ecosystem analysis (AESA).

In this way, pest and disease problems do not escape notice and are not allowed to develop to the extent that they cause very severe damage and heavy crop losses. The decision to use chemical pesticides will be taken only as the very last resort.

Pesticide use in general and pest issues amongst downstream project actors or participants (such as farmers, farm assistants, agro-chemical dealers, resellers, local communities, FBOs) will by surveyed regularly by MoFA, Departments of Agriculture of relevant Metropolitan Municipal District Assemblies (MMDAs and environmentalist.

Decision making on pest management strategies and measures at the Project implementation level will be influenced by suggestions and recommendations from the PPRSD with support from the Agriculture extension agents at the local level. Communicating any decision on pest management strategy or measure from the project implementation level will be undertaken by experts or/and trained project actors (such as identified staff of Environmental Protection Agency(EPA), MoFA PPRSD and DAES/regional officers, well known and trained NGOs including FBOs).

1.5 Methodology

The preparation of the PMP involved extensive literature reviews and stakeholder consultations. Various documents and literature reviewed can be found below (Relevant policies and laws). The key documents reviewed included:

1. Integrated Pest Management Extension Guide 2, Integrated Pest Management Practices for the Production of Cereals and Pulses, MOFA/PPRSD-Ghana with German Development Cooperation (GTZ) by Anthony Youdeowei

2. Integrated Pest Management Extension Guide 4 Integrated Pest Management Practices for the Production of Vegetables, MOFA/PPRSD-Ghana with German Development Cooperation (GTZ) by Anthony Youdeowei

3. MoFA. 2010. Agriculture in Ghana. Facts and Figures. Policy Planning, Monitoring and Evaluation. Ministry of Food and Agriculture. Accra, Ghana.

4. MoFA. 2004. Guidelines for the National Plant Protection Policy. PPRSD, July 2004.

5. Republic of Ghana, Ministry of Food and Agriculture, Food Safety Task Force, World Bank Africa Agriculture and Rural Development (AFTAR), Revised Food Safety Action Plan – Final Draft

1.6 Projects alignment with World Bank Safeguards Policies

The proposed grant activity will complement the Maternal, Child Health and Nutrition Project (P145792; $73 million) especially on improving the utilization of community-based health and nutrition services by women of reproductive age, pregnant women, and children under the age of 2 years. The activities proposed under this project cannot be funded through the Maternal and Child Health Improvement Project as the current design does not have space to include a social business model as part of the implementation arrangements. Moreover, the current project aims to scale up service delivery of essential interventions, but does not cater for the piloting of new approaches, such as the development of a social business model for the promotion of complementary feeding, and testing a new delivery approach to get essential commodities to the hard to reach areas at affordable rates.

These new approaches will represent important complements to the existing service delivery model particularly for services where the public sector supply-driven model appears to be inadequate to achieve results. Beyond the Ghana experience, there is growing interest to work with social entrepreneurs to improve public sector program efficacy and various countries have shown interest in learning from the Ghana pilot. Similarly, beyond complementary feeding, there are other services which could benefit from similar service delivery models in hard-to-reach areas including oral rehydration salts, family planning commodities and bed nets for as far as the health sector is concerned as well as seeds, fertilizer and other commodities and technologies to enhance local food security, and even commodities under humanitarian assistance. This pilot thus feeds into the global interest in social enterprise innovations, including through the Bank's Leadership, Learning and Innovation (LLI).

1. The Project triggers two (two) World Bank Safeguards Policies namely:

- Environmental Assessment OP/BP 4.01;
- Pest Management OP 4.09;

2. It is rated as a Category B project as it is not expected to induce significant adverse environmental and social impacts.

3. The Pest Management Plan will complement the ESMF to ensure that environmental and social impacts associated pest control activities are minimized.

2.0 REVIEW OF POLICY, REGULATORY AND INSTITUTIONAL FRAMEWORKS

2.1 Policy Framework

The control of pests and the use of fertilizers are also critical to increased agricultural production. A number of sectoral policies will impact on the performance of the project. Key policies include; agriculture, land, water, environmental protection, and pest/pesticide policies.

The major policies and relevant international institutional policies and regulatory frameworks include:

i. Food and Agriculture Sector Development Policy (FASDEP);
ii. Ghana 's Medium Term Agriculture Sector Investment Plan (METASIP)
iii. Guidelines for the National Plant Protection Policy, June 2004
iv. National Land Policy
v. National Water Policy, June 2007
vi. National Environment Policy
vii. Environmental Protection Agency Act, 1994, Act 490
viii. Environmental Assessment Regulations, 1999, LI 1652 and its Amendment
ix. Plants and Fertilizer Act, 2010, Act 803
x. Water Resources Commission Act, 1996, Act 522
xi. Food and Drugs Act 1992, PNDCL 3058
xii. World Bank Safeguard Policy on Pest Management, OP 4.09
xiii. ECOWAS new regulation on Pest and Pesticide Harmonization;

Food and Agriculture Sector Development Policy (FASDEP)

The first Food and Agriculture Sector Development Policy (FASDEP) was developed in 2002 as a framework for the implementation of strategies to modernization of the agricultural sector. The revised policy (FASDEP II) emphasizes the sustainable utilization of all resources and commercialization of activities in the sector with market-driven growth in mind. Enhance productivity of commodity value chain, through the application of science and technology with emphasis on environmental sustainability.

Ghana's Medium Term Agriculture Sector Investment Plan (METASIP)

The Government of Ghana has developed the Medium Term Agriculture Sector Investment Plan (METASIP) to implement the Food and Agriculture Sector Development Policy (FASDEP II) over the medium term 2011-2015. It is the framework of interventions for the agriculture sector to play its role in the national economy in the context of the Ghana Shared Growth and Development Agenda (GSGDA) which is the national programme of economic and social development policies coordinated by the National Development Planning Commission (NDPC). METASIP is also in fulfillment of Ghana's participation in agriculture related initiatives of the Economic Community of West African States (ECOWAS) and the Africa Union Commission (AUC) under the framework of the ECOWAS Agriculture Policy (ECOWAP) and the Comprehensive Africa Agriculture Development Programme (CAADP).

The METASIP is for the period 2011-2015 and comprises the following six programmes which correspond to the FASDEP II and represent Ghana's priorities within the four CAADP Pillars:

(i) Food security and emergency preparedness
(ii) Improved growth in incomes
(iii) Increased competitiveness and enhanced integration into domestic and international markets
(iv) Sustainable management of land and environment
(v) Science and technology applied in food and agriculture development
(vi) Enhanced institutional coordination

The METASIP considers the issue of environment very important and has made provision under the fourth programme, which is sustainable management of land and environment.

Guidelines for the National Plant Protection Policy, June 2004

The overall goal of the national plant protection policy is to achieve an efficient system that ensures that crop losses caused by biological, environmental and ecological factors are contained in a sustainable and economical manner. There are thirteen (13) principles underlying the Plant Protection Policy and these include:

1. Capacity building at national, regional and district levels
2. Intra and inter-ministerial collaboration
3. Private sector involvement
4. Partnerships with international development partners
5. Regional and international cooperation
6. Legislation
7. IPM
8. Coordination of IPM Activities
9. Contribute to IPM research
10. International trade
11. Planting materials production

12. Compliance
13. Participatory approaches and farmer empowerment

Three of the underlying principles, namely principle 7, 8, and 9 provide for integrated pest management (IPM) issues. Principle 7 on IPM specifically states that: promoting Integrated Pest Management (IPM) as the standard plant protection strategy for all crops to effectively reduce crop losses with minimum pesticide use.
The Plant Protection and Regulatory Services Directorate, PPRSD is the national agency assigned the national mandate to organize, regulate, implement, monitor and coordinate plant protection services needed for sustainable agricultural growth and development.
The PPRSD has adopted the FAO definition of pest which is any form of plant or animal life or any pathogenic organism that is injurious or potentially injurious to plants, plant products, livestock or people; pests include insects and other arthropods, nematodes, fungi, bacteria, viruses, vertebrates and weeds**.**

National Land Policy

The National Land Policy provides for the protection of water bodies and the environment in the long term national interest under any form of land usage be it for human settlements, industry and commerce, agriculture, forestry and mining. Two key aspects of Section 4.4 (Ensuring Sustainable Land Use) of the Policy relevant to the Project is provided below:
(h) In general, land use involving mining, other extractive industries, mechanised agriculture, cattle ranching, dairy farming and manufacturing industry will have to conform to prescribed environmental conservation principles and guidelines.
(m) All land and water resources development activities must conform to the environmental laws in the country and where Environmental Impact Assessment report is required this must be provided. Environmental protection within the 'polluter pays' principle will be enforced.

National Water Policy

The National Water Policy, approved in June 2007, is to provide the framework for the sustainable development of water resources in Ghana. The overall goal of the policy is to "achieve sustainable development, management and use of Ghana's water resources to improve health and livelihoods, reduce vulnerability while assuring good governance for present and future generations."

The relevant section of the Policy applicable to the project is found in Section 2.2.3 Focus Area 3 –Water for Food Security. The key objectives of this section are to:
• ensure availability of water in sufficient quantity and quality for cultivation of food crops, watering of livestock and sustainable freshwater fisheries to achieve sustainable food security for the country; and
• ensure availability of water in sufficient quantity and quality to support the functions of the eco-systems in providing alternative livelihoods.
Relevant policy measures to be undertaken which are in conformity with the project include:
a) (Policy measure iii) Promote partnership between the public and the private sector in the provision of infrastructure taking into consideration effects on economy, culture, environment and health;

b) (Policy measure iv) encourage the efficient use of fertilizers to reduce pollution of water bodies and ensure conservation of water;
c) (Policy measure v) promote and encourage water use efficiency techniques in agriculture; and
d) (Policy measure vi) manage land use and control land degradation, including bush fires, to reduce soil loss and situation of water bodies.
There is no mention of pests or pesticides usage in the policy. However, water quality concerns can be sited in many instances in the policy document which could generally encompass pollution concerns not only from fertilizers (which is categorically mentioned) but also from pesticides as well.

National Environment Policy/Action Plans

The policy aims at ensuring a sound management of resources and the environment, and to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment. Specifically, it provides for maintenance of ecosystems and ecological processes essential for the functioning of the biosphere, sound management of natural resources and the environment, and protection of humans, animals and plants and their habitats. The policy objectives are clearly in line with integrated pest management principles.

World Bank Safeguard Policy OP 4.09: Pest Management

World Bank uses various means to assess pest management in the country and support integrated pest management (IPM) and the safe use of agricultural pesticides: economic and sector work, sectoral or project-specific environmental assessments, participatory IPM assessments, and investment projects and components aimed specifically at supporting the adoption and use of IPM.

In Bank-financed agriculture operations, pest populations are normally controlled through IPM approaches, such as biological control, cultural practices, and the development and use of crop varieties that are resistant or tolerant to the pest. The Bank may finance the purchase of pesticides when their use is justified under an IPM approach.

• The purchase of a pesticide in a World Bank funded project is subject to an evaluation of the nature and degree of the associated risk.
• The pesticide selection and use criteria:
a) The unimportant negative impact on human health.
b) To have demonstrated their efficiency when used against target species;
c) To have a minimal effect on non-target species and the natural environment.
d) Their use must take into account the need to prevent the ability to develop resistance to pesticides;
• Pesticides must be prepared, packed, handled, stored, disposed of and used according to standards acceptable to the World Bank.

• The World Bank does not finance formulated products belonging to the World Health Organisation IA and IB Classes or Classes II formulations if:
a) The country has no (regulatory or legal) provisions imposing restrictions to their distribution and use or

b) They might be used by or accessible to the people applying them, agricultural or other workers with no adequate training, equipment and infrastructure for handling, storing and properly applying these products.

2.2 Regulatory Framework

2.2.1 National Laws

The relevant laws governing environmental pollution, plant protection, and pest and pesticide management and control include:

- Environmental Protection Agency Act, 1994, Act 490;
- Environmental Assessment Regulations, 1999, LI 1652 and its Amendment;
- Plants and Fertilizer Act, 2010, Act 803;Plant Protection Regulations 2012 LI 2193
- Water Resources Commission Act, 1996, Act 522;
- Food and Drugs Act 1992, PNDCL 3058;

Environmental Protection Agency Act, 1994, Act 490

This Act establishes and mandates the EPA to seek and request information on any undertaking that in the opinion of the Agency can have adverse environmental effects and to instruct the proponent to take necessary measures to prevent the adverse impacts. This law aims at controlling the volumes, types, components, wastes effects or other sources of pollution elements or substances that are potentially dangerous for the quality of life, human health and the environment.

Part II of the Act 490 deals with pesticides control and management and this was formally an Act on its own (Pesticides Control and Management Act of 1996, Act 528). This section of Act 490 provides the rules for registration, pesticides classification, approval, clearance, using, disposing off and non-disclosure of confidential information, the granting of license, labelling and pesticides inspections. Environmental Assessment Regulations, 1999, LI 1652 and its Amendment of 2002, LI1703 list activities for which an environmental assessment is mandatory. The Regulations describe the procedures to be followed to obtain permits for both existing and proposed undertakings through the conduct of environmental impact assessments and preparation of environmental management plans. The Environmental Assessment (Amendment) Regulations 2002, LI 1703 establishes the charges to be taken by the EPA for review and issuance of a Permit**.**

Plants and Fertilizer Act 2010, Act 803

The Plants and Fertilizer Act of 2010, combines the Seed Inspection and Certification Decree, NRCD 100 of 1972 and the Prevention & Control of Pests and Diseases of Plants Act of 1965, Act 307. The Act provides for the efficient conduct of plant protection to prevent the introduction and spread of pests and diseases to regulate imports and exports of plants and planting materials; the regulation and monitoring of the exports, imports and commercial transaction in seeds and related matters; and control and regulation of fertilizer trade. The LI 2193 provides for management of endemic and introduced plant pests, pest surveillance, internal quarantine and other procedures for pest prevention and management in line with International standards for Sanitary and Phytosanitary Measures

Water Resources Commission Act, 1996, Act 522

The Water Resources Commission Act 522 (1996) conferred on the Water Resource Commission (WRC) the mandate to regulate and control the use of water resources through granting of water rights and water use permits. The Water Use Regulations, (L.I.1692) provides the procedure for allocating permits for various water uses including domestic, commercial, municipal, industrial, agricultural, power generation, water transport, fisheries (aqua culture), and recreational.

Food and Drugs Act 1992, PNDCL 3058

Section 13 deals with prohibition on disposal of chemical substances and it states that a person commits an offence if that person uses or disposes of a chemical substance in a manner likely to cause
(a) contamination of food or water for human or animal consumption, or
(b) injury to, or be dangerous to the health of a person or an animal.
The Act defines a chemical substance to include an insecticide, rodenticide and a pesticide. It stipulates that "chemical substance" means a substance or mixture of substances prepared, sold or represented for use as
(a) a germicide,
(b) an antiseptic,
(c) a disinfectant,
(d) a pesticide,
(e) an insecticide,
(f) a rodenticide,
(g) a vermicide, or
(h) a detergent, or
any other substance or mixture of substances declared by the Minister, after consultation with the Board, to be a chemical substance.

2.2.2 Some key Conventions

IPPC — the International Plant Protection Convention — is an international treaty that aims to secure coordinated, effective action to prevent and to control the introduction and spread of pests of plants and plant products. It takes into consideration both direct and indirect damage by pests, so it includes weeds. It also covers vehicles, aircraft and vessels, containers, storage places, soil and other objects or material that can harbour or spread pests.

The International Plant Protection Convention came into force on 3 April 1952. The Convention has been adopted by the Food and Agriculture Organization of the United Nations. Its implementation is the mandate of National Plant Protection Organizations (NPPOs) — the official services established by governments to discharge the functions specified by the IPPC — and Regional Plant Protection Organizations (RPPOs), which can act as coordinating bodies at a regional level to achieve the objectives of the IPPC.

Ghana's National Plant Protection Organisation is the Plant Protection and Regulatory Services Directorate of MoFA. Ghana adopted the IPPC convention in February 1991.

Other relevant international conventions ratified by Ghana include:

• International Code of Conduct for the distribution and use of pesticides
• The Basel International Convention on the Trans-boundary Movement of Hazardous Waste of March 22, 1989;
• The Rotterdam Convention on prior Information and Contentment Principle (PIC)
• The Basel Convention on Persistent Organic Pollutants (POP's);
• International Standards for Phytosanitary Measures (ISPM) FAO;
• The Montreal Protocol.

2.3 Administrative and Institutional Capacity

2.3.1 National

The key national institutions responsible for the safe management of agro-chemicals and its related matters are represented below:

Environmental Protection Agency (EPA)
The Environmental Protection Agency has the mandate to regulate, coordinate and manage the environment. The functions of the EPA include:

• Edict standards and guidelines relating to air, water, and soil pollution and other forms of environmental pollutions including the discharge of toxic wastes and the control of hazardous waste.
• Promote research, the monitoring and analysis for environmental improvement and protection and the safeguard of safe ecologic systems in Ghana.
• Coordinate the activities in the ecosystems with the aims of controlling the generation, treatment, storage, transport and disposal of industrial waste.
The EPA and PPRSD have the oversight responsibility for pest management and control and it has the following prerogatives:

• The registration of pesticides
• The limitation or banning of the use of a pesticide if necessary
• The granting of licences to all categories of pesticides' resellers
• The levying of penalties.

The EPA and in particular its Chemical Control and Management Centre, responsible for pesticides control and management, has offices in all regions as well as three district offices. The Agency periodically provides a list of registered pesticides and banned pesticides for public consumption. The recent list is provided in Annex 2. The list is periodically updated and there is the need to liaise with the Agency for any updates during project implementation.

The Ghana Standards Authority (GSA)

The Ghana Standards Authority (GSA) The GSA has the full responsibility of ensuring the quality of the infrastructure including the Metrology, Standards, Assessment/Test and Quality control (MSTQ). It ensures the goods and services are of acceptable quality for both local and international consumers. The authority makes routine analyses of pesticides residues in fruits and vegetables in order to facilitate the exportations of these products and also protect the public health and safety.

The GSA has central facilities in Accra and regional offices in Ho (Volta region), Koforidua (Eastern Region), Takoradi (Western Region) and Tamale (Northern sector). GSA has been supported by the World Bank funded AgSSIP and UNIDO to bring its MRL analysis capacity up to ISO 17025 requirements.

The Food and Drugs Authority

The Authority is responsible for ensuring that any activity concerning chemicals be registered including, pesticides. Indeed, Section 18 of PNDC law 3058 stipulates that no person will be allowed to manufacture, prepare, sell, export or import any type of chemical product unless the product has been primarily registered with the FDA. According to the above mentioned provision (Supply) no product can be imported in Ghana without its prior registration by the FDA, and the appropriate fees paid. The word "chemical product" is however, defined according to the law to include germicide, pesticide, insecticide, rodenticide among others. By this law, the FDA has the authority to inspect any container or package, and if it suspects it to contain any type of pesticide, to seize such products.

The FDA has central facilities in Accra and five zonal offices in Kumasi (Middle Belt), Bolgatanga (Northern sector), Takoradi (Western Region), Ho (Volta Region) and Sunyani (Brong Ahafo Region).

The Customs, Excise and Prevention Service (CEPS)

The CEPS works in close collaboration with the EPA and PPRSD, and reviews the EPA documents, certificates/licences to make sure they concern the importation of approved chemicals,and agrochemical products. The importation reports of chemical products are submitted by the CEPS to the EPA on a quarterly basis. The CEPS staff are members to the various technical committees of the EPA including the hazardous waste committee, the pesticide technical Committee and other projects undertaken by the EPA. The CEPS is member of the national Coordination team of the Convention of Stockholm on the POPs.

The Ministry of Food and Agriculture (MoFA)-Plant Protection and Regulation Services Directorate

The Ministry of Food and Agriculture is responsible for the regulation of pesticides use in the country. The national plant protection policy is Integrated Pest Management (IPM). The Plant Protection and Regulation Services Directorate (PPRSD) of MoFA was established in 1965 by an Act of Parliament: Prevention and Control of Pests and Diseases of Plants Act of 1965, Act 307 now replaced by "Plants and Fertilizer Act, 2010 (Act 803).
The PPRSD as one of the Technical Directorate of MoFA is the national Institution with the mandate and capacity to organize, regulate, implement and coordinate the plant protection services (including pests

management and pesticide use) needed for the country in support of sustainable growth and development of Agriculture.

The PPRSD has its headquarters in Pokuase near Accra and there are also regional officers in all the ten regions of the country. It is also represented at the main borders throughout the country. It is not directly represented at the district level but however it collaborates with the District Department of Agriculture offices to carry out its functions at that level.

The PPRSD is divided into four main Divisions and these include:

- Crop Pests & Disease Management Division
- Pesticide and Fertilizer Regulatory Division
- Ghana Seed Inspection Division
- Plant Quarantine Division

Crop Pests & Disease Management Division

It is one of the Divisions of Plant Protection & Regulatory Services Directorate and it derives its mandate from Part I of the "Plants and Fertilizer Act" Act 803 (2010). The Crop Pests & Disease Management Division (CPDMD) develops and train farmers on Good Agricultural Practices (GAPs), guidelines for Integrated Pest Management (IPM) of crops. The division also provides information on pests and disease situation, provides comprehensive diagnostic and identification services of plant pests and diseases for stakeholders, monitors the pest situation in the country, ensures effective control of plant pests, manages calamity pest outbreaks (e.g. armyworms, grasshoppers etc), and carries out classical bio-control measures (mass rearing and release of bio-agents),

Pesticide and Fertilizer Regulatory Division

The Division derives its mandate from the following Acts: Part III of Plants and Fertilizer Act 803 (2010) The core mandate of this division is to regulate production, import and distribution of fertilizers. The functions of the Division include registration of importer, manufacturers and dealers, training of fertilizer inspectors, publication of information materials, inspection and quality control of fertilizers keeps records as well as statistics of fertilizers and manages fertilizer stocks in the country. The division also collaborates with EPA for the implementation of the part II of EPA Act 490 (1994) for post entry monitoring/surveillance of pesticides, supervision of bio-efficacy trials and capacity building of pesticide dealers and applicators

Ghana Seed Inspection Division (GSID)

This Division of the PPRSD derives its mandate from Part II of Plants and Fertilizer Act of 2010, Act 803. The Ghana Seed Inspection Division (GSID) is responsible for seed certification. Services provided include:

• Registration of Seed Growers and dealers, Monitoring of seed and planting material production of crop species, Certification of Foundation and Certified Seeds and also Primary and Secondary planting materials, Training of major stakeholders (Seed Inspectors, Registered Seed Growers, Seed Dealers, Extension Staff of MOFA and NGO's etc), seed health analysis, germination and purity test and Facilitation of promotional activities in the seed industry.

Plant Quarantine Division

The mandate of the Division under PPRSD is found in "Part I of Plants and Fertilizer Act." 2010 (Act 803). The Division works closely with the customs authorities (CEPS) at all the official entry points. It supervises and trains Phytosanitory Inspectors, develops and publishes information material, keeps records of plant imports and exports, the importers and exporters, as well as the pests and diseases of quarantine importance. It inspects and issues phytosanitary certificates and import permits in accordance to the IPPC format and international Standards for Sanitary and Phytosanitary Measures (ISPMs). Plants and plant materials to ensure freedom from pests. It also operates the National SPS Enquiry Point. The Division also carries out inspection on marketing quality standards on fresh fruits and vegetables for export.

Directorate of Crop Services- MoFA

The Directorate is responsible for the following among other things:

• Ensuring that there are planting materials (seeds) in adequate quantities at affordable prices and at appropriate times and places.
• Promoting the production of food, industrial and export crops in the country.
• Monitoring the development of the crop sub sector.
• Facilitating the capacity building of staff in the districts.
• Providing technical advice to the public on all crops within our mandate.
• Promoting the sustainable use of soil and water resources for agricultural production.
• Recommending issuance of permits and waivers for the importation of agricultural materials for the crops sub-sector/industry.
• Sourcing, soliciting, and analyzing information for the crop sub sector development.

The Environment, Land and Water Management Unit is directly responsible for environmental management and monitoring issues.

Women in Agricultural Development (WIAD)- MoFA

The Women in Agricultural Development Directorate (WIAD), is one of the seven Technical Directorates of the Ministry of Food and Agriculture (MOFA). Its function is to promote:
• Food based nutrition education in relation to food production and diet improvement
• Value addition to agricultural produce, food processing and preservation
• Food safety
• Natural Resource management (farm, home, processing site)
• Gender mainstreaming of all agricultural policies, programs and projects

The National Information Centre on Poisons

The National Information Centre on Poisons is located at the Ridge Hospital in Accra and has the following functions:

• Help health professionals in making diagnostics and managing intoxications by chemicals (including POPs), toxins, venons and drugs.
• Provide information to health professionals on the toxic effects of poisons.
• Provide information to the public on prevention and the management of first aid in case of acute intoxication.
• Train the public on the devastating effects of chemicals on the environment.
• Provide toxicological surveillance through the collection of data on chemical induced incidents, exposure and poisoning.
• Organise training sessions on the prevention and management of cases of intoxication for public health inspectors and all authorized agents such as PPRDS.

2.3.2 International

The key international institutions involved in the improved feeding practices project after 1000 days and its pest management issues are the World Bank and JICA.

World Bank

The World Bank safeguard policy on Pest Management (OP 4.09) has been triggered because of the procurement of pesticides (agricultural use, vector control weed control, etc) for or under the project and the likely introduction of new pest management practices, or likely changes to existing pest management practices and subsequent environmental and health risks.

The Bank requires the beneficiary country or institution hence MoFA, to prepare a Pest Management Plan (PMP) as a standalone document for approval by the Bank. The PMP will serve as a management tool for pest and pesticide issues under the project.

2.3.3 Non-Governmental Organisations/Private Institutions

Private institutions dealing with pest and pesticide issues are mainly involved in crop farming, agro-input trading, and the trade and export of agriculture products. The private organizations are rather fragmented and weak. The Ghana Agro-Input Dealers Association (GAIDA) is an apex body for pesticide dealers and distributors in Ghana. Various farmers associations abound but these are weak. Recently the Ghana Federation of Agriculture Producers (GFAP) has been formed. This federation comprises four major apex farmers associations - the Apex Farmers Organisation of Ghana (APFOG), Farmers Organisation of Ghana (FONG), Peasant Farmers Association of Ghana (PFAG and the Ghana National Association of Farmers and Fishermen (GNAFF) under one umbrella. Integration of these different groups under one federation is much better. Others such as the Vegetable Producers Exporters Association of Ghana (VEPEAG), and the Seed Producers Association of Ghana (SEEDPAG) also exist to take care of members interest. There is the

Ghana Agricultural Associations' Business and Information Centre (GAABIC). Crop life is the umbrella association of major pesticides importers and distributors in the country
These organizations take care of members' interest and to support members to meet the requirements of EPA/PPRSD. All institutions require training support and education of members on statutory obligations and requirements with regard to pesticide trading, use and control

3.0 ENVIRONMENTAL AND SOCIAL BASELINE CONDITION OF PROJECT AREAS

This section presents a description of the existing environment, comprising the bio-physical and socio-economic conditions of the proposed project area.

3.1 Methodology and Data Collection

Various techniques were applied for collecting data on the project environment. These included document review, institutional consultations, field surveys of the existing environment. An account of the existing physical and biological environment and socio-economic conditions (ethnic groups, culture, economic activities, etc.) were assembled. This formed part of the baseline information and the information obtained used in the environmental analysis/assessment.

The description of baseline information relevant to the project covers:

- The project areas;
- Biophysical Environment;
- Socio-economic environment;

3.2 General Information of Ghana

The Republic of Ghana is located between latitudes 5^{o} 36'N and longitudes 0^{o} 10'E. It has a total border of 2,093 km, including 548 km with Burkina Faso to the north, 688 km with Côte d'Ivoire to the west, and 877 km with Togo to the east. It has a coastline on the Gulf of Guinea, part of the Atlantic Ocean, measuring 539 km. It has an area of 239,540 sq km. The country is divided into 10 administrative regions and 170 districts.

The country is characterized by fairly low relief with few areas of moderate elevation in the north and east. The land is generally 600 meters above sea level. Physiographic regions include the coastal plains, the forest dissected plateau, and high hill tops which are important ecological subsystems in a generally undulating terrain. At the southern and northern margins of the Volta Basin, there are two prominent areas of highland – the Kwahu Plateau, and the Gambaga Escarpment. On the eastern margins of the Volta Basin is a relatively narrow zone of high mountains running in a south-west to north-east direction with the Akwapim, Buem, Togo Ranges registering the highest point (Mt. Afadjato) in the country.

Average rainfall over the country is about 1,260 mm/ year, but ranges from 890 mm/year in the coastal zone near Accra to 2,030 mm/year in the south-western rainforests. The rainfall is bi-modal in the south-western forest zone, giving a major and a minor growing season; elsewhere, a uni-modal distribution gives

a single growing season from May to October. Except for the south-western zone, the reliability of the rainfall, particularly after crop germination, is a major factor affecting crop growth and agriculture in general.

Ghana is drained by three (3) main river systems comprising the Volta, South western and Coastal River Systems. The Volta in Ghana occupies nearly two thirds (70%) of the land area of Ghana, the south western 22% and the minor coastal 8%. The areas covered by the respective river basins are described below. Global water resources are estimated at 53.2 km3 per year, consisting of 30.3 km3/year of internally produced water resource, and 22.9 km3/year of runoff from other countries.

3.3 World Vision International, Ghana, Administrative Regions

World Vision International, Ghana has three administrative regions namely; the Northern, Upper and Southern Operations. The project will specially be implemented in Kintampo South Cluster which falls under Northern Operations, Kassena-Nankane Cluster which also falls under Upper Operations and Sekyere East Cluster under the Southern Operations.

Project Location and Beneficiaries

The main target groups are women of reproductive age i.e., 14-49 years (including pregnant and lactating women) and children under two (the so-called "first 1,000 days of life") in Kintampo South, Kassena Nankane and the Sekyere East Districts of the Brong Ahafo, Upper East and Ashanti Regions of Ghana respectively.

3.4 Kintampo South District

Location and size

The District lies within longitudes 1º20’ West and 2º10’ West and latitude 8º15’ North and 7º45’ North. The District shares boundaries with the Kintampo North Municipality to the north, the Nkoranza North and Techiman North Districts to the South, the Atebubu and Pru Districts to the East and to the Wenchi Municipality to the West. It covers a land area of 1,513.34 km2 and comprises about 122 settlements (District Assembly’s survey).

Population size, structure and composition

The population of Kintampo South District, according to the 2010 Population and Housing Census, is 81,000 with more males (52.0%) than females (48.0%), giving a sex ratio of 108.4. Nine in every ten (91.1%) of the population reside in rural areas while 8.9 percent are in urban areas.

Climate

The Kintampo South District experiences a Wet Semi-equatorial climate. This is because the District lies in the transitional zone between the Wet Semi-Equatorial and Tropical Continental climates. Like other parts of the country, the District experiences two seasons namely wet and dry. The mean annual rainfall is between 1400mm-1800mm. The Wet season shows double maxima rainfall pattern (i.e. major and minor). The mean monthly temperature in the District is between 24ºC in August and 30ºC in March. These conditions create sunny conditions for most part of the year.

Vegetation

The vegetation of the District falls under the Woodland Savannah Zone. However, due to its transitional nature, the area does not exhibit typical savannah conditions. The District has an extensive forest reserve of about 150.50km2 known as the Bosomoa Forest Reserve. The tree species found in the reserves include, Teak, Odum, Wawa, Senya, Manana and Mahogany, which have given rise to timber extraction. These reserves can be found in the areas around: Krutakyi, Jema, Ampoma, Anyima, Nante and Krabonso.

Agriculture

About 90 percent (88.3%) of households in the district are engaged in agriculture. Nine out of ten households (90.5%) in rural localities and 70.0 percent households in rural localities are engaged in agricultural activities. An overwhelming majority of households (98.2%) are involved in crop farming and livestock rearing (42.5%). Poultry (57.4%) is the dominant animal reared in the district.

3.5 Sekyere East District

Location and Size

The District is located in the North-Eastern part of Ashanti Region, approximately between Latitude 6º45”-6º55” North and Longitude 1º15”-1º25”West. It shares boundaries with Sekyere- Kumawu District to the North-East, Asante-Akim Central Municipal to the South-East, Ejisu-Juaben Municipal to the South-West, Sekyere South District to the west and Asante Akim North District to the East. It covers an estimated land area of about 239.1square kilometres and has about forty-two (42) major settlements of varying sizes.

Population size, structure and composition

The population of Sekyere East District, according to the 2010 Population and Housing Census, is 62,172 representing 1.3 percent of the region’s total population. Females constitute 52.5 percent and males represent 47.5 percent. More than half the population (54.1%) reside in the urban areas compared to 45.9 percent in the rural areas.

Climate

The climatic conditions in the District conform to the general conditions that prevail within the middle belt of Ghana. The District experiences monthly mean temperature around 26°C, although some areas record lower figures. Maximum temperatures are between 29ºC and 31ºC are in March and April, while minimum temperatures of 21ºC and 23ºC are experienced in August.

Double maxima rainfall is experienced annually. The major season starts in April and ends in July, while the minor season begins in September and ends in early November. June is the wettest month of the year. Humidity is high during the wet months of the year and low during the dry months. Relative humidity within the District averages about 80 percent

Vegetation
The District has a semi deciduous forest, which supports the growth of big and tall trees of different kinds such as Wawa, Sapele, Odum, Mahogany etc. Uncontrolled bush burning, particularly in the smaller settlements is fast threatening the District's bio-diversity, thus putting the fertility of the soil at risk and reducing potential resources for future generations as the vegetation is fast degenerating

Agriculture
About 48.9 percent of households in the district are engage in agriculture. In the rural localities, seven out of ten households (70.6%) are agricultural households while in the urban localities, 31.9 percent of households are into agriculture. Most agricultural households in the district (90.9%) are involved in crop farming. Poultry (chicken) is the dominant animal reared in the district.

3.6 Kassena Nankana East Municipality

The Kassena Nankana Municipal was upgraded by LI 2106 from the Kassena Nankana District which was established in 1988 by LI 1855. It is one of the thirteen (13) districts/municipalities in the Upper East Region of the Republic of Ghana. The municipality has Navrongo as its political and administrative capital. The municipality lies approximately between latitude 11°10' and 10°3' North and longitude 10°1' West. The municipality shares boundaries to the north with Kassena-Nankana-West District and Burkina Faso. To the east, it shares boundary with Kassena-Nankana West District and Bolgatanga Municipal, to the west with Builsa District and to the south with the West Mamprusi District in the Northern Region

Population size, structure and composition
The population of Kassena Nankana East Municipality, according to the 2010 Population and Housing Census, is 109,944 representing 10.5 percent of the region's total population. Males constitute 48.8 percent and females represent 51.2 percent. About 72.7 percent of the population live in rural localities.

Climatic Conditions
The climatic conditions of the Kassena Nankana Municipality is characterized by the dry and wet seasons, which are influenced mainly by two (2) air masses – the North-East Trade winds and the South-Westerly's (Tropical Maritime). The harmattan air mass (North-East Trade Winds) is usually dry and dusty as it originates from the Sahara Desert. During such periods, rainfall is virtually absent due to low relative humidity, which rarely exceeds 20 percent and low vapour pressure less than 10mb. Day temperatures are high recording 42° Celsius (especially between February and March) and night temperatures could be as low as 18° Celsius.
The Municipality experiences the tropical maritime air mass between May and October. The average annual rainfall is 950mm
Vegetation

The Kassena-Nankana Municipality lies within the Guinea Savannah woodlands. The Municipality is covered mainly by the Sahel and Sudan-Savannah types of vegetation comprising mainly of the savannah grassland with short trees and thumps. Common trees found are Dawadawa, Baobab, Sheanut and Mango.

Agriculture

In the municipality, 82.7 percent of households are engage in agriculture. In the rural localities, 93.1 percent of households are agricultural households while in the urban localities, 56.8 percent of households are into agriculture. Most households in the Municipality (96.1%) are involved in crop farming with Poultry (chicken) as the dominant animal reared in the municipality. Agriculture is the dominant economic activity in the municipality. The major crops grown are millet, sorghum, rice, groundnuts, leafy vegetables, cowpea, bambara beans, okro, cotton, tomatoes and onions. Livestock reared in the municipality include cattle, sheep, goat, pigs, guinea fowls, fowls and other domestic animals like donkeys. Fish farming involving Tilapia and Mudfish are quite significant. Farm sizes are quite small and yields are very low as compared to other parts of the country due in part to poor soils and unreliable rainfall. There are few dams and dugouts which are being used for dry season farming. This has implications for food insecurity

Relief and drainage

The Municipality is generally low-lying. The landscape is generally undulating with isolated hills rising up to about 300 metres above sea level in the western parts of the municipality. Notably among these hills include Fie (280 metres), Busono (350 metres) and Zambao (360 metres) above sea level. The drainage system of the municipality is constituted mainly around the tributaries of the Sissili River – Asibelika, Afumbeli, Bukpegi and Beeyi.

Soil

Two main types of soil are present in the municipality namely the Savannah ochrosols and groundwater laterite. The northern and eastern parts of the municipality are covered by the Savannah ochrosols, while the rest has groundwater laterite. The Savannah ochrosols are porous, well drained, loamy, and mildly acidic and interspersed with patches of black or dark-grey clayey soils. The groundwater laterites are developed mainly over shale and granite and cover approximately sixty percent of the municipality's land area. This soil type is suitable for the cultivation of many crops, especially rice and vegetables and hence accounts for the arable land sites including most parts of the Tono Irrigation Project sites where both wet and dry season farming activities are concentrated (KNMA, 2010).

Common Fauna in the Project District

Type	Specie(s)
Vertebrates	Mole rats, rats, porcupines, goats, cattle, guinea fowl, monkeys. Hedges or thorn fences can help protect sweet potato against pests such as goats, cattle, wild pigs, and porcupines. Domestic animals should be tethered during the dry season to prevent them grazing on planting materials, conservation and Multiplication plots. Mole rats burrow through ridges and mounds feeding on the sweet potato roots. They often spoil more roots than they actually eat. Signs of their damage and presence include: small mounds of freshly dug soil, sweet potato vines being pulled back down into the soil, holes in the sides of ridges or mounds. Rodent control works better if done on a large scale, so farmers should work with their neighbours to combine forces.

Figure 1: Mean Annual Rainfall (mm) from 1961-1990 (after Mote, 1998)

4.0 POTENTIAL PESTS AND PESTICIDE PROBLEMS AND MANAGEMENT PRACTICES

4.1 MAJOR PESTS AND DISEASES

This section describes the major pests and diseases associated with the following commonly grown crops in the project regions

- Orange fleshed sweet potato (OFSP)
- Grain legumes (Soybeans)
- Vegetables (cabbage, cucurbits (cucumber, melon), egg-plant, okra, pepper)
- Fruits (pawpaw, moringa, cashew)

4.1.1 Orange fleshed sweet potato

Major Pests and Diseases of Orange fleshed sweet potato

This section describes the major pests and diseases associated with OFSP.

Major Pests and Diseases of orange fleshed sweet potato (OFSP)

No.	Major pests and Diseases	Description of pest
1	Sweet potato weevil (*Cylas* spp.)	It is the main pest of sweet potato found in all sweet potato growing regions. In its adult stage, it is an elongated, small black or metallic blue coloured beetle (5-6 mm long), that looks rather like a large ant. The male and female adults can be told apart by the shape of their antennae, the males' are straight while the females' have a club-shaped end. After mating, the female sweet potato weevil lays eggs singly in holes that she has chewed into either the vines or exposed and are easily accessible around storage roots. While the female weevil can survive for up to 4 months, she typically lays all her eggs (50-250) within the first two months. If she arrives on the plant prior to its formation of storage roots, she will lay her eggs in the vines and leaves
2	Sweet potato feathery mottle virus (SPFMV))	It is transmitted by aphids. Each virus by itself may cause only very mild symptoms but when a sweet potato plant gets infected by the viruses, a very severe disease results. If virus infected planting materials (vines or roots) are transported long distances, then the disease can be spread very widely
3	Sweet potato chlorotic stunt virus (SPCSV)	Sweet potato chlorotic stunt virus (SPCSV) transmitted by whiteflies
4	*Alternaria* diseases	This is a fungal disease, which produces Brown necrotic lesions on leaves, stems or petioles with typical bull's eye appearance of concentric rings and well-defined margins. Spots are usually

		surrounded by a chlorotic halo. Several lesion fuse, covering the leaf surface, followed by leaf drop. The ground under affected vines is often carpeted with blackened leaf debris. The fungus remains in plant debris on the soil as mycelium and conidia and can be spread by rain splash, wind and insects. High relative humidity is necessary for infection and sporulation.
5	Phomopsis disease	Is a fungal disease that affects older leaves to have irregularly shaped (~5-10mm wide) whitish to tan brown lesions surrounded by dark purple to brown margin, with black pinhead like structures in the centre. The fungus remains in plant debris on the soil, and its spores are released when the field receives moisture.
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 disease (*Ceratocystis* spp.)	Is fungal disease that affects storage roots, showing brown sunken spots (~0.5cm diam.) and then become firm, dry and black. They may coalesce to cover the whole root. The root area surrounding the spots has a bitter fruity taste. The plants appear stunted and chlorotic due to the cankers on the roots. Black rot can affect roots, plants and planting materials in field and storage. The fungus survives in soil and plant debris. Wounding increases the possibility of infection, although the fungus also penetrates through lenticels. Infected roots result in infected sprouts. Chlorotic discoloration on leaves, which turn to dark brown or black. Black discoloration of the vascular bundles and internal tissue break down.

4.1.2 Grain legumes (Soybeans)

Major Pests and Diseases of soybeans

Soya bean No.	**Major pests and Diseases**	**Comments**
1	Aphids (*Aphis craccivora and other species)*	Small, soft round, black or green insects that suck the sap of the young succulent green parts (leaves, stems and green pods) of the plant
2	Storage mothss *(Ephestia cantella, Corcyra cephabonica)*	Two species of moths attack soybean seeds in storage. The caterpillars of these moths feed on the grains, causing extensive damage by weaving threads around the grains, reducing their quality.
3	Storage weevils (*Callosobruchus maculates)*	Storage weevils attack soybean during storage
4	Sucking bugs (*Anoplocnemis spp., Clavigralla spp. and other species)*	Same group of six insect species that attack Soybean plants
5	Anthracnose disease	Disease affects all the growth stages of soybean.

	(*Colletotrichum truncatum)*	Attacks from stem and later appears on pods and petioles as irregularly shaped brown areas. The infected areas then become covered with

4.1.3 Vegetables (cabbage, cucurbits (cucumber, melon), egg plant, okra, pepper

Major Pests and Diseases of vegetables (Cucurbits (cucumber, melon)

Cucurbits (cucumber, melon)	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

Major Pests and Diseases of vegetables (Egg-plant)

Egg plant	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 many fruits
2	Epilachna beetles (*Epilachna*	Is a major pest that feed on leaves of egg plants by

	chrysomelina)	scraping surface and reducing leaves to skeletons
3	Jassids (*Jacobiasca spp./Empoasca spp.)*	Are small, green and very mobile insects that live on lower side of upper 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 nigt. 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	Fruit rot disease (Anthracnose) *Colletotrichum spp*	Is a fungal disease that remains asymptomatic until the is ripe and ready to harvest. The disease starts as small, sunken that eventually merge into large blotches.
7	Fruit and shoot borer	It is a moth which larval stage feeds on the shoots and fruits of egg plants. The larva bore inside the shoots resulting in the withering of the shoots. It also bore into and feed on young and maturing fruits making them unwholesome for human consumption
8	Collar rot (*Sclerotium rolfsii*)	Soil borne fungal disease which attack the roots and basal/collar region of the plants resulting in wilting and dying of affected plant

Major Pests and Diseases of vegetables (Okra)

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 stainers (*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 egg- plant, 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
8	White flies *(Bemisia tabaci)*	White fly adults are small, winged insects that suck sap and secret sticky honey dew on which black mould develops. Adult transmits various virus diseases

Major Pests and Diseases of vegetables (pepper)

Pepper (hot and sweet pepper)	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 are attacked by nematodes. Nematode infection result in blockage of water transport vessel resulting in wilting. Termites generally attack plants during the dry season in their search for water
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-
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	Soil-borne disease caused by two species of

	(Fusarium oxysporum)	fungi that infect roots, stems and leaves
7	Anthracnose	Fungal disease which attacks anypart of the plant during any stage of growth. Symptoms include water soaked lesions that become soft, slightly sunken/depressed and become tan. Lesions are covered with fungal fruiting bodies in concentric ring

4.1.4 Fruits (pawpaw, moringa, cashew)

Major Pests and Diseases of pawpaw

Pawpaw	Major pests and Diseases	Comments
1	Mosaic ring spot and yellow wrinkle virus	Mosaic virus reducing canopy and leaves leading to death of plant
2	Rust	When the fruit is green, little red spots appear on the skin. During ripening the spots enlarge to form patches
3	Corynespora spp	Circular brown to black leaf spots observable. Severe cases lead to extensive leaf damage
4	Phythium	Reduction of canopy and shriveling of fruits and rotten taproot
5	Phytopthora spp.	Reduction of canopy, rot at collar level, trunk with brown spots with liquid exuding from trunk, rot on tap root and shriveling of fruits
6	Anthracnose	Small round slightly dark spots appear on fruit. They quickly increase and become crater-like. The fruit rot and is not marketable.
6	Spider mites	Spider mite feeds on the leave and destroy the foliar system. The also feed on the terminal bud and stop the plant from further growth
7	Mealy bug	They are sucking insects feeding on leaves causing damage to affected plants. Aphid is a vector of ring spot virus.
8	Thrips	Is a small elongated insect with dark ring on abdomen. The pest causes leaf crinkle and localized discoloration of leaves.
9	Nematodes	Nematodes affects the root of the plant and reduces growth and yield

4.1.5 Major Pests and Diseases of Cashew

Pawpaw	Major pests and Diseases	Comments
1	Stem and root borer	The cashew stem and root borer, *Plocaederus*

	P'ocaederus ferrugineus (Cerambycidae: Coleoptera	*ferrugineus* is the most serious pest of cashew as its damage results in death of trees. It is an internal tissue borer and infestation can go up to 40% in different periods and severely attacked trees die within a period of two years causing substantial tree loss. Extensive tunnelling in the stem and root region and the tissues are tunnelled in irregular fashion. As a result of damage the supply of water and nutrients is arrested by which the leaves turn yellow and are shed and finally leads to the death of the tree
2	Tea mosquito bug: Heopets anton; Sign. *(Miridae: Heteroptera)*	The tea mosquito bug, is another important and most serious pest of cashew and causes more economic loss to the crop. Occurrence of dark brown patches on green tender stem of young shoots and inflorescence rachis. • Feeding on tender leaves causes crinkling and curling. Affected shoots show long black lesions. • The immature nuts infested by this pest develop characteristic eruptive spots and finally shrivel and fall off. • Heavily infested trees show scorched appearance, leading to the death of shoots and growing tips.
3	Nut borer: Thy'ocopfi'a panrosema (Pyralidae: Lepidoptera	It causes 10% yield loss during years of severe infestation in certain cashew growing areas. The caterpillars attack the fruits at all the stages and cause shrivelling and premature fall of nuts. The borer affected nuts do not develop, become shrivelled and dried up resulting in pre-mature fall of nuts and apples. • The borers tunnel near the junction of apples and nuts, and the entry holes are plugged with excreta.
4	Thrips: flower thrips, Rhynchofhrips raoensis; Foliage thrips, *Se'enofhrips rubrocincfus (Thripidae:Thysanoptera)*	Adults and nymphs are seen in colonies on the lower surface of leaves and suck the sap from leaves, inflorescence and apples and nuts. • As a result of their rasping and sucking activity the leaves become pale brown, scab on floral branches, apples and nuts, forms corky layers on the affected parts. • In severe cases there will be shedding of leaves and stunting of growth of trees.
5	Mealy bug: *Ferrisia virgata (Pseudococcidae: Heteroptera)*	The mealy bug, Ferrisia virgata is a serious pest of cashew in all cashew growing areas. Three other species of mealy bugs infesting cashew includes Planococcus lilacinus, Planococcus citri and Phenococcus solenopsis. It

		can be seen on the lower surfaces of tender leaves, twigs, inflorescence panicles and fruit peduncles. Besides causing direct damage, the bugs excrete copious amount of honey dew on which sooty mould develops which impairs normal photosynthetic activity. • Heavy nut yield loss observed under severe out-break conditions.
6	Leaf miner: *Acrocercops syngramma* (Gracillariidae: Lepidoptera)	Infestation by this pest is common in the post-monsoon flushes and young plantations. The larvae after hatching from the eggs, start mining the epidermal layer on the upper surface of the tender cashew leaves. • As a result of feeding, the affected areas form blistered patches of greyish white in colour. • As the infested leaves mature the damage is manifested as big holes.
7	Anthracnose *Colletotrichum gloeosporoides*	Water-soaked lesions on leaves, twigs, flowers or young apples which develop into orange-brown or red lesions; Disease emergence favored by rainfall and high humidity
8	Black mould *Pilgeriella anacardii*	Chlorotic spots on upper surface of leaves which spread to lower surface as infection progresses; dark-brown to black fungal patches on leaves; leaves shrivelling and dropping from plant
9	Angular leaf spot *Septoria anacardii*	Angular cream colored lesions with dark-brown margins on leaves of seedlings; angular black lesions with chlorotic halos on mature trees; defoliated seedlings

Major Pests and Diseases of Moringa

No.	**Major pests and Diseases**	**Recommended practices**
1	Lepidoptera pests *Leaf caterpillar or Leaf worm Noorda blitealis W. (Crambidae: Lepidoptera).*	To manage this pest, various practices have been tried such as pesticide sprays, biological control, botanical extracts, and search for resistant varieties
2	Hairy caterpillar, Eupterote mollifera W. (*Eupterotidae Lepidoptera*).	They can be killed with a burning torch; a spray of fish oil, rosin soap, methyl parathion, chlorpyrifos or quinalphos can also control the pest (
3	Thrips, Scirtothrips dorsalis Hood (*Thripidae Thysanoptera*	Thrips infests leaflets and sucks the sap. While it occurs sporadically, the infestation can be serious
4	Itch worm/caterpillar, Euproctis pasteopa Collenette	This is a major pest of Moringa. In the mixed cropping system, maximum defoliation is observed during the main

	(*Lymantriidae Lepidoptera*).	rainy season in July, reducing leaf biomass production by 31-70 percent; in the mono-cropping system, leaf biomass production can be reduced by more than 75 percent
5	Nettle worm/caterpillar, Metanastria hyrtaca C. (*Lasiocampidae Lepidoptera*).	Management techniques include collecting and destroying the egg masses and caterpillars, using a burning torch to kill the larvae that congregate at the trunk, or by spraying carbaryl
6	Coleoptera pests White grubs, *Holotrichia insularis Brenske* (Melolonthidae: Coleoptera *)*	The adult beetles emerge from the soil after the rains and start feeding on the leaves of Moringa.
7	Whiteflies, Bemisia moringae David and Subramanian, and Castor whitefly, *Trialeurodes ricini Misra (Aleyrodidae: Hemiptera*	Both of these species have been observed sporadically on Moringa by many researchers, but Palada & Chang (2003) and Okonkwo et al (2014) observed high prevalence.
8	Coleoptera Long horn beetle, Batocera rubus L. (*Cerambycidae*:	To manage the pest, the affected part can be treated with contact and systemic insecticides, or fumigated. However, the use of such highly toxic agrochemicals is currently not acceptable or recommended
9	Lepidoptera Bark borer, Indarbela *tetraonis Moore* (Cossidae:	Before undertaking any control measure, the web on the tree should first be removed. David & Ramamurthy (2016) suggested injecting chlorpyrifos or profenofos emulsion into the bored holes, and then sealing them with wet mud.
10	Hemiptera Scale insect, *Ceroplastodes cajani M*. (Coccidae:	The nymph and adult stages occur during January/February and from August to December. In case of severe attack, the tender shoots, fruits and stalks are fully covered by the scale. Eventually the shoots dry up and the size of the fruit is affected
11	The spider mites (*Tetranychus spp)*	Infesting moringa apparently, just after hatching (which takes 15 to 20 minutes) the mite remains motionless for some time and then starts feeding by inserting its stylet and sucking the sap.
12	Damping off	Disease of nursery beds and young seedlings resulting in reduced seed germination and poor stand of seedlings. Very high seedling mortality 25-75%. Pre-emergence damping off: Seedlings disintegrate before they come out of soil surface leading to poor seed germination. Post-emergence damping off is characterised by development of disease

		after seedlings have emerged out of soil but before the stems are lignified. Water soaked lesion formation at collar region. Infected areas turn brown and rot. Plants shrivel and collapse as a result of softening of tissues. Avoid Heavy rainfall. Also avoid Poorly drained soil and close spacing to control damping off. Raise nursery in light soil with proper drainage. Burning farm trash on the surface of the beds. Sow seed on raised beds of 6-8" high (15 cm). Use low seed rate of 650 g/40 sq mt.
13	Twig canker	The first symptom of the disease is clearing of the veinlets and chlorosis of the leaves. The younger leaves may die in succession and the entire leave may wilt and die in a course of few days. Soon the petiole and the leaves droop and wilt. In young plants, symptom consists of clearing of veinlet and dropping of petioles. The symptoms continue in subsequent leaves. At later stage, browning of vascular system occurs. Plants become stunted and die. Avoid relatively high soil moisture and soil temperature to control the Twig canker.

4.2 PEST PROBLEMS AND CONTROL PRACTICES

4.2.1 General Pest Problems and their Management

Common pests in the project areas include: rodents and migratory and outbreak pests such as rodents, locusts, borers, caterpillar, nematode, aphid, mealy bug. IPM strategies are recommended and used by some farmers as much as it is possible because there is no one control practice that can provide acceptable control of the target pest.

Rodents

Rodents, particularly the field rats (*rattus rattus*), the small house mice (*rattus norwegicus*) and multi-*mammate shamba* rat, (*Mastomys natalensis*) are key pests of food crops. The most affected crops are OFSP, soybeans, pawpaw and cabbage. The damage caused by rodents starts at early booting and continues through the mature stage as well as the storage stage.

Farmers are strongly advised to do the following to reduce potential damage to crops and the environment:

• Weeding for clean bunds and fields regular surveillance. The earlier the presence of rodents is observed, the cheaper and simpler any subsequent action will be and losses will remain negligible
• Store Sanitation. It is much easier to notice the presence of rodents if the store is clean and tidy
• Proofing i.e. making the store rat-proof in order to discourage rodents from entering
• Trapping. Place the traps in strategic positions

• Use recommended rodenticide. However, bait poisons should be used only if rats are present. In stores or buildings, use single-dose anticoagulant poisons, preferably as ready-made baits.
• Encourage team approach for effectiveness. The larger the area managed or controlled with poison, the more effective the impact
• Predation. Keep cats in stores and homesteads.

Migratory and outbreak pests
The key migratory and outbreak pests of economic significance in Ghana are armyworm (*Spodoptera exempta*) and the red locusts with an exception of the elegant grasshopper; the management of the rest of the pests under this heading is co-ordinated by the PPRSD of the Ministry of Food and Agriculture.

Locust
Locusts live and breed in numerous grassland plains/savannah zones. During periods with favourable weather, locusts multiply rapidly and form large swarms that can cause huge damage to plants in a very short period of time.

Grasshopper has become increasingly damaging on OFSP and soybeans in parts of the country. There being no research done on the management of the pest, farmers are forced to use any recommended insecticide whenever outbreaks occur.

Invasive alien species
Invasive alien species have become a problem in diverse ecosystems in Ghana. They affect both savannahs and tropical forests and they are found on land, in fresh water systems and along the coast in the country. The World Conservation Union (IUCN) identified 26 invasive alien species in Ghana which include following key pests:

• Siam weed, *Chromolaena odorata*;
• Water hyacinth, *Eichornia crasspes*;
• Cashew mealybug, *Rastracoccus invadens*; and
• Invasive fruit fly, *Aleurodicus disperses.*

These invasive alien species have had a huge adverse effect on the production of major food crops such as OFSP, Vegetables and also on pawpaw and cashew. Climate change, trade liberalization, and agricultural intensification (introduction of increased fertilizer use, introduction of new crops and varieties, changes in land use and landscape etc) could trigger the occurrence of new pest problems. This requires frequent pest risk surveillance and continuous updating of the existing pest list. The EPA and the PPRSD are currently the lead institutions in managing invasive alien species.

4.3 IPM Strategy for Pest Control

The integrated pest management is the adopted strategy for the fight against pests in Ghana. However, the use of the integrated combat is not widespread despite the efforts undertaken. The use of pesticides is increasing in spite of the high cost of the products relative to the financial capacity of majority of farmers.

Research Institutions in Ghana have had some good results with regard to the efficient use of botanical products.. In actual fact, several institutes (Crops Research Institute, Faculty of Agriculture/KNUST University of Ghana, Legon, Savannah Agricultural Research Institute (SARI) have conducted projects concerning the integrated management of pests in several operations (soybeans, pawpaw, OFSP, cucumber, etc), the development of a control system for the use of pesticides for communities practicing rural related agriculture, IPM Kit development, demonstration and transfer of technology in IPM.

The German Development Cooperation (GTZ) has supported the PPRSD of MOFA to develop separate booklets to serve as extension guides on integrated pest management practices for the production of (i) vegetables; (ii) pulses; (iii) fruits.

The national IPM approaches developed for cereals, pulses and vegetables are largely based upon 15 principles, practices and what happens in each case. The principles are presented in the table below.

Table 4.3 IPM Approaches for Pulses and Vegetables

Principles	**Cereals**	**Pulses/legume**	**Fruits**	**Vegetables**
Principle 1	Obtain good seeds	Obtain good seeds	Obtain good seeds	Obtain good seeds and other planting materials
Principle 2	Select fertile soils and suitable planting sites	Select fertile soils	Select well-drained fertile soils for the nursery and the farm	Select well-drained fertile soils for the nursery and the farm
Principle 3	Plan crop rotation	Plan crop rotation	Plan crop rotation with other crops	Adopt good nursery practices
Principle 4	Adopt appropriate planting distances and planting patterns	Adopt appropriate planting distances and planting patterns	Adopt appropriate planting distances and planting patterns	Practice rotation with appropriate crops
Principle 5	Plant crops at appropriate times	Plant crops at appropriate times so that their growth coincides with low pest and disease incidence	Plant crops at appropriate times so that their growth coincides with low pest and disease incidence	Adopt appropriate planting distances
Principle 6	Weed early and regularly	Weed early and carefully	Weed early and carefully	Plant crops at the appropriate time
Principle 7	Adopt good soil management practices	Adopt good soil management practices	Adopt good soil management practices	Weed early and carefully
Principle 8	Adopt suitable water management practices	Adopt suitable water management practices	Adopt suitable water management practices	Adopt good soil management practices

Principle 9	Visit fields regularly	Visit fields regularly	Visit fields regularly	Adopt suitable water management practices
Principle 10	Maintain high levels of sanitation in the field	Maintain high levels of sanitation in the field	Maintain high levels of sanitation in the field	Visit fields regularly
Principle 11	Manage pests and diseases efficiently	Manage pests, diseases and weeds efficiently	Manage pests, diseases and weeds efficiently and early	Maintain high levels of sanitation in the field
Principle 12	Enhance and protect the populations of natural enemies (e.g. predatory ants, spiders and parasitic wasps)	Enhance and protect the populations of natural enemies (e.g. predatory ants, hover flies, ladybirds, spiders, assassin bugs and parasitic wasps)	Enhance and protect the populations of natural enemies (e.g. predatory ants, hover flies, ladybirds, spiders, assassin bugs and parasitic wasps)	Manage pests and diseases efficiently
Principle 13	Minimize the application of chemical pesticides	Minimize the application of chemical pesticides	Minimize the application of chemical pesticides	Enhance and protect the populations of natural enemies (e.g. predatory ants, spiders, ladybirds, hover flies, lacewings, ground beetles and parasitic wasps)
Principle 14	Adopt good harvesting methods	Adopt good harvesting methods	Harvest timely and adopt good harvesting methods	Minimize the application of chemical pesticides
Principle 15	Adopt good, clean storage systems	Adopt appropriate and clean storage systems	Adopt good, clean storage systems	Adopt good harvesting methods

Sources: MoFA-PPRSD/GTZ: Integrated Pest Management Extension Guide 4/Integrated Pest Management Extension Guide 2

4.4 Key Pests and Recommended Management Practices

4.4.1 Major Natural Enemies and Enhancing Natural Enemy Populations

One important aspect of the IPM approach is the role of natural enemies, or beneficials. Natural enemies are the predators and parasites, parasitoids and beneficial micro-organisms that attack crop pests and disease organisms. Predators are hunters that usually feed on a range of insects or other animals, while parasitoids are often very specific to a certain pest in which they develop. The table below shows the major natural enemies and the pests they feed upon.

Table 4.4 Major natural enemies and the pests they feed upon

Natural Enemy Groups	Examples	What they feed upon
Predators	Predatory mites	Pest mites and thrips
	Spiders	A wide range of insects, such as flies, aphids, caterpillars, butterflies, moths, plant hoppers
	Mantids	A wide range of insects, such as flies, aphids, moths, caterpillars
	Assassin bugs	Other bugs, aphids, leafhoppers, maggots, caterpillars
	Predatory ants	Insect eggs, caterpillars, grubs, maggots, termites
	Ladybirds (larva and adult)	Aphids, scale insects, mealy bugs, white flies, mites
	Lacewings (Larvae only)	Aphids and other soft-bodied insects, as well as insect eggs and mites
	Ground beetles (larva and adult)	Caterpillars, grubs, bugs, beetles, maggots
	Hover fly (larvae only)	Aphids, thrips and other soft-bodied insects
	Robber fly	Caterpillars and small insects
Parasites	Parasitic wasps	Caterpillars, aphids, scale insects, maggots, mealy bugs, white flies, insect eggs, beetles
	Parasitic flies	Caterpillars

Source: Integrated Pest Management Extension Guide 1. Principles of Integrated Pest Management: Growing Healthy Crops, Anthony Youdeowei, MOFA/GTZ

Populations of natural enemies can be increased in the field so that they help to control crop pests. Simple techniques for doing this are based on creating a conducive environment for their development and on providing attractive substances to concentrate them on infested crops. Some things that can be done include:

• Minimise the use of chemical pesticides, as these will kill the natural enemies and thus destroy their populations; if it is absolutely necessary to spray crops with pesticides, use selective rather than broad-spectrum pesticides;
• Mulch crops with dried leaves and other plant materials; mulch provides protected, cool and moist sites suitable for the breeding and resting of natural enemies such as predatory ants, spiders, centipedes and ground beetles;
• Predatory ants are attached to sugar/water solutions; prepare a sugar solution by adding about 90kg of fine sugar to 1 litre of water; mix thoroughly until all the sugar dissolves, and then spray this solution on the leaves of the infested crop once a week or as needed; this solution will attract ants onto the crop plants where they will prey on thus eliminate the pests;
• Water solutions of the juices of ripe fruits (e.g. cashew) can serve as a cheap substitute for sugar;
• Leave strips of flowering weeds around the crop field to serve as a refuge for natural enemies.

4.4.2 Recommended IPM Practices for Selected Vegetable Crop Pests/Diseases

Cabbage

Cabbage No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
1	Diamond-back moth (DBM) (*Plutella xylostella)* (Pre-harvest stage: Vegetative to head formation)	• Embark on filed sanitation (uproot and burn stalks or feed to animals) • Plant during rainy season to wash off young larvae • Intercrop with repellent plants such as tomato or chilli pepper between rows 30 days before planting cabbage • Do not leave overgrown cabbage in the field • Scout weekly when plants are young and destroy eggs and caterpillars • Conserve and encourage natural enemies . • Use microbial insecticides such as Bacillus thruringiensis (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 of different active ingredients and modes of action • Observe the pre-harvest intervals of synthetic pesticides
2	Webworms or cabbage borer (*Hellula undulalis)* (Pre-harvest- seedling to	• Embark on field sanitation (uproot and burn stalks or feed to animals) • Use bio pesticides, such as neem based insecticides • Use insect growth regulators (IGR) or other recommended pesticides
3	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 running water 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 (local soap - alata samina) 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
4	Cutworm (*Agrotis sp)* (Pre-harvest –Seedling stage)	• Timely weed control. • Plough to expose larvae (specially Egret birds) and to bury others and prevent them from reaching the surface • Replant severe losses • 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).* • Flooding the soil before planting will expose caterpillars to predators
5	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)
6	Root knot nematode (*Meloidogyne spp.)* (Pre-harvest – all stages starting at nursery)	• 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 • 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 of damage. • Uproot plants after harvesting and burn them • Flooding the soil for a few weeks will reduce nematode population Use trap crops such as African marigold and Crotalaria
7	Black rot (*Xanthomonas campestris)* (Pre- and post harvest – heading stage, leaves)	• Deep plough • 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) • running water 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 overhead irrigation. Water splash helps spread bacterial pathogens

Cucurbits (cucumber, melon,)

Cucurbits (cucumber, melon,) No.	**Major pests and Diseases/ Stage**	**Recommended cultural practice and direct interventions**

1	Aphids *(Aphis gossypii)* (Pre-harvest stage-vegetative stage)	• Observe build up of predators (ladybird beetles, lacewings, hoverflies) • Use appropriate pesticide or neem extracts if need arises (check for winged aphids as transmitters) • Observe build- up of aphid populations and of natural enemies
2	Melon flies (Pre-harvest and 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 culied 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 hosts close to the field
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 EPA 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
6	Downy mildew *(Pseudoperonospora cubensis)* (Pre-harvest – vegetative to generative stage)	• Grow young plants away from older plants • Ensure adequate spacing to lower humidity • 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

Egg plant

Egg plant	**Major pests and Diseases/ Stage**	**Recommended cultural practice and direct interventions**
1	Budworms (*Scrobipalpa blasigona)* (Pre-harvest – flowering stage)	• Avoid growing eggplant 2 years in succession • Practice crop rotation • Rotate pesticides e.g. spray organophosphate (OP) and then pyrethroid pesticide. • No chemical control advocated in small populations and damages • Monitor pest
2	Epilachna beetles (*Epilachna chrysomelina)* (Pre-harvest stage)	• Usually no control measures necessary • Spray with a short persistence synthetic insecticide if numbers are great.
3	Jassids/leafhoppers (*Jacobiasca spp./Empoasca spp.)* (Pre-harvest – all stages)	• Avoid use of chemicals only use recommended pesticides if there is heavy infestation • Balance fertilizer do not over fertilize with nitrogen
4	Mole crickets (*Brachytrupes spp)* *(Pre-harvest – seedling stage)*	• A most crumbly bait of approved pesticides with maize flour or wheat bran may be used in nursery. • Pick adults from their burrows and destroy or feed

		to animals • Sprinkle wood ash in nursery • Do deep ploughing to destroy burrows and expose insect to predators (e.g. birds) • Land preparation exposes crickets to predators
5	Root-knot nematodes (*Meloidogyne spp)* (Pre-harvest stage – seedling to fruiting stage)	• Rotate crops for at least three years with non-susceptible crops e.g. maize, pulses or cassava to effect reduction in residual juvenile populations • Use non infected seedlings for planting. • Solarise soil (4-6 weeks) before sowing seeds in nursery • Grow resistant varieties, however continuous or frequent use of resistant varieties may result in resistance breaking races • Clean planting and cultivating equipment from contaminated soils before moving to un infested fields • Destroy alternative weed host plants • Use trap crops such as Tagetes sp. • Improve soil with manure and fertilizer • Add 1-2 tonnes/ha neem cake (if available) to the field to reduce nematode infestation
6	Stem and fruit borers *(Leucinodes orbonalis)* (Pre-harvest – shoots and fruits)	• Use resistant variety • Avoid growing garden egg for 2 years in succession. • Fruit sanitation: remove and bury affected fruits. • Frequent harvesting and destruction of unwanted and fallen fruits. • Destroy damaged shoots on a community wide basis as part of an overall IPM strategy
7	Damping-off disease (*Pythium spp)* (Pre-harvest – nursery problem)	• Use certified disease free seed • Treat seed with hot water before planting • Sow seed thinly or thin seeding when they appear crowed • Do not apply too much nitrogen fertilizer • Practice solarisation (4-6 weeks) before sowing seeds. • Sterilize soil for seed boxes for nursing. • Drain off excess water • Improve aeration by stirring soil • Drench soil with approved copper fungicide follow instruction on the label • Burn diseased seedlings.

8	Wilt disease (*Fusarium semisectum)* (Pre-harvest – seedling to fruiting stage)	• Do not locate seedbeds on a land with a previous history of fusarium wilt • Raise soil pH by liming where soil is acidic • Control root not nematodes • Avoid application of excessive nitrogen • Use resistant varieties if present • Treat seed with recommended fungicide • Spray the crop with fungicide will not control the disease once established • Plant in neutral soils for seedbed • water plants regularly • Undertake long rotation
9	Fruit rot disease (Anthracnose) *Colletotrichum spp*	Prevent fruit from touching the soil and harvest before they become overly ripe. Remove infected plant from the garden and throw away and plant disease free seed.

Okra

Okra No.	**Major pests and Diseases/ Stage**	**Recommended cultural practice and direct interventions**
1	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 running water discourages aphides. • Spray with soap solution or neem
2	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
3	Flea beetles (*Nisotra spp., Podagrica spp.)* (Pre-harvest – early vegetative stage)	• Ensure good agricultural practices (fertilization, , 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 organo phosphate insecticide
4	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 crotalaria and Indian mustard as trap crop. • Use indicator plants (e.g) to monitor presence of nematodes. • Deep plough, expose nematode infected roots • Try solarisation 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
5	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

6	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. • water plant at regular intervals

Hot and Sweet pepper

(Hot and Sweet pepper attacked by same pests and diseases) No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
1	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
2	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. • Use of repellents such as botanicals. • Spray with soapy solution or neem extract • Use yellow sticky traps • Use trap crops and use sprinkler • African marigolds and masturtiums intercropped with pepper discourage whiteflies • Chemical spray is not necessary
3	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

4	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
5	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
6	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

Soybeans

(Soybeans) No.	**Major pests and Diseases/ Stage**	**Recommended management practices**
1	Aphids (*Aphis craccivora and other species)* (Pre-harvest stage)	• Promote build -up of indigenous natural enemies • Observe recommended time of planting • Apply wood ash in case of a heavy attack • Carry our regular crop inspection to detect early attacks • Apply recommended insecticide when necessary
2	Storage weevils *(Callosobruchus maculates)* (Post-harvest stage)	• Use PICS bag • Use neem extract to store soybeans
3	Flower thrips *(Megalurothrips sjoestedtii)* (Pre-harvest stage)	• Use resistant varieties if available • Adopt mixed cropping/intercropping system with cereals

		• Biological control • Practice crop rotation • Apply recommended selective insecticides if absolutely necessary • Apply botanical extracts (e.g. neem seed or leaf extracts in water)
4	Pod borers (*Maruca vitrata, Euchrysops sp.)* (Pre-harvest stage)	• Apply recommended insecticides or botanical extracts • Promote build up of indigenous natural enemies • use resistant varieties if available • Biological control • Crop rotation
5	Sucking bugs (*Anoplocnemis spp., Clavigralla spp. And other species)* (Pre-harvest stage)	• Use resistant varieties if available • Promote build up of indigenous natural enemies • Mixed cropping system Biological control • Crop rotation
6	Anthracnose disease (*Colletotrichum lindemuthianum)* (Pre-harvest stage)	Use of resistance varieties • Use of healthy seeds • Crop rotation • Seed dressing • Post harvest tillage • Field sanitation • Plant tolerant/resistant varieties
7	Mosaic virus diseases (Pre-harvest stage)	Plant tolerant/resistant varieties if available • Effect good control of aphids
8	Striga (witchweed) *(Striga gesnerioides)* and other weeds (Pre-harvest stage)	Early and frequent weeding

4.4.5 Management of post- harvest pest of pulses

The most important post-harvest pest of pulses include; the storage weevil for soybean and the storage beetle and grub for groundnuts. Losses due to damage caused by these pests can be minimized through the following IPM strategies:

• Dry seeds properly immediately after harvest and before storage to prevent attack by storage pests and diseases.

• Divide seeds into batches for short term (less than 3 months) and long-term storage, and treat only the long term batch, if necessary, using neem oil at a rate of 2-4 ml/ kg of seed, or a recommended pesticide.
• Clean the store properly before storing pulses there; use containers that are airtight and clean, and do not allow humidity to build up.
• For storing cowpea and soybean, use triple bagging with polythene bags.
• Adopt solar disinfestations by heating cowpea and soybean grains between black and transparent plastic sheets.
• Treat small quantities of pulses for storage with wood ash, groundnut oil, neem oil or black pepper powder
• Use rodent guards in areas with rat/rodent problems

4.4.6 Pesticide applications –cereals, pulses and vegetables - In line with IPM approaches

1. A decision to use chemical pesticides should be taken only as the very last resort and should also be based on conclusions reached from an agro-ecosystem analyses (AESA).
2. All pesticides should be EPA approved and PPRSD recommended.
3. If it is absolutely necessary to spray crops with pesticides, use selective rather than broad-spectrum pesticides.
4. All pesticides should be applied using knapsack sprayers.
5. All the insecticides for storage pests of cereals/pulses are in dust or liquid form and therefore used as supplied without mixing with anything else.
6. The list of pesticides can change as new products are recommended and/or some of the chemicals are withdrawn. Therefore always consult the retailer/stock list, the nearest PPRSD extension worker if in doubt and/read the label.

4.5 Controlling Pesticides used in Crop Protection:

Every pesticide produced in Ghana is subjected to registration and approval by the EPA. However due to porous border control and the fact that EPA do not have the requisite staff stationed at entry points to regulate the products, PPRSD officers at the entry points in collaboration with custom officials should make Phytosanitary Checks at the border.
The control of pesticides is also done in principle at the distribution level in the towns/villages through decentralized services, which see to it that distributors, dealers and resellers abide by the established texts (sales permit).
In order to ensure the efficient use of the pesticides for the fight against crop pests/diseases, the maximum residues limits (MRL) have been defined by European markets/EU standards, if not it is the codex alimentarus that is considered. Indeed Ghana is required to comply with sanitary and phytosanitary measures (SPS) and especially the pesticides residue values available in farm products that should not exceed the acceptable MRLs, otherwise produce from Ghana will be banned. Currently, compliance with MRLs is restricted to crops earmarked for export. There are no restrictions on MRL for crop products sold locally. Indeed it is an accepted fact by West African countries that the presence of residues in food stuff is a reality.

The Ghana Standard Board laboratory is qualified for the analysis of the MRL. It is important both from an economic point of view (exports) and also from a sanitary/health point of view to systematically carry out the monitoring of MRL for crops sold in the local markets.

4.6 Management and Use of Pesticides

4.6.1 Production and importation of pesticides

In West Africa, there are no industrial units ensuring the synthesis of active materials through brandy laboratories. Thus, production of pesticides in the proper way is not effective in the whole of these countries. Finished products are rather imported notably through mother companies represented at the national level or active matters for formulation purposes. In Ghana, the following can be cited among others – Abuakwa Formulation unit, Wienco, Dizengoff, CHEMICO, Reiss & Co., Calli Ghana. The pesticides import statistics from 2007 to 2010 is provided in the table below.

Table 4.6 Pesticides Import Statistics 2007 – 2010

YEAR	2007		2008		2009		2010	
Formulated Pesticide Product	**Solids (Mt)**	**Liquid (Lt)**	**Solids (Mt)**	**Liquid (Lt)**	**Solids (Mt)**	**Liquid (Lt)**	**Solids (Mt)**	**Liquid (Lt)**
Insecticides	5.900	969,944	273.000	3,269,000	60.430	3,388,275	40.666	3,028,724
Herbicides	500.170	1,581,190	1,429.000	6,102,000	998.147	8,981,102	323.580	13,161,585
Fungicides	588.558	365,100	1,561.000	179,000	325.932	947,656	242.926	697,913
Nematicides	287.030	-	-	-	-	-	-	-
Others e.g. Plant growth regulators, wood preservatives etc	62.700	34,464	-	-	-	-	7.096	5,061
Totals	**1,444.358**	**2,950,698**	**3,263.000**	**9,550,000**	**1,384.509**	**13,317,033**	**614.268**	**16,893,283**
Grand Total	**4,395.056 Mt**		**12,813.000 Mt**		**14,701.542 Mt**		**17,507.551 Mt**	

Source: EPA/PPRSD

4.6.2 Organization and practice used in selling and distribution

The distribution channel is entirely private. Suppliers who import the products feed the market through distributors, who supply to retailers who display them for sale. Certain distribution spots and – sales point- are well kept and abide by commercial rules; in general, the products are well displayed on shelves. However, at the level of many retailers who display for sale there are great risks.

On account of the low financial capacity of local farmers/peasants and other buyers, some of the products are sold by decanting. Smaller retailers may decant products into smaller containers to meet farmers' purchasing ability, usually without proper labels, which should describe active ingredients and concentration, dosage, handling instructions and hazards, batch and date of expiry.

Some retailers are polyvalent and therefore engage in other types of commerce in the same premises. Distribution is also carried out sometimes without authorisation as required by the regulation and with the personnel not having received any training in the pesticides chemical

products domain in general. In actual fact many of these actors do not have the requisite approvals/permits/license. Nevertheless, retailers affiliated to suppliers receive this type of training through the suppliers themselves.

Other challenges

The problems associated with the adulteration of pesticides by some pesticide dealers have created real concern for a wide variety of interest groups in recent times. Stakeholders from the Environmental Protection Agency (EPA), Ministry of Food and Agriculture (MOFA) as well as farmers have observed that some pesticide dealers adulterate and fake pesticides, using methods such as the alteration of expiry dates of pesticides, the change of labels on pesticide containers, and the preparation and bottling of mixtures in already used pesticide containers.

These criminal and unethical practices are attributed to the desire of bad dealers to make huge profits. These unscrupulous dealers exploit the low literacy levels and financial capacity of their customers, most of whom are smallholder farmers, who cannot tell the difference between fake and genuine products and the implications and sources of low-priced pesticides.

4.6.3 Use of pesticides by farmers:

In most cases, farmers themselves or farm assistants spray the plant protection products. The protection of farmers and farm assistants against any type of contamination by pesticides is not guaranteed. Farmers use various types of applications and in most cases the appropriate personal protective equipment (PPEs) such as hand gloves, overalls etc are not worn. The time of spray during the day is sometimes not appropriate. Farmers have been observed spraying during hot afternoons when sunshine is at its peak and such farmers who are usually not in appropriate PPEs are exposed through inhalation and skin contacts.

As regards the bad use of pesticides, the treatments are done several times which leads to product waste but also to a lack of good judgement as regards their efficiency. The documents that allow to monitor product traceability are very scarce or even nonexistent as well as the notification of product usage. All of this could lead to the availability of residues in the products with the associated difficulties to export these.

4.6.4 Management of pesticide containers

The management of pesticides containers is under the responsibility of resellers and farmers because of the retail sales system. They find themselves with the most important share of the empty containers which are differently managed.

• Sales to pesticides buyers who do not have empty containers and who straightforward reuse these containers;
• Sales for other uses
• Farmers/buyers reuse empty containers for storage purposes at household levels.

Littering of farms with empty pesticide containers

However, with big commercial farms or companies, management of pesticide containers are expected to be clearly stated in their environmental management plans (EMP) to the EPA. Usually, these companies indicated that they will liaise with the appropriate MOFA office to provide guidance to the disposal of the containers.
Facility for the treatment of large empty containers are not known to be installed or in use in the country at the moment. Such facilities will be useful for the treatment of high capacity drums for recycling or reuse. A collection and disposal system and cleaning of pesticide containers need to be put in place by PPRSD-MOFA and the EPA under the Project. Currently there are few private companies recycling empty containers and other plastics. Farmer under the intervention should be linked to these companies for efficient disposal of empty containers

4.6.5 Accidents resulting from pesticide use

As regards the sanitary consequences of the use of pesticides, there are often cases of death or intoxication. Indeed, cases of lethal intoxication have been recorded for human, and animals. PAN Africa keeps a database on the cases that occurred in Senegal and in some countries of the sub region. The Ghana Poison Control Centre is expected to keep records on pesticide poisoning and accidents. The existence of the Centre is not very popular among many Ghanaians. The Centre needs to be supported for the collection and keeping of accurate statistics on these events. Currently, the data on pesticide poisoning and accidents resulting from pesticides use or disposal must be fragmented and still remains in the various newspapers that have reported such cases, and various hospital cases. There is the need to create awareness raising actions that will target the different pesticide users in order to avoid accidents and incidents.

4.7 General health problems and environmental hazards associated with pesticides

There are acute and chronic health effects and these effects may manifest as local or systemic effects. They include skin irritations, such as itching, rashes, blisters, burns, wounds, irritation of throat leading to cough or difficulty in breathing with or without wheezing or choking, chest pain, burning mouth and throat with pain on swallowing, runny nose, sore throat, head ache, dizziness, sudden collapse with or without unconsciousness.

Others include eye irritation, blurred vision, lots of tears or saliva or mucus secretion and sweating, nausea, vomiting, chest infections due to aspiration of vomits, fever, abdominal pain or discomfort, diarrhea, uncontrolled urination and defecation, slowing of heart beat or rapid heartbeat, weakness including muscles for breathing, muscle twitching or pains, tremors, convulsion, coma, hallucinations, pain and numbness in legs, allergic reactions. Others are problems with liver, kidney, or nerves functions, improper functioning of the heart etc.
The table below provides a summary of pesticide problems relating to human health, environment and crops.

Table 4.7 Pesticide problems relating to health, environment and crops

Hazards to health	Hazards to Environment	Hazards to crops
Acute poisoning: 3 million poisonings including 20,000 unintentional deaths occur annually (WHO). Symptoms of acute poisoning include severe headaches, nausea, depression vomiting, diarrhea, eye irritation, severe fatigue and skin rashes. Chronic ill-health problems can affect women and men, girls and boys exposed to pesticides, whether because of their occupation or because they live near areas of use. Such problems can include neurological disorders, cancers, infertility and birth defects and other reproductive disorders.	Contamination of drinking water and ground water. Water contamination kills fish. Soil contamination. Wildlife and domestic animals can be killed by spray drift or drinking contaminated water. Exposure may also cause infertility and behavioral disruption. Persistence in the environment and accumulation in the food chain leads to diverse environmental impacts. Loss of biodiversity in natural and agricultural environments	Pesticide resistance: 520 species of insects and mites, 150 plant diseases; and 113 weeds are resistant to pesticides (FAO). Resistance can create treadmill syndrome, as farmers use increasing inputs to little effect, while elimination of beneficial insects causes secondary pest outbreaks. High cost of pesticides can lead to falling incomes for farmers: Newer products are often safer, but are more expensive. Farming communities lose knowledge of good horticultural practices and become dependent on expensive external inputs.

Challenges and Potential Impact of Improved Feeding Practices for first 1,000 Days Project

The impacts and challenges identified include:

a. Lack of Integrated Pest Management (IPM) sustenance measures national pest control strategy
b. Likely pollution of water resources and aquatic life from pesticide usage;
c. Mycotoxin poisoning from poor soybeans drying;
d. Poisoning from improper use of pesticides by farmers and farm assistants;
e. Impact from improper disposal of pesticide containers;
f. Production losses from threats from other crop pests and diseases;
g. Abuses associated with pesticide supply and sales; and
h. General health and safety of farmers and environmental hazards.

Action Plans

The action plan detailed in this document revolves around training, awareness creation, adoption of IPM approaches and environmentally friendly water conservation practices.

Programme to meet Pest Management Plan (PMP) requirements

The project will adopt the following programmes and strategies to achieve an effective pest and pesticide management process:

a. Collaborate with relevant institutions such as Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture, EPA, to register and train all interested pesticide distributors/resellers under the Project.
b. PMP Communication and IPM/PMP Orientation Workshop
c. Education and awareness creation
d. Pests Inventory and Monitoring Measures
e. Stakeholder and Interest Group consultation and Involvement
f. Prevention of new Pest Infestations and management of established Pests
g. IPM Capacity Building
h. Institutional Arrangements and Training Responsibilities
i. Participatory Monitoring and Evaluation
j. Ensuring Sustainability
k. Annual Reporting and Management Reviews

5.0 POTENTIAL IMPACTS AND CHALLENGES ASSOCIATED WITH IMPROVED FEEDING PRACTICE PROJECT INTERVENTIONS

The use of various agro-chemicals especially pesticides is more likely during the implementation stage under this project. This section assesses the likely potential impacts from the external environment on the Project and vice-versa.

5.1 Impact of pesticides on water bodies

The use of agro-chemicals on farms could affect the fresh water sources. The main water bodies, and underground water. Apart from these, there a number of seasonal rivers and creeks within the project zone. The excessive use of agro-chemicals such as herbicides can contaminate water bodies through run off especially during the rainy season and/or water logging.

5.2 Impact of pesticides on aquatic fauna

Pollution from agrochemicals may also affect aquatic animals in water bodies. Some of the common diseases are *loiasis* and *brugian* among large herbivores and *encephalitic* in birds. The animals can host vectors, pathogens and viruses. These can be transmitted to human beings by contact or through consumption of those aquatic animals

5.3 Improper pesticide use and disposal of pesticide containers

This is caused by poor knowledge, inadequate equipment and storage. There is application of unregistered and non-approved pesticides and the use of an excessive dosage. With an average annual use of 12,355 mt of pesticides over the period 2007 – 2010, pesticides use is relatively moderate in Ghana.

There are pockets of high use in vegetable cultivation, such as in tomatoes, cabbage, onion and okra. The inappropriate use of pesticides is reflected in the pesticide content on vegetables. According to Amoah *et al, 2006, a* survey in three major cities in Ghana, showed up to 80 percent of the vegetables contaminated, often with residue levels exceeding the MRLs.
The production of vegetables and pulses will increase under the project and this will require proper storage to prevent pests from ravaging the grains. Improper use of pesticides during storage is also a concern as pesticide residues above the MRLs are more likely to occur with stored legumes.

Pesticide containers have been found to be reused at homes. Improper washing or cleaning could lead to harmful consequences where containers are reused as food or drink containers. The population groups at risk include women, children, elderly and rural farmers who are mostly illiterate and principal users of empty containers without proper treatment. An increase in pesticide containers in the project area is expected during the implementation stage and proper

collecting system and disposal is required to minimize reuse of containers for domestic activities.

5.4 Production and market losses from fruit fly attacks

Fruit flies affect fruits such as citrus, papaya, and vegetables, like eggplant and pepper**.** The fruit fly *(Bactrocera invadens)* was identified in Ghana in 2005. Both males and females are similar in appearance but damage is often caused by females. They pierce the fruit to lay eggs. The larvae live and feed inside the fruit and destroy the pulp. The losses because of the fruit fly are major, including a likely ban on fresh fruits and vegetables imports from Ghana with the consequent reduction in foreign exchange earnings, post-harvest losses for sale in the domestic market, loss of farmers income, and increased risk of exposure of producers and consumers to pesticides. Good Agricultural Practices, treatment of the fruits/vegetables and eventually the establishment of pest free zones are some of the control measures available.

5.5 Abuses in pesticide supply and sales

The abuses associated with the supply and sale of pesticides are likely to occur under the Project and these abuses include:

- Use of banned and or unregistered pesticides
- Decanting of pesticides into improper containers without appropriate labels and use information at the retail level and farm gate points
- Supply and sale by unauthorized persons /persons without EPA/PPRSD license and permits
- Supply and sale of adulterated and or expired pesticides

6.0 INTEGRATED PEST AND PESTICIDE MANAGEMENT ACTION PLAN

Various impacts and challenges are likely to be associated with the proposed Project with regard to pest and pesticide management issues. The impacts and challenges identified from previous sections of the report include:

- Lack of IPM sustenance measures even though national pest control strategy is IPM
- Likely pollution of water resources and aquatic life from pesticide usage;
- Public health concerns from water-borne diseases such as malaria and bilharzia that can trigger the use of pesticides in controlling their vectors;
- Poisoning from improper use of pesticides by farmers and farm assistants;
- Poisoning from improper disposal of pesticide containers;
- Impact of fruit fly;
- Production losses from threats from other crop pests and diseases;
- Abuses associated with pesticide supply and sales; and
- General health and safety of farmers and environmental hazards.

Appropriate mitigation measures and implementation tools as well as monitoring indicators are required to be instituted to contain any adverse occurrence. The key actors to be involved in the implementation of the mitigation and management need to be identified as well. The table below provides the action plan for pest and pesticide management under the Project.

Table 6.1 Integrated Pest and Pesticide Management Action Plan

Impact issue / Pest & pesticide threat/ risk	Mitigation Measures	Implementation tool	Expected result	Monitoring indicators	R in
Pollution of water resources and aquatic life	Control and supervise pesticide use by farmers	Adoption of IPM approaches/ techniques	Farmers trained in IPM techniques	Number of farmers trained, Training records	PPRSD-MoF regional offi
	Proper disposal of pesticide containers by resellers/farmers	Pesticide container collection and disposal plan	Pesticide container disposal plan developed and implemented	Number of farmers/ resellers aware of pesticide container disposal plan	PIU/MoFA/F
	Monitor pesticides in water resources	Environmental quality monitoring plan (linkage with Project ESMP)	Pesticide concentration in water resources	Levels of pesticides in water resources	Environment
Improper use of pesticides by farmers and farm assistants	Educate farmers and farm assistants on proper use of pesticides and pesticide use hazards	Pesticide hazards and use guide manual or leaflet for the project (include simple pictorial presentations)	Proper use of pesticides by farmers and farm assistants. Awareness created among farmers and farm assistant on pesticide harzards. Leaflets/manuals on pesticides hazards developed, printed and distributed	Number of farmers and farm assistants trained. Number of leaflets developed and distributed. Number of cases of pesticide poisoning occurring under the project	a) PPRSD-M
	Control and supervise pesticide use on farms	Adoption of IPM approaches/ techniques	Farmers trained in IPM techniques	Number of farmers trained, Training records	PPRSD-MoF regional offi
	Monitor pesticide residue in crops	Random sampling procedure for crops and storage products	Pesticide residue in crops within acceptable limit/MRL	1. Levels and trend of pesticide residue in sampled crops 2. Number of times exported crops are rejected due to pesticide residues	Ghana Sta PPRSD-MoF
Poisoning from		1. Pesticide hazards and use guide	Farmers, farm assistants,	Number of cases of	1. a) PPRS

Impact issue / Pest & pesticide threat/ risk	Mitigation Measures	Implementation tool	Expected result	Monitoring indicators	R in
improper disposal of pesticide containers	1. Educate farmers, farm assistants and local communities on health hazards associated with use of pesticide containers 2. Properly dispose pesticide containers	manual or leaflet for the project 2. Pesticide container cleaning and disposal plan	FBOs, local communities educated on pesticide health hazards Pesticide container cleaning and disposal FBOs, resellers trained in proper cleaning of pesticide containers plan developed and implemented	pesticide poisoning through use of pesticide containers; Number of farmers returning empty pesticide containers at collection points; Number of farmers,	hospitals and clinics 2. PPRSD/E
Production and market losses from fruit fly pest and Fruit Fruit fly	Educated and train farmers to adopt good agricultural practices (GAP)	Adoption of IPM techniques/ approaches	1. Farmers trained in IPM techniques and GAP	1. Number of farmers trained, Training records 2. Number of times exported crops rejected due to fruit fly pest 3. Production losses from crop pests	PPRSD-MoF Regional off
	Establish pest surveillance system	Early detection and warning system in place	Pest outbreaks minimized	Incidence of pest outbreaks recorded.	PPRSD-MoF DAES/Regio
	Apply EPA approved and PPRSD recommended pesticide if necessary	Inspection of pesticides at farm/storage gate prior to use (Project Policy)	Applied pesticides registered and approved by key stakeholders and in conformity with IPM principles	Records of pesticides applied on each farm	PPRSD-MoF MoFA Regio
Threat from other crop pests and diseases	Educated and train farmers to adopt good agricultural practices (GAP)	Adoption of IPM techniques/ approaches	Farmers trained in IPM techniques and GAP	1. Number of farmers trained, Training records 2. Incidence of crop pests 3. Production losses from crop pests	PPRSD-MoF Regional off
		Inspection of pesticides at		Records of pesticides	PPRSD-MoF

Impact issue / Pest & pesticide threat/ risk	Mitigation Measures	Implementation tool	Expected result	Monitoring indicators	R in
	Apply EPA approved and PPRSD recommended pesticide if necessary	farm/storage gate prior to use (Project Policy)	Applied pesticides registered and approved by key stakeholders and in conformity with IPM principles	applied at each farm	MoFA Regio
Impact on post harvest losses due to pests	1. Educate farmers on post harvest handling of produce	Post-harvest loss reduction plan based on IPM techniques in place	a.) Post harvest losses avoided or minimised b) Applied pesticides registered and approved by key stakeholders and in conformity with IPM	Number trained techniques harvest storage; Number and condition of storage facilities in use of farmers in IPM for post	MoFA-AES
	2. Monitor incidence of post- harvest pests		principles	Number of cases of post-harvest pests	PPRSD-MoFA
	3. Confirm status and integrity of pesticides at storage gate prior to use	Inspection of pesticides at farm/storage gate prior to use (Project Policy)		Records of pesticides applied at storage sites/ rooms	PPRSD-MoFA; MoFA-DAES/ MoFA Regional Officers
Abuses in pesticide supply and sales	Identify all pesticide distributors and resellers interested in providing services and products to farmers under the Project	Registration policy for all interested distributors and resellers under project	Only approved and licensed resellers pesticides under project dealers and supply	a.)Company registration documents b)Evidence of license/permit to operate in pesticides c)Evidence of location and contacts of suppliers/resellers	PPRSD of MoFA/CCMC of EPA
	Confirm status and integrity of pesticides supplied under project	a.) All pesticides are to be in the original well labeled pesticide containers prior to use b.) No	a) Only approved and registered pesticides used under project b)Banned	a) List of pesticides supplied and used in line with Ghana EPA and USEPA list of	PPRSD-MoFA; MoFA-

		decanting of pesticides under this project c) Inspection of pesticides at farm gate prior to use	pesticides avoided c) Fake and expired pesticides avoided d)Integrity of pesticide guaranteed at farm gate level	registered and approved pesticides b) Cases of pesticides found in non-original containers c) inspection records for pesticides at farm gate prior to use	DAES/ MoFA Regional Officers
	Ban big pesticide containers to minimize decanting cases	Decanting policy (No decanting of pesticides under project)	All pesticides delivered for use are in the original containers	Cases of pesticides found in non-original containers	PPRSD-MoFA; MoFA-DAES/ MoFA Regional Officers
General health and safety of farmers/crops and environmental hazards	Educate farmers to adopt GAP based upon IPM techniques; and do not use chemical pesticides unless advised by PPRSD	IPM techniques with emphasis on cultural and biological forms of pest control	Compliance with national IPM policy and WB policy on Pest/ pesticide management	Number of farmers trained in IPM techniques; Number of farmers implementing IPM on their farms Frequency of chemical pesticides usage	WB/ MoFA-DAES/ MoFA Regional Officers
	Provide PPEs to farmers/ farm assistants for pesticide use in the fields	Health and safety policy for farm work	Farmers and accompanying dependants (children) protected against pesticide exposure in the fields	Quantities and types of PPEs supplied or made available under the project	MoFA
	Educate farmers/ farm assistants in the proper use of pesticides	Pesticide hazards and use guide manual or leaflet for the project (include simple pictorial presentations)	Farmers know and use pesticides properly; pesticide hazards and use guide leaflet or flyers produced	Number of farmers trained in pesticide use; Number of farmers having copies of the pesticide hazard and use guide flyers;	MoFA/EPA
	Properly dispose obsolete and unused pesticides	Obsolete and unused pesticide disposal plan	obsolete and unused pesticide disposal plan prepared and implemented	Relationship between pesticide supply and usage	PPRSD-MoFA/CCMC-EPA
	Educate farmers to obtain or purchase quantities of	Pesticide use policy/plan	Only pesticides needed are purchased; long term	Relationship between pesticide supply and usage	PPRSD-MoFA/CC

	pesticides required at a given time and to avoid long term storage of pesticides		storage of pesticides by farmers avoided		MC-EPA
	Provide emergency response to pesticide accidents and poisoning	Emergency response plan	Pesticide accidents and emergencies managed under the project	Number of pesticide accidents emergencies and	PPRSD/GHS/National Poisoning Control Centre

7.0 PROGRAMME TO MEET PMP REQUIREMENTS

7.1 Planning

The rationale behind the Plan is illustrated in the matrix below which confirms the results expected from the development and implementation of the Pest Management Plan.

Table 7.1 Planning Matrix

Narrative summary	Expected results	Performance indicators	Assumptions/risks
Goal: empower small holder crop farmers to contribute significantly to household, local and national economies through environmentally friendly pest management practices.	• Food security enhanced, • Environmental quality improved, • Crop productivity and farmers' income increased • Crop export improved • National foreign exchange improved	• Evidence of improvements in food availability, level of poverty, and environmental protection • Evidence of crop export increased •	• Government policies continue to support food security programme • Nation continue to pursue stable democratic governance
Purpose 1. To prevent losses caused by pests in order to increase profitability of agriculture. 2. In the longer term, strengthen national and local capacity to reduce environmental and health risks associated with pest management practices.	**Medium-term results/outcomes** • Farmers in project areas prioritize their pest problems and identify IPM opportunities to mitigate negative environmental and social impacts associated with pesticides. • Farmers in Project areas adopt ecologically sound options to reduce crop losses with minimal personal and environmental health risks. • project decision makers and actors provided with clearer guidelines enabling then to promote IPM approaches and options in agriculture • National IPM policy supported and promoted in compliance with international conventions and guidelines on pesticide use	• Availability of sufficient food. • Perception of state agencies regarding the value of IPM in agriculture. • Level of compliance with World Bank policies etc. • Level of chemical control practices • Types and level of use of alternatives to synthetic chemical pesticides	

7.2 IPM Implementation Strategies

World Vision, Ghana will adopt the following specific strategies to achieve an effective pest and pesticide management process:

7.2.1 Formation of a Safeguard Team

The Project Coordinators/PIU will form a Safeguard Team to oversee and ensure that the project complies with relevant safeguard policy documents prepared for the Project including this PMP.

7.2.2 Registration and training of all interested pesticide distributors/resellers under the Project

World Vision, Ghana will notify pesticide distributors or publish in the national dailies that all interested pesticide distributors or resellers interested in providing services or products for the Project are to register with the Project by providing specific requested information which will include but not limited to the following:

- Certificate of registration or incorporation with the Register General's Department of Ghana;
- License or permit to operate from EPA or PPRSD;
- Locations of company; and
- Type of activities or services or products to be provided.

The Project will organize an orientation workshop for all registered pesticide distributors/resellers under the Project on the following but not limited to these:

- EPA registered and banned pesticides
- EPA/PPRSD requirements on purchase, supply and safe distribution of pesticides

7.2.3 PMP Communication and IPM/PMP Orientation Workshop

World Vision, Ghana will communicate the content of the Pest Management Plan to all upstream project actors or participants such as the EPA, PPRSD, MoFA at the national and relevant regional levels (i.e. within project beneficiary regions). It will establish on-going communication with both the national and relevant regional level pest and pesticide management representatives. World Vision, Ghana will also organize an orientation workshop on IPM techniques as well as the PMP for relevant primary communities, which will in fact be at the forefront in terms of use of pesticides and are likely to be exposed to its various and gradual risks.

7.2.4 Education and awareness creation

World Vision, Ghana will create awareness among downstream project actors or participants (pesticide distributors/resellers, farmers, farm assistants) of the importance of pest and pesticide management in the framework of this PMP and the national IPM strategy; avenues created or available for obtaining appropriate pesticides among other things.

Availability of Information: World Vision, Ghana will ensure that all downstream actors or participants have access to information on relevant crop pests/diseases, MoFA-PPRSD IPM strategies regarding pest control, , current EPA list of registered and banned pesticides, Key information on crop pests/diseases, IPM

strategies regarding pest control as well as pesticide use toolkits will be provided in easy to read and understand format /pictorial presentations and translated into at least two local languages for easy understanding and use by illiterate beneficiary communities. The awareness creation programme will be regular, say every 3 months or 6 months to enable communities become use to the schedule.

Education and Training: World Vision, Ghana will incorporate pest management awareness into environmental training programs.

7.2.5 Participatory Pests Inventory and Monitoring Measures

The project will track and document all pest cases, be it minor or major in a pest inventory register. It will identify the types, abundance, location of pest, date of first spotted or seen and date reported. This information will be gathered from surveillance or monitoring system to be put in place, periodic surveys to be conducted and feedback from farmers/farm assistants. The data will be managed in a standardized way so that trends can be established.

7.2.6 Stakeholder and Interest Group Consultation and Involvement

The PMP implementers will co-ordinate the pest management process with all relevant stakeholders and major land users in the project areas (such as traditional authorities/landowners,). Any activities that may have an impact on pest management will be identified and included in the pest management planning process. Contacts will be established with significant neighboring land managers and consult with them when appropriate and co-ordinate management activities with representatives of the identified government agencies and other land users when appropriate.

7.2.7 Prevention of new Pest Infestations

The Project will endeavor to treat and manage new pest infestations as soon as they are identified. Pest and vector surveillance, early detection and eradication: A process for the reporting and identification of unusual plants, animals and pests will be established. Pest surveys will be conducted on a regular basis to detect new infestations and a rapid response process for the management of new infestations will be established.

Prevention of Spread: The PMP will establish protocols for appropriately managing risks of all human assisted transport of declared pests.

7.2.8 Management of established Pests

The PMP will ensure that established pest infestations are effectively managed. Priorities for pest management will be regularly reviewed. These will include the reduction of Class 3 pests (environmental weeds) where appropriate. The impact on non-target species, particularly those of environmental significance, will be minimized.

7.2.9 IPM Capacity Building

The purpose of the capacity building of farmers in particular is to help farmers use the IPM approaches to manage pests and diseases under the Project. The success of IPM depends largely on developing and sustaining institutional and human capacity to facilitate informed decision making by farmers and farm assistants, and empowering them to integrate scientific and traditional knowledge to solve location-specific problems, and respond to market opportunities. Poor communication between farmers/farm assistants,

extension agents and researchers has often led to poorly-targeted research or to poor adoption of promising options generated by research. The full benefits of investments in agricultural research thereby remain untapped under these circumstances.

Farmer Field Schools (FFS), Farmer participatory research (FPR) and participatory learning (PL) approaches in capacity building efforts help to bridge this gap and make research results more understandable and useful to farmers and farm assistants. This is particularly the case in knowledge intensive disciplines such as IPM.
Farmers will have the capacity to accurately identify and diagnose pests and pest problems, understand trophic relationships that underpin biological control opportunities, and use such knowledge to guide pesticide and other kinds of interventions. Through the participatory approaches, the Project will build local capacity to ensure rapid spread and adoption of ecologically sound and environmentally friendly management practices especially among smallholder farmer. The farmers will learn cultural, biological and ecological processes underpinning IPM options, and use the newly acquired knowledge to choose compatible methods to reduce losses in production and post-harvest storage.

A foundation element of the capacity building exercise is the accurate diagnosis of the pest problem and to provide baseline information that will enable stakeholder groups to develop a shared vision on felt needs and IPM strategies. Through informal interviews, field visits, and planning meetings, stakeholder groups will develop joint understanding of the key issues affecting production and develop a common IPM plan based on agreed concerns.

The PMP implementation will be anchored at the MoFA regional level with field action by farmer groups which will receive training and advisory services from MoFA and appropriate NGOs, who would have graduated from Training of Trainers (ToT) sessions. Training at all levels will be based on participatory learning modules for capacity building in IPM information delivery. The participants will be equipped with skills in facilitation, group dynamics, and non-formal education methods to encourage adults.

Group decision making will be achieved through Agro-Ecosystem Analysis (AESA) involving a comparison of IPM practices with normal farmer practices. At each AESA, farmers observe, record and monitor changes in soil, crop and trophic relationships affecting crop growth. Farmers analyse and discuss their findings and recommend corrective action based on the results of their own analyses. Group learning helps to increase scientific literacy, ownership of biological and ecological information and knowledge, and informed decisions making habits in the communities. Also trained farmers and leaders of farmers' associations will be expected to promote secondary adoption of proven options. For example, leaders of farmers' associations trained will be expected to assist in training new farmers through demonstrations and farm visits. Additionally, the trained farmers will organize field days to train other farmers and explain new/improved IPM practices they have learnt. Field day participants will include representatives of the PIU, local community leaders, NGOs, local community FM stations, researcher institutes, and national extension services.

7.2.10 Institutional Arrangements and Training Responsibilities

Annual work plans will be developed in consultation with participating farmers/investors and in line with their respective farm work plans to indicate institutions and networks that will be required to provide

research and development support. The principal actors will include a number of local institutions directly involved in the implementation of the PMP while other agencies (partners) will include international and national institutions to provide technical and other support for implementation of the plan. These are explained in **Table 7.2.**

Training Responsibilities

The PIU/MoFA with input from PPRSD/EPA are to standardize training needs assessment across sites; and organize appropriate workshops to develop participatory learning modules.

The PPRSD with input from the EPA, will liaise with appropriate farmers' associations to plan training implementation; provide technical support such as in preparing and delivering specific training materials, and evaluating resource materials; identify and select suitable local training resource persons and materials; and prepare training progress reports.

The MoFA (Regional/District Officers) will collaborate with farmers'/agriculture associations to identify and organize farmers groups for training (i.e. use of farmer field school to teach farmers on the efficient and responsible use of pesticides, use of certified sprayers to reduce exposure); prepare, organize and supervise training implementation plan; verify reports of persisting pest problems and farmers training needs; monitor performance of farmer trainers and post-training assignments; and prepare training progress reports..

Table 7.2 Actors and Partners Actors

Actors	**Partners**
The actors will collaborate with the project: • Contribute field staff to be trained as IPM Trainers. • Organize its members into farmer groups for training and promotion of IPM practices. • Facilitate extension and farmer training • Prepare and produce field guides and other relevant IPM information materials • Provide policy guidance/oversight for implementation of the PMP • Monitor, supervise and coordinate IPM activities • Document user compliance on pesticide use Examples of actors: 1. MoFA/PIU 2. EPA (national and regional officers) 3. PPRSD (national and regional officers) 4. Customs, Excise and Preventive Services (CEPS) 5. Ministry of Health/Ghana Health Service (for disease vector control) 6. Farmers and Farmers Associations (e.g. GFAP, GAABIC, SEEDPAG, VEPEAG, APFOG) 7. Agric-input dealers (e.g. GAIDA)	The partners will be IPM experts who: • Serve as technical reviewers for IPM activities. • Provide technical support in pest and natural enemy identification • Assist to organize study tours and networking with international IPM groups. • Provide expertise in planning, training and field implementation of IPM Examples of partners: 1. The Integrated Pest Management (SP-IPM) which is dedicated to breaking isolation barriers to the full realization of IPM research results 2. The Global IPM Facility which assists interested Governments and NGOs to initiate, develop and expand IPM programmes mostly through farmer field school training. 3. Research Institutes (Council for Scientific and Industrial Research, CSIR), and Universities. 4. NGOs

Farmers/local communities as the principal beneficiaries, will be organized into farmer groups for training and adoption of IPM practices. The farmers will be facilitated to set up Community IPM Action Committees to coordinate IPM activities in their areas.

7.2.11 Participatory Monitoring and Evaluation

There will be regular monitoring and evaluation of control programs to determine the level of progress being made with regard to pest and pesticide management and control issues identified in the PMP. Monitoring indicators are provided in the action plan under the previous section. The following performance indicators will be incorporated into a participatory monitoring and evaluation plan.

Table 7.3 Performance Indicators

No	Area	Indicators
1.0	Training and awareness creation	Types and number of participatory learning modules (PLM) delivered; Category and number of extension agents and farmers trained and reached with each PLM; Category and number of participants reached beyond baseline figures; Practical skills/techniques most frequently demanded by extension agents and farmers; and Crop management practices preferred by farmers.
2.0	Technology acceptance/ field application	Category and number of farmers who correctly apply the skills they had learnt; New management practices adopted most by farmers; Category and number of other farmers trained by project trained farmers; Types of farmer-innovations implemented; Level of pest damage and losses; Rate of adoption of IPM practices; Impact of the adoption of IPM on production performance of farmers
3.0	Project direct benefits	• Increase in crop production; • Increase in farm revenue; • Low incidence of pests and diseases • Social benefits: e.g., improvement in the health status of farmers; • Level of reduction of pesticide purchase and use; and • Number of project co families using preventive mechanisms against diseases

7.2.12 Sustainability Issues

Scientific information, adapted into user-friendly format will strengthen training and extension delivery, and increase IPM literacy in project sites/communities.

Strategic alliances with international IPM groups will strengthen national capacities to integrate new IPM options in crop production. Farmer-educational activities will be central to the exit strategy which will feature increased roles and responsibilities of committed national and local farmers' associations and communities to take primary responsibilities in the development of action plans and expertise exchange for **IPM development and promotion**.

Short-term technical study visits (to Centre of No- Till and other West African countries with proven experience in IPM development and implementation) for hands-on laboratory and field training, and farmer participatory learning will help to create favourable conditions for continuity of IPM processes and results. The tour will involve representatives from PIU, PPRSD, and selected farmers' associations.

7.2.13 Reporting

Annual report on the progress of pest and pesticide management at the project sites will be prepared. The reports will indicate the pest cases identified and treated using IPM approaches, location of pests, level of success of treatment, the amount and type of herbicide/pesticide used, level of corporation from farmers and other relevant information (e.g. training programmes organized, farmer field schools held etc).

7.2.14 Management Reviews

The PIU will undertake annual pest and pesticide control and management reviews to confirm the implementation of the various control measures or programmes or actions outlined in the PMP. Recommendations from the reviews will help the PIU to refocus and plan effectively towards achieving planned targets. The management review team will include:

- Representatives of the funding agencies (World Bank and JICA)
- Project Implementation Unit/Project Coordinators
- Representative of the Minister of Food and Agriculture
- Representatives of the EPA Representative of PPRSD

8.0 IMPLEMENTATION BUDGET

PMP Budget

The estimated budget for the implementation of the PMP during a 4- year period is US$ 63,000. Details are provided in the table below

Component/Sub-component	**Total US$**
Capacity Building	
Orientation workshops (on PMP, IPM, and for project registered agro-input dealersEPA, PPRSD, MoFA at the national and relevant regional levels (i.e. within project beneficiary regions	3,000.00
Training of trainers and Farmer group training (monitoring, prevention and control, technologies, safe use of pesticides)	3,000.00
Study visits by lead farmers to Centre of No Till, Amanchia	6,000.00
Support/Advisory services	
Registration and training of all interested pesticide distributors/resellers under the Project	3,000.00
IPM problem diagnosis	3,000.00
Pest/ vector surveillance	3,000.00
Development of brochures on targeted Pesticides for use (Field guides/ IPM materials)	3,000.00
Public awareness/ sensitization campaigns	3,000.00
Emergency response support	6,000.00
Training on application methods and the use of certified sprayers or applicators to reduce the exposure	3,000.00
Environmental management	3,000.00
Support to IPM R&D	6,000.00
Pesticide monitoring in and around project areas	3,000.00
Development of Guidelines - Training and Dissemination of findings	6,000.00
Project management	3,000.00
Reviews and reporting	3,000.00
Monitoring and surveillance	3,000.00
TOTALS	**63,000.00**