SFG2436

Republic of Ghana

Ministry of Food and Agriculture

Ghana Peri-urban Vegetable Value Chains Project

Pest Management Plan

Final Report

September 2016

Executive Summary

Project Background

The Government of Ghana is seeking financial assistance from the World Bank to finance the implementation of the Ghana Peri-Urban Vegetable Value Chains for Poverty Reduction. The project implementation will be under the overall responsibility of the Ministry of Food and Agriculture (MoFA). The development objective of the project is to improve on productivity and access to markets for vegetable farmers in selected peri-urban communities in Ghana. The project will promote water harvesting and small-scale irrigation schemes to facilitate an all year round vegetable production and consumption. It will also develop capacity and provide support to enable resource poor farmers improve productivity and the quality of their produce. It is further to 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.

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

PMP Objectives

The objective of the Pest Management Plan is to:

i. Promote the use of environmentally friendly practices (hygienic, cultural, biological or natural control mechanisms and the judicious use of chemicals) in pest control;
ii. Effectively monitor pesticide use and pest issues amongst participating farmers;
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. 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;
v. 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:

i. Food and Agriculture Sector Development Policy (FASDEP);
ii. Ghana 's Medium Term Agriculture Sector Investment Plan (METASIP)
iii. National Irrigation Policy, Strategies and Regulatory Measures, June 2010
iv. Guidelines for the National Plant Protection Policy, June 2004
v. National Land Policy
vi. National Water Policy, June 2007
vii. National Environment Policy
viii. Environmental Protection Agency Act, 1994, Act 490
ix. Environmental Assessment Regulations, 1999, LI 1652 and its Amendment
x. Plants and Fertilizer Act, 2010, Act 803
xi. Water Resources Commission Act, 1996, Act 522
xii. Food and Drugs Act 1992, PNDCL 3058

xiii. Irrigation Development Authority Act, 1977, SMCD 85
xiv. World Bank Safeguard Policy on Pest Management, OP 4.09

Challenges and Potential Impact of the Ghana Peri-Urban Vegetable Value Chain Project

The impacts and challenges identified include:

a. Lack of IPM sustenance measures even though national pest control strategy is IPM;
b. Likely pollution of water resources and aquatic life from pesticide usage;
c. Public health concerns from water-borne and water-related diseases such as malaria and bilharzia cases under irrigation projects that can trigger the use of pesticides in controlling their vectors;
d. Mycotoxin poisoning from poor maize drying;
e. Poisoning from improper use of pesticides by farmers and farm assistants;
f. Impact from improper disposal of pesticide containers;
g. Large scale production losses from fruit fly and armyworm outbreaks;
h. Production losses from threats from other crop pests and diseases;
i. Abuses associated with pesticide supply and sales; and
j. 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 irrigation systems designs.

Programme to meet PMP requirements

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

a. Collaborate with other projects such as WAAPP and GCAP 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

PMP Budget

The estimated budget for the implementation of the PMP is US$10 000

1. INTRODUCTION

1. The Government of Ghana is seeking a US$ 2.85 million equivalent grant support from the International Development Agency, IDA, to implement an agricultural project dubbed: Ghana Peri-urban Vegetable Value Chain for Poverty Reduction. The Project seeks to improve production and productivity of selected vegetable crops as means to reduce rural poverty, improve livelihood and living standard among peri-urban vegetable producers who are currently constrained with a number of problems including unreliable irrigation water supply, poor capacity and technical know-how, post-harvest losses, poor access to market etc.

2. Vegetable production is recognized as an integral part of Ghana's agricultural system as it is linked not only with the nation's food and nutrition security but also with income generation and employment creation. It is estimated that Africa's daily consumption of fruit and vegetables remains at 100g/person/day as against the FAO and WHO recommended daily intake of at least 400g/person/day (146kg/person/year).

3. In Ghana, national fresh vegetable requirements could be met from local production. Most vegetables are currently produced under rain-fed conditions without irrigation systems, which cause a significant drop in production volume during the dry season. It is estimated that the Ghanaian vegetable farmers are only producing at 50 percent of attainable yields because of the lack of irrigation systems and improved inputs creating a country supply and demand deficit. In rainy seasons where there is usually product glut, farmers experience high post-harvest losses due to lack of processing and storage facilities. External Trade Statistics of Ghana show that large sums of money are spent each year on importing vegetables and vegetable products to augment local production.

4. It is against this backdrop that the proposed Project is crafted to contribute to addressing the constraints of vegetable producers in selected locations within the Greater Accra, Volta and Western Regions of Ghana.

5. The Project triggers three (3) World Bank Safeguards Policies namely:
   - Environmental Assessment OP/BP 4.01;
   - Pest Management OP 4.09; and
   - Involuntary Resettlement OP/BP 4.12

6. It is rated as a Category B project as it is not expected to induce significant adverse environmental and social impacts. Some of the activities such as the rehabilitation of small irrigation schemes, construction of processing facilities and other productive sub-projects may, however, have localized but remediable environmental impacts.

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

1.2 Objective of the PMP

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). It will also seek to reduce reliance on synthetic chemical pesticides and ensure that health, social and environmental hazards associated with pesticides are minimized within acceptable limits by key stakeholders (i.e. primary users among farmers and their immediate dependants/families).

The specific objectives of the PMP are to:

- Ensure appropriate pest management techniques supported under the Project;
- 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 which would 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 World Bank safeguard policy OP 4.09; and

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 also 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 provision for adequate measures to enable the Project sustain the adoption of IPM techniques.

1.4 General approach

In line with the focus of the project, pesticide use in the project area will be integral to project activities. The 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 interventions to mitigate the need or demand for the use of chemical pesticides.

The Project will assist and train farmers and other value chain operators to be able to develop their IPM approaches to the 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 and operators will be trained and encouraged to make detailed observations in their fields, storage areas and processing facilities to ensure the detection of early infestations and make the appropriate management decisions using agro-ecosystem analysis (AESA). 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 be surveyed regularly by MoFA and Departments of Agriculture of relevant MMDAs.

Decision making on pest management strategies and measures at the Project implementation level will be influenced by suggestions and recommendations from the downstream project actors. 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 EPA, PPRSD, MoFA DAES/regional officers, well known and trained NGOs including FBOs).

Project Location and Beneficiaries

8. The **main target groups** are smallholder producers in urban and peri-urban farming satellite communities in Sega Akpokope I & II (Dangme East District of the Greater Accra Region), Aklusu Saisi (Upper Manya Krobo District in the Eastern Region), Anoe (Shama Ahanta Municipal in the Western Region), Tordzinu, Hikpo, Nutekpo, New Bakpa, and Humadikope (Central and South Tongu Districts in the Volta Region).

9. The aforementioned communities are located in the fringes of the major rivers including the Volta Lake, River Tordzi etc. The indigenes are predominantly farmers producing mainly staple crops and vegetables. These farmers are constrained by seasonality of production due to overdependence on rain-fed agriculture and low level of irrigation systems, low productivity and inability to access markets due to low productivity and low quality of farm produce. 1,508 farmers including 527 women are targeted for the support and they will be cultivating a total area of 676.89 hectares (The distribution per community is shown in table 1 below).

Table 1: Distribution of land for the project

	Region	**District**	**Community**	**River/ Waterbody**	**Land area (Ha)**	**Net Irrigable land**	**No. of Farmers**
Eastern Corridor	Greater Accra	Dangme East	Sega Akpokope I	Agor/Volta	19.05	16.70	42
			Sega Akpokope II	Agor/Volta	13.79	12.8	32
	Sub-total				**32.84**	**29.5**	**74**
	Volta	South Tongu	Tordzinu	Tordzi	73.58	67.2	168
			Hikpo	Tordzi	36.45	34.0	85
			Nutekpo	Volta	22.75	20.0	53
		North Tongu	New Bakpa	Volta	22.53	18.0	47
			Humadikope	Volta	11.00	10.0	25
	Sub-total				**166.31**	**149.2**	**378**
	Eastern	Upper Manya Krobo	Aklusu Saisi	Volta	198.43	174.42	436
	Sub-total				**198.43**	**174.42**	**436**
Western Corridor	Western	Ahanta West	Anoe	Dugout	150.61	133.68	334
			Ahanta	Dugout	128.7	114.23	286
	Sub-total				**279.31**	**247.91**	**620**
Eastern Corridor Total					***397.58***	***353.12***	***888***
Western Corridor Total					***279.31***	***247.91***	***620***
Grand Total					***678.69***	***601.03***	***1,508***

1.5 Description of Ghana Peri-Urban Vegetable Value Chain Project

10. Vegetable production in Ghana is generally weak despite the huge local market demand for the produce. The industry's contribution in Ghana's economy is well recognized in helping the nation meet its food and nutrition security as well as creating jobs and improvement in living standards among vegetable producers. In the light of this, the Ghana Peri-Urban Vegetable Value

Chain for Poverty Reduction Project is created to help address some of the challenges facing the industry and to contribute towards increasing vegetable production and productivity in Ghana.

11. The Projects Development Objective (PDO) is to improve on the productivity and access to market by the beneficiary vegetable farmers in selected peri-urban communities in Ghana. The Project has four (4) key components as follows:
a) Farmer Managed Irrigation Systems Development;
b) Farmer Capacity Development and Support to Productivity Improvement;
c) Improving Post-Harvest Handling and Access to Markets; and
d) Project Management, Monitoring and Evaluation, and Knowledge Dissemination

12. **Component 1**: Farmer Managed Irrigation Systems Development: The objective of the component is to improve the existing small-scale riverine irrigation systems for the resource poor farmers in the selected farming communities which are bounded by perennial water bodies with high potential for irrigation farming. The component will address the characteristic seasonality of vegetable production and thus empowering the resource poor farmers to improve their productivity for increased earnings.

13. The component will cover the design and implementation of agriculture irrigation infrastructure. In particular, it will involve the construction of closed conduit irrigation systems all the way from water source to the farmers' field. The proposed model, unlike the open canal system which has faced challenges of over irrigation and soil degradation, will enable farmers to have control over the water application and to also shut it off immediately after each irrigation activity. The furrow irrigation technologies will be deployed under the conduit irrigation system. The design will have a network of farms and perimeter roads, which will serve for tractor and other transport activities such as for push trucks. Along the roads will be laid the pipes for pond filling and gravity water distribution from the ponds.

14. The component will further organize the farmers in each participating community into 2 or more blocks of producer associations/water users (depending on the number of beneficiaries in each community). Selected members of the Groups in each community will serve on the local project management committee who will ensure distribution of water fairly and overall responsibility for the management of the irrigation infrastructure. The component will also develop the requisite capacity for irrigation systems management and it will include organizational management, installation, maintenance and repair of irrigation infrastructure etc.

15. The project will at every participating community, install one Amiran Farmers Kit (AFK) to demonstrate the technology to farmers. The AFK, which is a greenhouse technology using drip irrigation, has been proven to have high potential to improve on productivity and quality of produce and thus increase in incomes. Due to the cost per kit vis-à-vis the cost per beneficiary however, the project will not immediately introduce the technology on a mass scale to the farmers. It is expected however that as the farmers profit margins increase, they will in themselves begin to invest in the technology to further improve on their yields and hence incomes.

16. **Component 2**: Farmer Capacity Development and Support for Productivity Improvement: The aim of this component is to facilitate the adoption of modern and improved production technologies through sustained farmer capacity development and other support systems. The component will design and implement an intensive farmer capacity development program to ensure that farmers have the know-how and adopt modern vegetable production and post-harvest handling techniques to be able to improve their productivity and output. Both workshop based and field based training including FAO's Famer Field School approaches will be adopted for the

farmer capacity development. Training areas will include productivity improvement technologies, appropriate use of chemicals and pesticides, agribusiness management, farm management and farm record keeping accounting financial management, post-harvest handling etc. Relevant themes under the Ghana Good Agricultural Practices (GHANA GAP) will be incorporated into the farmer training program.

17. Capacity development for selected Agriculture Extension Agents (AEAs) in the beneficiary communities who will be directly involved in field activity implementation will also be undertaken. This is to ensure the technical capacity of the selected AEAs is upgraded to effectively provide extension and other support services to the beneficiary farmers and communities. Depending on the number of communities and/or farmers, between 2 to5 AEAs from each of the District Agriculture Departments will be assigned to the project to provide extension support services to the farmers and communities.

18. The grant will provide subsidized starter kits (improved seeds, fertilizers, weedicides etc.) to the farmer groups. At the end of the growing season, the farmers will be required to repay the cost of items supplied to them. The repaid amounts will constitute a revolving fund managed by the executives of the farmer groups and saved in local Microfinance Institutions or Community/Rural Banks. The project will support the groups through capacity development (on organizational/planning, revolving fund management, procurement of inputs) to use these revolving funds to procure the inputs for their members in the subsequent growing seasons.

19. **Component 3**: Improving Post-Harvest Handling and Market Access: The project grant will support farmers to enter into productive partnership arrangements with agriculture entrepreneurs to establish and operate a Farmer Cooperative Vegetable Warehousing Systems with cold storage, cleaning, packaging and labelling facilities. The Warehousing System which will be equipped with refrigerated and cold chain transport system will be an essential off-take facility that guarantees ready high value markets for the farmers' produce. Multi-year supply-purchase agreements between the farmer groups and the Warehousing Centre will be facilitated and this will be supported with capacity development for better understanding and adherence to the basic tenants and guiding principles of such systems.

20. The inclusion of the productive partnership entrepreneurs (B-Bovid Limited and Eden Tree Limited) are for strategic reasons. These private enterprises are already well established in the market and have market linkages with supermarkets and restaurants as well as the farmers. They will in addition bring on board their managerial experience to enhance efficiency in the management of the Warehousing System.

21. The farmer groups becoming shareholders in the Warehousing Systems is expected to contribute to reducing and/or mitigating the risk of produce side-selling. It is also to enable the farmers earn additional income to cater for the repair and maintenances of the irrigation infrastructure to be established by project grant. As the profit margins of the Warehousing System improves and farmers earn more income, they can use the additional incomes towards GLOBALGAP Certification to ensure they have the competitive advantage on local vegetables market.

22. The ownership arrangement will be such that the farmer groups will have 37% shareholding while the B-Bovid Ltd and Eden Tree Limited will together hold 63% equity shares. Profits accruing to the farmers' groups from their shareholdings will be paid into an dedicated account managed by the executive of the farmer groups, of which withdrawals will be made as to when required to maintain the irrigation infrastructure and to support such activities as the procurement of inputs for the farmers.

23. The component will specifically co-finance i) the procurement of Vegetable Warehousing Systems Equipment; and ii) training of technician operators.

24. **Component 4**: Monitoring and Evaluation, and Knowledge Dissemination and Project Management and Administration: This component would support all activities necessary to ensure that the project is implemented in accordance with the project implementation manual. This component will: (i) finance the incremental expenses incurred by the Government in implementing the project and finance various monitoring and evaluation roles.

Sub-Component A. Monitoring and Evaluation and Knowledge Dissemination

25. The monitoring and evaluation (M&E) system will be in line with the implementation structure and results measuring framework for the MESTASIP. A dedicated M&E team will put together to ensure effective and timely monitoring of progress towards achieving the development objective as set out in the Results Framework. The grant proposal will conduct a baseline survey on key parameters within three to six months of project inception. This will form basis for monitoring of progress and achievement of results. An independent evaluation will be conducted at the end of the project to capture project achievements, experiences and lessons learnt for future guidance. Project Implementation Progress reports will be generated quarterly which will be consolidated into annual reports to be shared with all project stakeholders. The project will document the methodologies and processes, achievements, experiences and lessons learnt and circulated it widely including the websites of MOFA, the World Bank, JSDF and other project partners.

Sub-Component B. Project Management and Administration

26. The Ministry of Food and Agriculture will establish a project office at the Crops Services Directorate. A Senior Officer of the Directorate will be assigned to coordinate the day-to-day administrative activities of the project. There will be a Project Steering Committee (PSC) comprising the Directors of Crops Services Directorate, Directorate of Agriculture Extension Services, Women in Agriculture Development Directorate, Ghana Irrigation Development Authority, Agriculture Engineering Services Directorate of the Ministry as well as collaborating agencies i.e. Food and Drugs Authority and Crops Research Institute. The PSC will meet semi-annually and will serve to provide the overall policy direction to the project.

27. At the decentralized level, the District Agriculture Development Unit of the participating communities will be responsible for field level implementation of activities and will provide agriculture extension services, training and other support services to the beneficiary farmers. 2-5 AEAs and Agriculture Officers in each of the District, depending on the number of farmers in a particular district, will be assigned to provide required support services to the farmers. Staff (including the Regional Crops Officer, Regional Extension Officer, Regional Engineering Officer etc.) from the Regional Directorates of Agriculture in the Greater Accra, Eastern, Volta, Central and Western Regions will from time to undertake backstopping and supervisory visits to farmers and communities under their respective jurisdictions.

2.0 REVIEW OF POLICY, REGULATORY AND INSTITUTIONAL FRAMEWORKS

2.1 Policy Framework

Irrigation systems rely heavily on water and access to water is crucial for human development. The control of pests and the use of fertilizers are also critical to vegetable production. A number of sectoral policies will affect the performance of the Ghana Peri-urban Commercial Vegetables

Project and the key policies include agriculture, land, water, environmental protection, irrigation and pest/pesticide policies. The major national policies include:

- National Irrigation Policy, Strategies and Regulatory Measures, June 2010
- Guidelines for the National Plant Protection Policy, June 2004
- National Land Policy
- National Water Policy, June 2007
- National Environment Policy

The relevant international institutional policies are

- World Bank Safeguard Policy on Pest Management, OP 4.09 and
- 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 modernisation of the agricultural sector. The revised policy (FASDEP II) emphasizes the sustainable utilization of all resources and commercialisation of activities in the sector with market-driven growth in mind. Enhancement of productivity of the 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 program 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 Program (CAADP)

The METASIP is for the period 2011-2015 and comprises the following six programs 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 program, which is sustainable management of land and environment

Ghana Irrigation Policy

The Ghana Irrigation Development Policy (National Irrigation Policy, Strategies and Regulatory

Measures), was approved by Cabinet on June 30th 2010. The policy addresses the problems, constraints and opportunities, which cut across the whole irrigation sub-sector; and specifically for informal, formal and commercial irrigation. It is to be complemented with a strategic framework to be called National Irrigation Development Master Plan (NIDMAP) to specify how the strategies in the policy document will be implemented in order to put an area of 500,000ha under irrigation in the medium term.

Under Section 2 Specific Problems Addressed by the Policy, subsection 2.3 on Environmental Degradation Associated with Irrigated Production is concerned about the degradation of land and water resources from the use of agricultural chemicals. Subsection 2.3 is reproduced below.
Irrigated agriculture's environmental "footprint" in Ghana is no larger-than that of any other sub- Saharan country, but concentration of intensive agriculture in a relatively narrow and densely populated coastal margin will exacerbate degradation of land and water resources. The management of agricultural chemicals and drainage across irrigation schemes will be of crucial importance in relieving these pressures and maintaining the productive services of the natural resource base. This is as much an economic opportunity as an environmental imperative. Also human health has to be considered due to water-related diseases like malaria and as some parts of the informal sector have only access to marginal quality water for irrigation.

Under Section 5, Policy Implementation Strategy, subsection 5.3 provides for the implementation strategy on one of the policy objectives, which is responsible production, which emphasizes the need to internalize agricultural impacts on environment and human health. Subsection 5.3 is reproduced below:

This policy thrust will ensure that the irrigated sub-sector is capable of environmentally responsible production that is both compliant with Ghana's environmental legislation and regulation and is also up to date with international norms and practices in minimizing the sub-sector's hydrological footprint on the environment and human health. The key implementing units will be GIDA, the EPA and Ministry of Health (MOH). Supporting regulations and guidelines which include stipulation of minimum stream flows and agricultural effluent with updated guidelines for the application of pesticides and fertilizers in irrigation practice.

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:

Capacity building at national, regional and district levels Intra and inter-ministerial collaboration Private sector involvement Partnerships with international development partners Regional and international cooperation
Legislation IPM Coordination of IPM Activities Contribute to IPM research International trade Planting materials production Compliance 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, mechanzsed 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 iv) encourage the efficient use of fertilizers to reduce pollution of water bodies and ensure conservation of water;
b). (Policy measure v) promote and encourage water use efficiency techniques in agriculture and reduce transmission losses of water in irrigation systems; and
c). (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

In Bank-financed agricultural operations pest population are normally controlled through Integrated Pest Management (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 World Bank can finance the acquisition of pesticides when their use is justified in within the framework of integrated management approach and the below mentioned pesticide selection criteria met:
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 development of 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 Organization IA and IB Classes or Classes II formulations :

a) When the country has no (regulatory or legal) provisions imposing restrictions to their distribution and use or
b) If 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, irrigation, 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;
- Water Resources Commission Act, 1996, Act 522;
- Food and Drugs Act 1992, PNDCL 3058;
- Irrigation Development Authority Act, 1977, SMCD 85.

Ghana Environmental Protection Agency Act, 1994, Act 490 The 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 of and non disclosure of confidential information, the granting of license, labeling and pesticides inspections.

Environmental Assessment Regulations, 1999, LI 1652 and its Amendment of 2002, LI1703 The Environmental Assessment Regulations 1999, LI 1652 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.

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.

Irrigation Development Authority Act of 1977 (SMCD 85) and IDA Regulation of 1987

The Irrigation Development Authority (IDA) Act of 1977 establishes the Irrigation Development Authority and provides for its functions and administrative framework. The Act mandates the IDA to formulate plans for the development of irrigation, and to co-operate with any other agencies for safeguarding the health and safety of the population living within and around

irrigation project areas among others. The Irrigation Development Authority Regulation, 1987 (L.I.1350) provides the procedure for managing irrigation projects including water management within such projects.

2.2.2 Some key International Conventions

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

the IPPC convention was adopted by Plant Protection and Regulatory Services Directorate of MoFA in February 199.

Other relevant international conventions ratified by Ghana include:

i. International Code of Conduct for the distribution and use of FAO pesticides
ii. The Basel International Convention on the Transboundary Movement of Hazardous Waste of March 22, 1989;
iii. The Rotterdam Convention on prior Information and Consentment Principle (PIC)
iv. The Basel Convention on Persistent Organic Pollutants (POP's);
v. 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 presented 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 has 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 licenses 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 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 Board 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 ensure 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 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 FDB 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 Division of Ghana Revenue Authority

The Customs works in close collaboration with the EPA and PPRSD, and reviews the EPA documents, including certificates/licenses to ensure only approved chemicals, meat and agrochemical products are imported in to the country. The importation reports of chemical products are submitted by the Customs to the EPA on a quarterly basis. Customs is represented on relevant technical committees of the EPA including the hazardous waste committee, the

pesticide technical Committee and other projects undertaken by the EPA. The Customs is also a member of the national Coordination team of the Stockholm Convention on the POPs.

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

The PPRSD as one of the Technical Directorates of MoFA and 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 Ministry of Food and Agriculture is responsible for regulations of pesticides use in the country. The National Plant Protection Policy is Integrated Pest Management Plan. The Plant Protection and Regulation Services Directorate (PPRSD) of MoFA was established in 1965 by an Act of Parliament.

The PPRSD has its headquarters in Pokuase near Accra and there are regional officers in all the ten regions of the country. It is also represented at the main entry and exit points throughout the country. It is represented at the district level by field officers who collaborate with the district Departments 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 Good Agricultural Practices (GAPs), guidelines for Integrated Pest Management (IPM) of food crops. The division also provides information on pests and disease situation.

The division carries out training in GAPs and 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), and serves as secretariat for National Fruit Fly Management Committee and National IPM program.

Pesticide and Fertilizer Regulatory Division

Ghana Seed Inspection Division (GSID)

It is one of the Divisions of PPRSD. The Division derives its mandate from the following Acts: Part III of Plants and Fertilizer Act 803 (2010) and Part II of Environmental Protection Agency Act 490 (1994). The Division supervises and trains Regulatory Inspectors, publishes information materials, registers and trains pesticides and fertilizer dealers and applicators, keeps records as well as statistics of pesticides and fertilizers and manages pesticide and fertilizer stocks in the country. It supervises bio-efficacy trials carried out by research.

As a Division of PPRSD, it 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:

Seed growers:

- Registration of Seed Growers
- 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)
- Facilitation of promotional activities in the seed industry.

Seed dealers:

- Registration of Seed Dealers
- Monitoring of Seed Dealers' outlets

Seed importers and exporters
Farmers

- Registration of importers
- Monitoring of importers' outlets
- Registration of exporters
- Monitoring of exporters' outlets
- Education and awareness creation on the benefits of utilization of certified seed/planting materials

National Seed Testing Laboratory (NSTL)

The National Seed Testing Laboratory (NSTL) located at Pokuase near Accra carries out seed sampling and laboratory seed quality tests such as moisture, purity, germination and health before seeds are certified for distribution and marketing. The National Seed Testing Laboratory is a member of the International Seed Testing Association (ISTA) and now awaits accreditation.

The mandate of the Division under PPRSD is found in Part 1 of the 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 issues phytosanitary certificates and import permits according to the IPPC format. It inspects plant materials and makes sure they are free 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. The Division implements relevant International Standards for Phytosanitary Measures (ISPMs).

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.

Ghana Irrigation Development Authority (GIDA)

The functions of the Authority are:

a) to formulate plans for the development of irrigation;
b) to develop the water resources of the country for irrigated farming, livestock improvement and fish culture;
c) to execute comprehensive programmes for the effective use of irrigated lands in co-operation with any other agencies involved in providing extension services to farmers;
d) to carry out land-use planning in areas earmarked for development in order to conserve the soil and water resources in those areas;
e) to layout the environs of each project area for housing purposes and for the provision of any other social amenities;
f) to co-operate with any other agencies for safeguarding the health and safety of the population living within and around irrigation project areas;
g) to undertake any other activities that are incidental or conductive to the performance of its functions under this Act.

GIDA Environment Desk: In terms of environmental management and monitoring of GIDA activities, GIDA has an environment desk officer who is supposed to ensure that GIDA activities are in consonance with national environmental management and protection requirements. However, the environment desk is largely unresourced, inadequate and lacks the requisite capacity to effectively carry out its functions.

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:

a) Food based nutrition education in relation to food production and diet improvement
b) Value addition to agricultural produce, food processing and preservation
c) Food safety
d) Natural Resource management (farm, home, processing site)
e) 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, venoms 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.
- Organize training sessions on the prevention and management of cases of intoxication for public health inspectors and all authorized agents such as PPRSD.

2.3.2 International

The key international institutions involved in the Per-urban Vegetable Project 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 stand alone 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 Organizations/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).
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. ENVIRONMENTAL AND SOCIAL BASELINE CONDITION OF PROJECT AREAS

28. 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

29. Various techniques were applied for collecting data on the project environment. These included document review, institutional consultations, focus group discussions and 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. These formed part of the baseline information and the information obtained used in the environmental analysis/assessment. Samples of the questionnaires and the outcomes of the consultations and stakeholder involvements are attached in the Annex.

30. The description of baseline information relevant to the project covers:

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

3.2 General

31. The Republic of Ghana is located between latitudes 5o 36'N and longitudes 0o 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.

32. 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.

33. 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 southwestern rainforests. The rainfall is bi-modal in the southwestern 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 southwestern zone, the reliability of the rainfall, particularly after crop germination, is a major factor affecting crop growth and agriculture in general.

34. 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 in the Table 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 South and Central Tongu Project District

3.3.1 Biophysical Environment

3.3.1.1 Location

35. The District is located in the Volta Region of Ghana and shares boundaries with the Central Tongu District to the north and north-west, the Akatsi South District to the north-east, Keta Municipal to the south and the Dangbe-East District to the west and south-west.

36. The main river draining the district is the Volta, which runs along its western border, but it is also drained by numerous streams, prominent among them being the Chinni and Todzi, with a large number of lagoons in the southern sector of the District.

37. The District lies within the wet semi-equatorial and dry equatorial climatic zones, which are very good for livestock production. The coastal strip is covered by swamp and mangrove vegetation.

3.3.1.2 Climate Conditions

38. The climate of the South Tongu District is characterized by humid conditions and a bimodal rainfall pattern. The major rainfall season starts from mid-April to early July and the minor rainfall season from September to November. The average annual rainfall varies between 900mm and 1100mm (see Figure 5) with more than 50% of the rain occurring in the major season. The minor season rains are unreliable and may fail in some years. The dry season starts from November extending to March during which only occasional rains are experienced. During the early part of the dry season, the harmattan winds from the Sahara regions blow across the district, drying up seasonal streams and ponds and exposing the vegetation to bushfires.

39. The temperature and relative humidity in the district vary little during the year. The average minimum and maximum temperature are 22°C and 33°C respectively, with the mean temperature being 27°C. The average humidity is about 80%. The warmest month is usually March whiles the coolest month is usually August. The variations between day and night temperatures are highest during the dry season between the months of January and February. During this period, the days are very hot and the nights are cold.

40. The bimodal pattern of rainfall influences the cropping pattern in the district, giving rise to two cropping seasons – the major and minor cropping seasons. Rainfall is generally inadequate even during the major season, which affects crop production in the district. The relative humidity is quite conducive for farming.

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

3.3.1.3 Surface Water Resources and Drainage

41. The Volta River is the main water body in the South Tongu District. Other rivers which drain the district are the Alabo, Kolo, Aklakpa, Gblor, Bla, Anyorgborti and Nyifla streams and their tributaries which flow into the Volta River. Many of these streams are seasonal and dry up

during the dry season. During the rainy season however, they sometimes overflow their banks, causing damage to roads and farms.

42. The Volta River is about 70 meters from the western boundary of the project site and will serve as a source of water for irrigation. The Nyifla and Gblor streams are located about 50 meters and 200 meters from the project site respectively.

3.3.1.4 Vegetation and Fauna

43. The project district falls within the tropical savanna grassland zone of Ghana. The vegetation is characterized by dense thickets and shrubs with short trees along the Volta River and the other streams, and dominated by grasslands with sparsely spread thickets away from the rivers and streams. The grasslands are interspersed mainly by Neem trees (Azadirachta indica), Cassia (Senna siamea), Fan palms (Borassus aethiopum) and Ceiba (Ceiba pentandra). The trees serve as important sources of fuelwood for households. Bamboo (Bambusa vulgaris) and Oil palm (Elaeis guineensis) are also quite common along the Volta River and other streams which are used for poles, fencing and in construction. The vast grasslands make the area suitable for cattle grazing which is common in the district. During the dry season, the area is usually burnt to promote the growth of new shoots of grass for cattle. Charcoal production and gathering of fuelwood is also common in the district. These practices are gradually reducing the tree stands in the area.

44. Portions of the project site have been previously farmed and are characterized by short grasses, stands of previously farmed crops (mainly maize), young shrubs and saplings. Figure 2 and 3 below show typical vegetation in the project area.

Figure 2.Typical grassland vegetation at the project district

Figure 3.Typical vegetation along streams at the project site

45. The common fauna in the project district are shown in the Table 2 below:

Table 1. Common Fauna in the Project District

Type	Specie(s)
Birds	Cattle Egret (*Bubulcus ibis*); Hooded Crow (*Corvus albus*); Hooded Vulture (*Necrosyrtes monachus*); Red Kite (*Milvus milvus*);, Black Kite (*Milvus migrans*)
Reptiles	Common Agama (*Agama agama*); Black-necked Spitting Cobra (*Naja nigricollis*); African Egg-eating Snake (*Dasypeltis*); Puff Adder (*Bitis arietans*)
Amphibians	Common Toad (*Amietophrynus regularis*)
Fish	Mudfish (*Claris senegalensis*); Oyster (*Egeria radiata*); Tiger fish (*Hydrocyon radiata*)
Mammals	Grass cutter (*Thryonomys swinderianus*); Gambian Sun Squirrel (*Heliosciurus gambianus*); Typical Striped Grass Mouse (*Lemniscomys striatus*); House Rat (*Rattus rattus*); African Pouched Giant Rat (*Cricetomys gambianus*); West African Ground Squirrel (*Xerus erythropus*)

(Modified from Gbireh, 2015)

3.3.1.5 Topography and Relief

46. The topography is characterized by vast stretches of Volta flood plains bordering the Volta River on both sides. Within the flood plains, the topography is fairly flat, between 1.5% and 2%. Due to the flat nature and heavy soils, the plains are poorly drained.

3.3.1.6 Geology and Soil

47. Along the Volta River, the soils are dominantly medium to moderate textured alluvial soils. Below these the soils are heavier clay soils which are characteristic of most parts of the district. This results in poor surface and sub-surface drainage. Due to this the soils have low water holding capacity making it difficult to cultivate. The soils are shallow, hence have low effective rooting depth. The district abounds in rocks such as igneous and sedimentary rocks in some areas.

48. The soils are suitable for vegetable cultivation under irrigation. In addition, the soils are also suitable for the pottery, brick and tile industries.

3.3.1.7 Seismic Activity

49. Ghana is in relatively seismic active region, the great earthquakes in history are M6.5 strong on July 10, 1862 in Accra and M6.8 strong on June 22, 1939 also in Accra. According to the data from Ghana Geological Department, regional active faults as Akwapim Fault Zone and Coastal Boundary fault are main earthquake control structure in Ghana. The above two great earthquakes are associated with the activities of Akwapim Fault Zone and Coastal Boundary Fault. As a result, Magnitude 7 earthquake may happen in Akwapim Fault Zone and Coastal Boundary Fault. They are crossed at Nyannyanu which is about 5 km West of Accra. The design specifications for seismic parameters in Ghana are determined by the seismic zoning map (Figure 4). The zoning map does not define the exceeding probability, and parameter is of the maximum ground acceleration.

50. Southern Ghana is not a highly active seismic area; however, it is a region capable of producing significant earthquakes. The seismic zoning map indicates that the proposed project district falls within a medium to high risk zone. Thus, as a precautionary measure it will be prudent to factor seismic concerns into the designs.

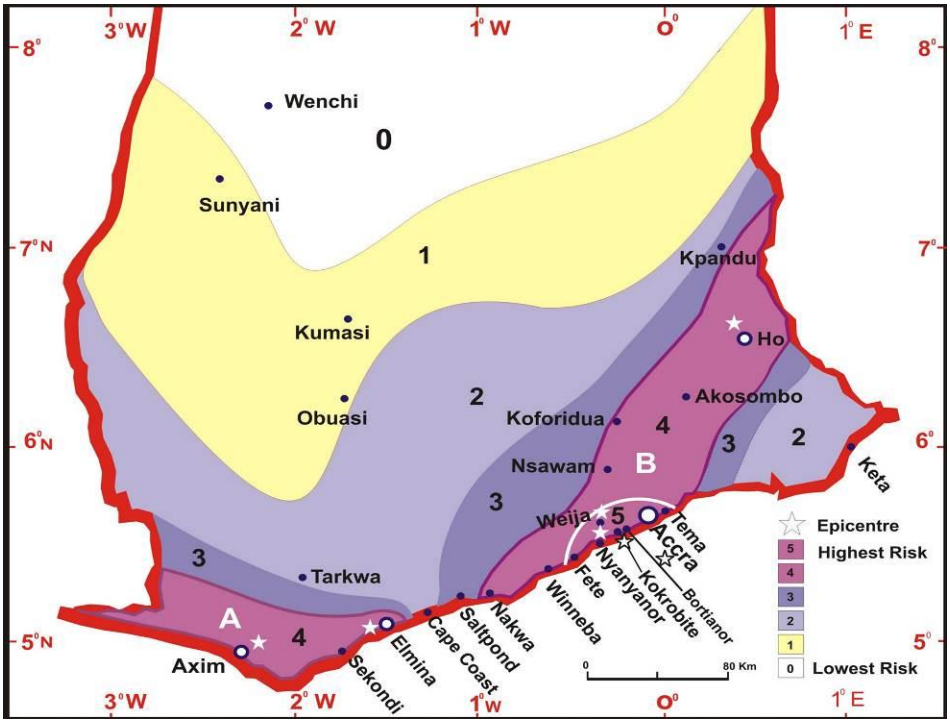

Figure 4. Seismic zoning map of Southern Ghana

3.3.2 Socio-Economic Environment

3.3.2.1 Demographic Characteristics

51. According to the 2010 Population and Housing Census, the total population of South Tongu District in 2010 was 89,777, representing 4.2% of the Volta Region's population and 0.4% of the national population. Females are 47,285 representing 52.7% of the population of the district, with the male population at 42,492 (47.3%). About 60% of the population is in the rural areas. The population of the district is youthful, with 38% of the population in the 0-14 age group, depicting a broad base population pyramid which tapers off with a small number of elderly persons. The districts age dependency ratio is 79.5 dependents (children and old age) for every 100 people working, and the dependency ratios for males and females are 81.9 and 77.5 respectively for every 100 persons in the working ages.

3.3.2.2 Employment and Economy

52. About 66.3% of the population in the South Tongu District aged 15 years and older are economically active whiles 33.7% are not economically active. Of the economically active population, 95.8% are employed while 4.2% are unemployed. More females (55%) are employed as compared to males (45%). For those who are not economically active, a greater percentage of them are in full time education (53.3%); with pensioners being the lowest (1.9%).

53. The economy of the South Tongu District is agrarian with more than half (57.2%) of the employed population engaged in agriculture, forestry and fishery, whiles 15.3% are involved in sales and services. Wholesale, retail, repair of motor vehicles and motorcycles accounts for 12.9% of the employed population, with manufacturing making up 10%. The majority of the employed population engaged in skilled agriculture and fishery are women, constituting 53%. This is similar for those engaged in services and sales with females constituting 82% and males 18%.

3.3.2.3 Agriculture

54. Agriculture is the most important economic activity in the district, with the majority of the employed population engaged in it. However, agriculture in the district is dominated by small-scale farmers who are unorganized and depend mainly on simple labour-intensive production methods. This creates opportunities for nucleus agriculture investor to support the smallholder farmers to increase their productivity and recoup the investments made. The major crops cultivated in the district are maize, cassava, groundnuts, sugarcane, vegetables, cowpea, rice, oil palm and mangoes. Farming is mainly rain-fed.

55. Livestock rearing and fishing are other main economic activities in the district. Fishing serves as the main economic activity among inhabitants along the Volta River. Traditional methods are usually employed for fishing including the use of traps, cast nets and hook and line. Streams and ponds in the district provide avenues for fishing and aqua-culture, however these are heavily silted and overgrown with aquatic weeds.

3.4. **Ada East District (Formerly Dangme East) Project Sites (Sega Akpokope I & II Communities)**

3.4.1. Location:

56. The District is located in the Greater Accra Region and shares common boundaries with the Central Tongu District to the North, South Tongu District and Ada West District to the East and

West respectively. It is bounded to the south by the Gulf of Guinea, which stretches over 19 kilometres (27.9 miles) from Kewunor to Totope. It is also bounded by the Volta River South–Eastwards extending to the Gulf of Guinea southwards thereby forming an Estuary, about 2 kilometres away from the District capital, Ada-Foah

3.4.2 Population and Demography

57. The population of the district according to 2010 population and housing census stands at 71,671 with 34,012 males and 37,659 females.

3.4.3 Topography

The District forms the central portions of the Accra plains. The relief is generally gently and undulating, a low plain with heights not exceeding 60 meters (200 ft) above sea level. The prominent relief features include the Tojeh boulders rising about 240 meters (800 ft) above sea level. These boulders are scattered irregularly over the sea. The photograph below portrays a devastated road from Ada-Foah-Otrokpe by tidal waves.

Heavy and strong tidal waves of the sea have eroded the sandy coastline leading to occasional flooding of some communities Kewunor, Lolonyakope, Pute, Otrokpe, Anyakpor, Elavanyo and Totope. The low lying nature of these coastlines otherwise known as "coastline of submergence" has aggravated the problem. Following this untimely disaster that has bedevilled past and present communities, the Sea Defence initiative has been launched and main works had begun ahead of construction.

3.4.4 Drainage

The general drainage pattern of the Ada East District can be described as dendritic with some of the streams taking their sources from the Volta River. Water bodies such as Futue and Tamatoku among others are sprung ups with increased and decreased capacities in the wet and dry seasons respectively. The major river in the District is the Volta, which meanders slowly into the sea at Azizanya. A feature highly conspicuous at this stage of the river is the great Estuary, which attracts thousands of tourists yearly. The district is therefore making strenuous efforts to develop innovative techniques to harness this great potential. Below is the Futue River, a main tributary of the Volta River.

3.4.5 Vegetation

The vegetation is basically the coastal savannah type, characterized by short savannah grasses and interspersed with shrubs and short tress. Along the coast, there are stretches of coconut trees and patches of coconut groves, which combine to give the area a classic look. This type of vegetation is also common along the fringes of some of the islands on the Volta River. The mangrove trees grow to heights of 15m averagely and are densely vegetated and green in appearance throughout the year. However, human activities such as burning of charcoal, indiscriminate cutting down of trees for fish processing (smoking) are working together to destroy this beautifully formed vegetation.

3.4.6 Climatic Conditions

The Ada East District is encapsulated by the south-eastern coastal plains of Ghana which is one

of the hottest parts of the country. Temperatures are high throughout the year and ranges between 23°C and 28°C. A maximum temperature of 33°Cis normally attainable during the very hot seasons. Rainfall is generally heavy during the major seasons between March and September. The average rainfall is about 750 millimetres. The area is however very dry during the harmattan season when there is no rainfall at all. Humidity is about 60 per cent high, due to the proximity of the sea, the Volta River and other water bodies. Daily evaporation rates range from 5.4 - 6.8 millimetres. The relatively high temperatures help in the quick crystallization of salt for the salt industry.

3.5 Ahanta West District Project Sites (Anoe and Ahanta Communities)

3.5.1 Location and Size

Ahanta West District is located at the southern most point of the Republic of Ghana and the entire West African Sub-Region with its capital Agona Nkwanta also called Agona Ahanta. The Ahanta West District has a total land area of 591 square kilometers and it is occupied by 95,140 people according to the 2000 Population and Housing Census report. The District is bounded on the East by the Shama Ahanta East Metropolitan Assembly (SAEMA), on the West by the Nzema East District, and the North by Mpohor Wassa East and Wassa West Districts and the Gulf of Guinea to the South. The District is about 15 minutes drive from the commercial capital of Western Region, Takoradi and about 25 minutes drive from the administrative capital, Sekondi. In terms of distance, it is approximately 25 kilometers from the central business district of Takoradi. This proximity to the central business district of Takoradi enhances business and trade in particular. The District lies between latitude 4º.45”N and longitude 1º.58”W.

3.5.2 Climate and Temperature

The District is found within the South-Western Equatorial Climatic Zone of Ghana the highest mean temperature is 34ºC which is recorded between March and April, while the lowest mean temperature of 20ºC is experienced in August. Relative humidity is very high averaging between 75% to 85% in the rainy season and 70% to 80% in the dry season. The District is located within the wettest region in Ghana. It experiences a double maxima rainfall of over 1,700 millimeters. This abundant rainfall supports agrarian activities in the District. . However, due to the high number of third class roads in the district, accessibility to most parts of the district is thwarted during the rainy season.

3.5.3 Mineral Resources

Geological study has indicated that Princess Town has industrial granites that have not been exploited. A number of companies are also prospecting for gold in the district.

3.5.4 Oil Wealth

The recent oil discovery is located within the district at Cape Three Points and plans are far advanced in its drilling by the Ghana government.

3.5.5 Demographic Characteristics

According to the 2000 Population and Housing Census, Ahanta West District has population of 95,140. This is made up of 46,024 males and 49,116 females. Out of the total population, only 3,219 are in gainful employment. The current population growth rate of the

district is 3.2%. Based on this growth rate the current projected population is about 115,278. Most of the people are found in the urban areas of Agona-Nkwanta, Apowa, Dixcove and Abura. The average household size is about 4.1 and the population density is about 161 persons per square kilometre. The average household size could have adverse effects on savings and per capital income.

The bulk of the populations are Christians with Traditionalists and Muslims following. About 60% of the total population is employed by the Agriculture sector. The remaining is engaged in small-scale trading, fishing and the formal sectors. Immigration by and large takes place only in the fishing industry. Large proportions of fishermen in the District emigrate from other coastal districts during the major fishing season which is normally between July and September to the coastal areas of Ahanta West District.

3.5.6 Vegetation

The District falls largely within the High Rain Forest Vegetation Zone, capturing several hectors of plantation of the rubber plant. To a large extent, this contributes significantly to reducing the problem of global warming, since a chunk of CO2 emissions by the automobile especially, are absorbed. Due to human activities, all the forest except Cape Three Points Forest Reserve which occupies an area of 51.02 square kilometers has been reduced to secondary forest.

3.5.7 Drainage

The largest river in the District is Butre which enters the sea at Butre. However, there are other rivers such as Whin, Suoni, Nyila and Yani. The District has also considerable lagoons such as Ehonle, Mabowodindo, Akpluho, Mfuma and Nana Pete at Butre.

3.5.8 Water Bodies:

Muddy and polluted from mining activity

B. Hwin River provides relatively good quality water and provides wildlife habitation for crabs and fish

C. Butre River has relatively good quality water.

3.5.9 Relief

The District is generally flat land with a few isolated hills at Butre and Banso with height ranging between 20 to 40 metres above sea level between Cape Three Point and Princess Akatekyi. There is also a plateau at Egyambra. Some of these hills are the sources of some of the rivers in the District. The coastline has features such as capes and bays especially at Cape Three Points. As a result of the sandy nature of the coast, it has attracted beach resorts along the coastlines.

3.5.10 Soil Types

Generally, the soils in the District are very fertile and their types range from loose sand to clay. The table below depicts the various soil types and the crops suitable for cultivation on them.

Soil types & Crops

Soil	Suitability

Sandy – Clay – Loam	Cocoa, coffee, citrus, oil palm, rubber and food crops
Moderately well drained clayey loam	Cocoa, coffee, citrus, oil palm, rubber and food crops
Loamy sand	Maize, vegetables, legumes, and food crops
Silty clay	Maize, vegetables, legumes, and food crops and sugar cane
Loose sand	Vegetables and sugar cane
Clay	Vegetables sugar cane and rice

3.5.11 Local Economy

The small scale farming continues to dominate the economy of Ahanta West District. The Agriculture sector which formerly employed about 58% currently employs about 65% of the population. The average farm size per farmer is 0.35 hectares since most farmers still use simple tools such as hoes and cutlasses. The five major crops grown in the district are maize, oil palm, rice, plantain and cassava.

NORPALM and GREL are the two major companies with large hectares of oil palm and rubber plantations respectively. These two companies employ considerable number of the youth in the district. GREL employs about 2,500 people while NORPALM also gives employment to 1,500 people.

3.6 Upper Manya Krobo District Project Site (Aklusu Saisi)

3.6.1 LOCATION

The district is located within latitudes 60 20" North and 6050"North and longitudes 00 30"West and 00 00" West.Covers an area of 885 sq. km constituting 4.8% of the total land area of the Eastern Region. The district shares boundary with the Volta Lake in the north, Fanteakwa District in the west, Asuogyaman District in east, Yilo Krobo District in the south-west and Lower Manya Krobo in the south-east.

3.6.2 CLIMATE

The district falls within the semi-equatorial climate belt. It has two major seasons, namely the wet and dry seasons. The wet season is from April to early August and from September to October. August is normally dry and cold with November to March being dry and warm. The total amount of rainfall is between 900 mm and 1,150 mm. Relative humidity is high during the wet season between 70% and 80% and low in the dry season about 55% – 60%.

Two major winds affect the climate of the district. These are the wet South-west trade winds which blow across the district from the Atlantic Ocean between March and July and the Northeast trade winds (harmattan) from the Sahara desert between November and early March.

The temperatures are generally high with average ranging between about 26º C and 32º C.

3.6.3 Relief and Drainage

The topography of the district can be generally described as undulating. The highest point in the district is over 660 meters above sea level located in the southern part of Sekesua. The lowest area which is located in the south- eastern part of the district is about 50 meters above sea level. The average height of the land is about 452 meters above sea level. Underlying these landmasses are several rocks or parent rocks from which several rocks have developed.

The district is drained with several rivers such as the Volta, Dawado and Anyaboni. With the exception of the Volta River, almost all these rivers are seasonal with most of them overflowing their banks during the rainy season

3.6.4 Vegetation

The dominant vegetation cover is semi-deciduous forest and derived Savannah zone.

Human activities on the vegetation have resulted in scattered patches of secondary or broken forest. Traditional practices such as collection of fuel wood, charcoal burning and overgrazing coupled with climate change have degraded the vegetation. Because of these the semi-deciduous forest is gradually turning into savannah woodland especially at areas like Akateng, Sesiamang and Akotoe.

These activities have resulted in low crop yields, poor soil fertility, surface run-off and erosion among others.

3.6.5 Farming Systems

The people of the district, mainly Krobos, are Huza farmers. Huza system is a settlement pattern where owners of the lands settle on their farms with their farm families. This system enables the farmers to have frequent visits to their farms and protect their lands from encroachers.

Nonetheless, the system makes extension delivery very difficult, due to the fact that officers have to cover long distances to transfer technology to the farmers who are separated from one another far apart.

Most of these farmers practise mix-cropping and mixed-farming with others engaging in mono cropping.

3.6.6 AGRICULTURAL INVESTMENT POTENTIALS

3.6.6.1 Crop Production

The district is an agricultural one due to the fact that natural resources namely; arable land and water resources abounds in it. The soils in the district are also suitable for a lot of crops, some of which are maize, cassava, rice, vegetables and tree crops.

Yam and cocoyam are cultivated mainly at Sekesua and Sutapong operational areas. Plantain is cultivated in Asesewa and Sekesua zones. Rice is cultivated in Anyaboni zone. Pepper is cultivated alongside the local vegetables at Akotoe, Asesewa, Sekesua and Otrokper.

3.6.6.2 Animal Husbandry

About 25% of the population practice livestock farming. Animals reared include cattle, sheep, goats, pigs, poultry and grasscutters. Asesewa, Anyaboni, Akorkorma, Sesiamang and Sekesua are the main livestock rearing areas.

3.6.6.3 Fishing/Aquaculture

Fishing is the main activity carried out by the people along the Volta Lake and rivers. Some of these communities are include; Akateng, Akorkorma, Battorkope, Akrusu and Ponponya. People around Akateng and its environs are also engaged in fish production using cage culture.

3.6.7 MAJOR ECONOMIC ACTIVITIES

Agriculture is the main economic activity of the people of the district, employing about 80% of the population. 50% of these people are engaged in crop farming, cultivating 21,226.05 hectares of arable land. Most of the farmers in the district are subsistence farmers with very few commercial ones. The farmers produce food crops such as maize, cassava, plantain and vegetables and tree crops including oil palm and mango.

Also, 20% of the agriculture population is into animal farming. The animals they rear are cattle, sheep, goats, pigs, poultry and grasscutters.

Fishers who engage in both wild fishing in the lakes and rivers and cage culture forms 10% of the farming population.

Other income generating activities exist in the district employing about 20% of the total population. These people are mainly traders who engage in the sale of farm produce, operation of provision stores and petty trading. Others also engage in food processing activities such as fish smoking, gari processing, extraction of palm oil and distilling of alcoholic beverages

Operators of commercial vehicles also employ a number of the youth in the district.

One rural bank and two private investment companies located at Asesewa also employ a portion of the population.

4.0 POTENTIAL PESTS AND PESTICIDE PROBLEMS AND MANAGEMENT PRACTICES

4.1 Major Pests and Diseases of vegetables

This section describes the major pests and diseases associated with selected vegetables to be supported under this project (cabbage, cucurbits (cucumber, melon, pumpkin and courgette), egg plant, lettuce, okra, onion, pepper and tomato) .

4.1.1 Major Pests and Diseases of Cabbage

No.	Major pests and Diseases	Comments
1	Diamond-back moth (DBM) (*Plutella xylostella)*	It is the most serious pest of cabbage. DBM female moth lays its eggs singly. Eggs are glued to the underside of leaves and hatch after 3-5 days into green larvae. Larvae creep to underside of leaf, pierce the epidermis and tunnel or bore through the leaf tissue. Progressively eat leaf from underneath leaving the upper cuticle intact creating a bizarre window, which later disintegrates.
2	Webworms or cabbage borer (*Hellula undulalis)*	The light brown larvae or caterpillars of the cabbage webworm bore into the main veins of the leaves of cabbages and later into the centre of the stems, where they then feed. This makes these pests very difficult to control with pesticides.
3	Cabbage aphids (*Brevicoryne brassicae)*	Usually occur in large numbers, mainly during dry spells. Sucking pests, grey or green with soft pear shaped bodies often in colonies on lower side of leaves. Suck sap causing stunting growth and honeydew excretes on leaves
4	Cutworm (*Agrotis sp)*	Dull coloured moths lay eggs in soil surface or on stems. Mature larvae hide during day and emerge at night to feed on crop causing damage by cutting young plant stems at the base and feeding on foliage. Larvae bend characteristically in an o-shaped when disturbed
5	Bacteria soft rot (*Erwinia carotovora)*	Is a major disease of cabbages. Attacks the leaves of cabbages and affected areas take on a water-soaked appearance and start to decay, emitting an unpleasant smell. Cabbage heads decay rapidly and turn dark
6	Root knot nematode (*Meloidogyne spp.)*	Nematodes invade roots causing swelling and deformation of roots (galls on roots). Stunted growth and chlorosis are above-ground symptoms
7	Black rot	Chlorotic discoloration on leaves, which turn to dark brown or black. Black discoloration of the vascular bundles and internal tissue break down.

4.1.2 Major Pests and Diseases of Cucurbits (cucumber, melon, pumpkin and courgette)

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

4.1.3 Major Pests and Diseases of Egg plant (Aubergine)

No.	Major pests and Diseases	Comments
1	Budworms (*Scrobipalpa blasigona)*	Small brown caterpillars of budworms bore into flower buds to feed inside flowers causing them to drop off and

		plant cannot produce many fruits
2	Epilachna beetles (*Epilachna chrysomelina)*	Is a major pest that feed on leaves of egg plants by scraping surface and reducing leaves to skeletons
3	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	Stem and fruit borers *(Leucinodes orbonalis)*	Whit larvae or caterpillars of the pest bore into top sections of fruits and stem of egg plants. Tunnel through stems causing plants to grow poorly and sometimes die prematurely. Fruits change colour and taste
7	Damping-off disease (*Pythium spp)*	Major disease that affects young seedlings in the nursery. Seedlings become constricted near ground surface and then collapse and many die.
8	Wilt disease (*Fusarium semisectum)*	Soil fungus disease that causes egg plants to wilt. Leaves turn yellow and plant dies.

4.1.4 Major Pest and Diseases of Lettuce

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

4.1.5 Major Pests and Diseases of Okra

No.	Major pests and Diseases	Comments
1	Aphids *(Aphis gossypii, Myzus persicae)*	Several species of aphids affect okra leaves and young fruits. Are very small, light to dark green, round insects that suck sap from okra leaves, causing leaves to turn yellow and become twisted; later plants may wilt and die
2	Cotton 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

4.1.5 Major Pests and Diseases of Onions

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

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

No.	Major pests and Diseases	Comments
1	Root-knot nematodes (*Meloidogyne spp)*	Are same nematodes that attack egg plant and okra. Affected roots develops gall become malformed inhibiting plant growth; leaves become yellow, then curl and drop off before they mature. Pepper plants attacked by nematodes are also easily infected by wilt diseases and attacked by

		termites
2	White flies *(Bemisia tabaci)* and Aphids *(Ahis gossypii)*	White flies and aphids are important as vectors of virus diseases. Same aphids attack cabbage and same white flies attack tomatoes
3	Leaf spot *(Cercospora capsicii)*	Disease affects mainly leaves of pepper seedlings. Initial symptoms are small dark spots on leaves and these spots later enlarge to cover whole leaf, causing leaf to turn yellow and drop off.
4	Pepper leaf curl mosaic virus	Virus disease infects pepper leaves, stems and fruits and is transmitted by white flies. Leaves become yellow, mottled, distorted, small and cup- shaped. Plants become stunted and fruits are malformed.
5	Pepper mottle virus	Is transmitted by aphids. Leaves and fruits of infected plants are badly formed; become mottled, twisted and curled. Plants are stunted, turn yellow, and finally die.
6	Pepper wilt disease *(Fusarium oxysporum)*	Soil-borne disease caused by two species of fungi that infect roots, stems and leaves of pepper. Seedlings wilt and die and old leaves turn yellow

4.1.7 Major Pests and Diseases of Tomato

No.	Major pests and Diseases	Comments
1	Aphids *(Aphis gossypii)*	Occasionally attack tomato heavily. Feed on the soft terminal shoots and on the underside of leaves. May also transmit virus disease during feeding. Honeydew produced by aphids causes unsightly black moulds on tomatoes which reduces their market value. Attacked plants may wilt and die
2	Fruit borers (American bollworms [Helicoverpa armigera] and leaf-eating caterpillars (cotton leafworms [Spodoptera littoralis])	Different kinds of caterpillars attack developing and mature fruits of tomato. The American bollworm comes in various colours. A single caterpillar can bore into m ay tomato fruits in one night. Fungi and bacteria enter these fruits through the holes and cause the fruits to rot and become worthless. The cotton leaf worm feeds on leaves of tomato and bores into the fruits, especially those lower down the plant
3	Fruit fly (Rhagoletis ochraspis)	It is an important pest of tomato at the fruiting stage. It pierces fruits and leaves rotten spots. Adult fly pierces fruit to lay eggs inside. The small white maggots or larvae develop in the fruit and pupation occurs in the soil below the host plant.

4	Root-knot nematodes (*Meloidogyne spp.)*	Nematodes are one of the most important pests of tomato. These same species also attack egg plant, pepper, cabbage, carrot and other vegetables. They are microscopically small worms that live in the roots of their host and cause galls or root-knots. Some affected plants may show yellow leaves, poor growth and even wilting. Affected roots are short and have many swellings or galls. Plant become stunted and may die
5	Tomato mirid bugs *(Cyrtopeltis teriuis)*	Adults and nymphs of slender, dark green mired bugs feed on tender terminal stems and flower stalks of tomato plants. Inject a toxic substance/saliva into the tissues, causing small, brown necrotic spots to develop. Adult female mirids pierce tomato stems to lay eggs resulting in major damage to stems.
6	White flies (Bemisia tabaci)	White fly adults are small, white, winged insects that fly off readily when disturbed. They attack tomatoes from seedling stage to maturity. White fly adults and nymphs occur under tomato leaves, sucking the sap and secreting a sticky honeydew on which black mould develops. The adult transmit the leaf curl virus disease, which causes considerable damage to tomato plants.
7	Dumping-off disease *(Pythium spp.)*	Is a major disease that attacks tomato seedlings. Water-logging creates conditions that favour development and spread of disease. Is a soil fungus and attack causes young stems to rot. Affected seedlings wither and die.
8	Early (or dry) tomato blight *(Alternaria solani)*	Is a major disease during the rainy season. It is caused by a soil-borne and air borne fungus. Symptoms are brownish-black angular spots with concentric circles on the leaflets. Black or brown sunken lesions develop on stems and fruits
9	Late blight *(Phytophtora infestans)*	Symptoms show as necrotic spots on leaves which enlarge rapidly to become water-soaked areas on leaves and fruits. Infestation leads to defoliation and fruit blotches.
10	Rots and cankers *(Phoma spp., Phomopsis spp.)*	Rots and cankers are caused by fungi and bacteria that infect tomato stems and roots. Root and stem rot fungus is present in soil and attacks roots, causing collars to rot. The bacteria that attack plants cause blight and cankers of stems, leaves and fruits.
11	Tomato yellow leave curl virus (TYLCV)	It is the most serious disease of tomatoes. Transmitted by white flies feeding on tomato leaves. Plants infected by disease are stunted and turn yellow, and leaves curl. Affected flowers and fruits drop off.
12	Wilts *(Fusarium oxysporum)*	Caused by a soil-borne fungus that attacks roots through small wounds (made during transplanting or resulting from nematode attack). Plant wilt from lower leaves and leaves turn yellow and die; later whole plant wilts and dies.

4.2 IPM Strategy for Pest Control

The integrated pest control 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 products, the alternatives. 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 (maize, cowpea, mangoes, lemon, rice, cucumber, cotton etc), the development of a control system for the use of pesticides for communities practicing urban 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) cereals/pulses; (iii) roots and tubers, and plantains.

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 IPM Approaches for Vegetables

	Recommended Actions
Principle 1	Obtain good seeds and other planting materials
Principle 2	Select well-drained fertile soils for the nursery and the farm
Principle 3	Adopt good nursery practices
Principle 4	Practice rotation with appropriate crops
Principle 5	Adopt appropriate planting distances

Principle 6	Plant crops at the appropriate time
Principle 7	Weed early and carefully
Principle 8	Adopt good soil management practices
Principle 9	Adopt suitable water management practices
Principle 10	Visit fields regularly
Principle 11	Maintain high levels of sanitation in the field
Principle 12	Manage pests and diseases efficiently
Principle 13	Enhance and protect the populations of natural enemies (e.g. predatory ants, spiders, ladybirds, hover flies, lacewings, ground beetles and parasitic wasps)
Principle 14	Minimize the application of chemical pesticides
Principle 15	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 beneficial organisms. Natural enemies are the predators and parasites that attack crop pests and disease organisms. Predators are hunters that usually feed on a range of insects or other animals, while parasites 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 5 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, planthoppers
	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 Parasitic flies	Caterpillars, aphids, scale insects, maggots, mealy bugs, white flies, insect eggs, beetles, 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:

- Minimize 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 your 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 attracted 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. mango) 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.

4.4.3 Recommended IPM practices for selected Vegetable Crops Pests/Diseases

A. 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 chilly pepper between rows 30 days before planting cabbage • Do no leave overgrown cabbage in the field • Scout weekly when plants are young and destroy eggs and caterpillars • Conserve and encourage natural enemies such as Trichogramma and Diadegma insulare. • Use microbial insecticides such as Bacillus 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 • Observe the pre harvesting intervals of synthetic pesticides
2	Webworms or cabbage borer (*Hellula undulalis)* (Pre-harvest- seedling to head formation)	• Embark on field sanitation (uproot and burn stalks or feed to animals) • Use bio pesticides, such as Bt and neem based insecticides • Use insect growth regulators (IGR) or other recommended pesticides
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 overhead irrigation washes aphids off. • Scout and monitor aphid infestation for early detection and control. • Control ants that protect aphids against attack to ensure the supply of honeydew, which they also feed on either

		with pesticide or by removing nesting sites such as old tree trunks, rock heaps, debris and weeds. • Prune/remove basal (lower) old leaves of head forming cabbages as may be a source of aphid infestation • Use water jet spray for the lower leaves to wash off aphids. • Plant solutions such as chilli, neem and garlic can also be applied on the crop. Spray with a soapy solution (local soap - *alata samuna)* 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 form reaching the surface • Replant severe losses • In severe cases, dust around the plant with a recommended insecticide such as an Organophosphate (OP). • Dried grounded red pepper sprinkled on dampened plants deters insect attacks. Spreading red pepper powder around the base of plants can repel cutworm such as Braconid wasp larvae (*Meteorus communis),* Ichneumonid wasp larvae (*Nepiera spp),* Green Lacewing larvae (*Chrysopidae).* • 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	• 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

	stages starting at nursery)	• 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
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) •Over head irrigation may increase the rate of infection if other conditions are favourable for the disease. • Undertake early harvesting • Store only sound cabbages without blemish and not wet • Avoid practices that transfer infested areas

B. Cucurbits (cucumber, melon, pumpkin and courgette)

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 cullied fruit with live melon fly larvae in areas close to the field • Pick all infested fruits and bury them deep to break their life cycle and prevent them from serving as field reservoirs. • Eliminate all alternate hosts that serve as reservoirs. • Periodically monitor melon fly populations through trapping

		• Bag fruits • Spray around the plants as bait • As a preventive measure in known high infestation areas spray with appropriate pesticides starting from flowering
3	Cucumber mosaic virus disease (CMV) (Pre-harvest – vegetative to fruiting stages)	• Eradicate infected plants in vegetative stage. • Select tolerant varieties where applicable • Control aphids (vectors) with insecticides before disease spreads • Try spraying with emulgated oil (e.g. milk powder) to keep winged aphids from flying. • Avoid transmission by tools and cultivation practices. • Plant during wet season when least likely to occur. • Wash and clean farm tools thoroughly. Destroy alternate weedy hosts aphids from flying. • Avoid transmission by tools and cultivation practices. • Plant during wet season when least likely to occur. • Wash and clean farm tools thoroughly. Destroy alternate weedy hosts
4	Powdery mildew (*Erysiphe cichoracearum)* (Pre-harvest stage)	• Control weeds and eliminate volunteer cucurbit crops around the field or in the field • Practice good sanitation • Try to spray with sodium bicarbonate and potassium silicate Plant resistant varieties where applicable •Use 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		• Grow young plants away from older plants

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

C. Egg plant (Aubergine)

No.	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 or too much irrigation water • 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 irrigate plants regularly undertake long rotation

D. 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 overhead irrigation 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, irrigation, soil management) to allow okra to out grow damage • Stir around plants to expose eggs and grubs in the soil to predators, e.g. ants, birds. • Control only if it is damaging seedlings and young plants severely with soil treatment recommended systematic organo phosphorus 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 crotolaria and Indian mustard as trap crop. • Use indicator plants 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. • Irrigate at regular intervals with potable water

E. Onion

No.	Major pests and Diseases/ Stage	Recommended cultural practice and direct interventions
1	Onion flies (*Delia antique)* (Pre-harvest – vegetative stage)	Practice crop rotation with non host crop (not from onion family). Infested plants should be carefully uprooted and burnt or buried deeply. Destroy crop debris after harvesting.
2	Onion thrips (*Thrips tabaci)* (Pre-harvest – all stages, from seedling)	Grow tolerant varieties. Plant early to avoid pest attack or organize closed season. Irrigate regularly (twice daily). Apply appropriate insecticides approved by EPA as a last resort (>30 thrips scouted) after AESA. Maintain weed free field and borders
3	Bacterial soft rot (*Erwinia*	• Cure onion bulbs before storage

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

F. 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. • Controlled in nature by hymenopteran parasitoids Encarsia spp and Eretmocerus spp, by phytoseiid mites, Amblyseius spp and by Chrysopa spp (lace wings). • Use of repellents such as botanicals • Spray with soap solution or neem extract • Use yellow sticky traps • Use trap crops and use sprinkler or over head irrigation. • African marigolds and masturtiums intercropped with pepper discourage whiteflies • Chemical spray is not necessary
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 least three years with non host crops

G. Tomato

No.	Major pests and Diseases	Recommended cultural practice and direct interventions
1	Aphids *(Aphis gossypii)* (Pre-harvest – vegetative to reproductive stages)	• Neem extract sprays recommended if populations are high, following AESA • When attacked in early growth, spray with quick acting, short persistent Organo-Phosphate insecticide following AESA • Spray solution of local soap (1-2%) if infestation is heavy)
2	Fruit borers (American	• Grow trap crops such as pigeon pea (Cajanus cajan) and Crotalaria in and around tomato fields

	bollworms [Helicoverpa armigera] and (Pre-harvest – fruiting stage) leaf-eating caterpillars (cotton leafworms [Spodoptera littoralis]) (Pre-harvest –vegetative to reproductive stage	• As soon as young caterpillars are seen, spray with Bacillus thuringiensis based bio-pesticides, neem seed extracts or short residual pyrethroid, after AESA • Predators and parasitoids usually control the pest Use Bacillus thuringiensis products or neem extracts following AESA
3	Fruit fly (Rhagoletis ochraspis) (Pre-harvest – fruiting stage)	• All infected fruits should be gathered and destroyed Destroy wild host plants, e.g cherry tomatoes
4	Root-knot nematodes (*Meloidogyne spp.)* (Pre-harvest – all stages, from seedling to fruiting)	• Crop rotation (at least 3 years) with non-host crops (e.g. cereals, pulses, cassava etc) • Plant Tagetes spp. (marigold) in alternate rows or as intercrop Plant Tagetes spp. Or Crotalaria as fallow crop Add organic matter to stimulate and encourage antagonistic organisms in soil • Flood field if water can be controlled
5	Tomato mirid bugs *(Cyrtopeltis teriuis)* (Pre-harvest –vegetative stage)	• Usually no control necessary Spray with a quick acting but ephemeral carbamate or organo-phosphate insecticide if damage is likely to be substantial after AESA
6	White flies (Bemisia tabaci) (Pre-harvest – seedling to reproductive stages)	• Use yellow sticky traps to reduce populations but cannot prevent the spread of TYLCV • Spray solution of local soap (1-2%) if infestation is heavy
7	Dumping-off disease *(Pythium spp.)* (Pre-harvest –seedling stage)	• Use clean, hot water treated seeds Use subsoil for nursery seedbed. Also apply solarization • Sterilize soil for seed boxes. Drain off excess water Avoid overcrowding in nursery • Drench soil with copper fungicide.
8	Early (or dry) tomato blight *(Alternaria solani)* (Pre-harvest – vegetative to fruiting stages)	• Remove and burn affected leaves • Rotate crops and observe strict sanitation (no new plots alongside old ones) • Use clean, disinfected seeds • Practice staking and mulching

		• Spray with fungicides when environmental conditions are favourable for infection (cool and humid, for several days after rains), or at first sign of disease and every 7-10 days there after
9	Late blight *(Phytophtora infestans)* (Pre-harvest – vegetative to fruiting stages)	• See early blight above • Grow resistant cultivars where available • Use copper fungicides after AESA in disease favoring weather • Remove and destroy infected plants detected early • Avoid wetting plants for protracted periods
10	Rots and cankers *(Phoma spp., Phomopsis spp.)* (Pre-harvest – vegetative to reproductive stages)	• Remove and destroy infected debris • Avoid planting in infested fields for 3 years • Adequate spacing between rows and plants • Practice staking • Use seed from uninfected fields • Hot water treated seeds 30mins at $122^{o}F$ • Spray with a copper fungicide after AESA
11	Tomato yellow leave curl virus (TYLCV) (Pre-harvest – seedling to reproductive stages)	• Rotate crops (minimum 2 years) • Destroy weeds • Use resistant varieties • Control vector chemically with contact insecticide or 1-2% solution of local soap (*alata samina)* • Rogue infested plants early, from seedbed on, and destroy • Enhance nutrition to help plants recover
12	Wilts *(Fusarium oxysporum)* (Pre-harvest – vegetative to reproductive stages)	• Destroy whole plant and roots after harvest • Use resistant varieties (e.g. Roma VF) • Follow strict field sanitation • Remove solanaceous weeds • Avoid infected fields • Use health seedlings • Controlled burning on fields • Use clean seed-beds (subsoil nurseries, solarization)

		• Avoid excessive use of nitrogen fertilizer, which encourages the fungus • Practice rotation with non solanaceous crops (minimum of 5 years)

4.4.6 Pesticide applications – vegetables - In line with IPM approaches

1. A decision to use chemical pesticide 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 necessary to spray crops with pesticides, use selective rather than broad-spectrum pesticides.
4. All herbicides should be applied using knapsack sprayers.
5. 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.
6.

4.5 Controlling Pesticides used in Crop Protection:

Every pesticide produced in Ghana and also imported is expected to be subjected to approval. This constitutes the primary barrier making it possible to filter the products entering the country. In order to ensure that it is done, Phytosanitary Controls are stationed at the borders (sea ports, airports, and roads). It is done by the PPRSD and assisted by custom officials at the entry points also in charge of pesticides control.

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 maximum residue limit, otherwise produce from Ghana will be banned. Currently, compliance with MRL 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 country. 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 and Calli Ghana. The pesticides import statistics from 2007 to 2010 is provided in the table below.

Table 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		
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**	**12,813.000**	**14,701.542**				**17,507.551**	

Source: EPA/PPRSD

4.6.2 Organisation and practice used in selling and distribution of pesticides

The distribution channel is entirely private. Suppliers who import the products feed the market through distributors, retailers who supply traders and they display for sale. Certain distribution spots – 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 and traders 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 in retail. This practice is carried out without caution notably with 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 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.

In commercial irrigated farms, treatment by ferti-irrigation is used in association with drip irrigation. The plant products and soluble fertilizers are directly injected in the irrigation system. The treatment method involves less risk for users but it is not affordable by the vast majority of farmers because of the high level of investment.

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.
  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. Equipment for the treatment of large empty containers are not known to be installed or in use in the country at the moment. Such equipment 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 in collaboration with projects such as GCAP and WAAPP..

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 are 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, headache, dizziness, sudden collapse with or without unconsciousness.

Others include eye irritation, blurred vision, lots of tearing, saliva or mucus secretion, sweating, nausea, vomiting, chest infections due to aspiration of vomits, fever, abdominal pain or discomfort, diarrhoea, uncontrolled urination and defecations, slowing of heartbeat 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 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.

5.0 POTENTIAL IMPACTS AND CHALLENGES ASSOCIATED WITH PROJECT INTERVENTIONS

The use of various agro-chemicals especially pesticides is more likely during the implementation stage of the Peri-urban vegetable project mainly irrigation interventions. 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 irrigated farms could affect the fresh water sources. The main water bodies within the Volta, Tordzi, 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 the water bodies through run off especially during the rainy season and/or water logging.

The over concentration of toxic chemicals in water is a major health risk for the local population and aquatic/fish life. This is because some households drink water from the lakes and creeks while others use them for domestic purposes. Another source of water pollution may be from the return flow of irrigation water heavy with pollutants and inorganic salts. Draining excess water contaminated with agro-chemicals from the irrigation fields into the lakes and creeks within the project zone is also a source of water pollution.

5.2 Impact of pesticides on aquatic fauna

Pollution from agrochemicals may also affect aquatic animals in water bodies. A host of animal diseases are associated with the implementation of irrigation schemes. 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 contaminated meat or diary productions.

5.3 Public health concerns from water-borne or water-related diseases

Water-borne or water-related diseases are commonly associated with the introduction of irrigation. The diseases most directly linked with irrigation are malaria and bilharzia (schistosomiasis), whose vectors proliferate in the irrigation waters.

Uncovered trenches, excavations and manholes to be developed during the construction phase and the use of irrigation infrastructure such as canals, reservoirs and drains are potential breeding grounds for female anopheles mosquitoes that transmit malaria. If not managed properly, malaria cases are likely to increase in the project areas under irrigation schemes. The project could increase mosquito pests which cause malaria in human beings. This could necessitate the use of malaria control pesticides.

Bilharzia is an infection caused by parasitic worms or blood flukes of certain species of the genus *Schistosoma*. Adult parasites live in the blood of mammals, but their life cycle requires a phase of asexual multiplication within a fresh-water snail host. The flukes infect humans who enter their exposed skin in water, usually through swimming, bathing or wading.

5.5 Improper pesticide use and disposal of pesticide containers

This is caused by poor knowledge, inadequate equipment and storage.` 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 cereals and pulses will increase under the Accra Plains 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 grains.

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.

5.6 Production and market losses from fruit fly attacks

Fruit flies affect fruits such as mango, citrus, guava and papaya, and vegetables, like tomato, 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.

5.7 Production losses and food security concerns from Armyworm and other crop pests and disease outbreaks

Armyworms are occasional pests but when they occur, the devastation is alarming and disastrous. The project will put large tracts of land under cereal and pulse cultivation and this can easily be devoured within few days during armyworm outbreaks. Food security concerns will arise because an outbreak could wipe-off most if not all cereal/pulses farms at the Accra Plains and its environs within few days. Cereals and pulses are key staple foods of Ghanaians. Adequate armyworm surveillance is required to contain and eliminate any threat.
Though pests and diseases have been around since farming began, the problem has been accentuated as a result of expanded farm sizes, intensive methods applied and the need to make adequate returns on investment. According to MOFA, crop losses due to pests in the fields in Ghana are estimated to be 30%. Horticultural production has always been a hot spot for both pests and disease losses and the sometimes excessive use of agrochemicals. Any form of production losses will impact negatively on crop prices in the local market.

5.8 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 8 Integrated Pest and Pesticide Management Action Plan

Impact issue / Pest & pesticide threat/ risk	Mitigation Measures	Implementation tool	Expected result	Monitoring indicators
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, Train records
	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 aw of pesticide container disposal pla
	Monitor pesticides in water resources	Environmental quality monitoring plan (linkage with Project ESMP)	Pesticide concentration in water resources	Levels of pesticides in wa resources
Public health concerns from water-borne or water related diseases in project areas under irrigation	Design appropriate irrigation systems and ensure functional operation system (removing aquatic vegetation, lining canals with cement or plastic, regularly fluctuating water levels, periodic rapid drying of irrigation canals)	a) Adoption of environmentally friendly irrigation system designs; b) Selection of experienced and proven contractors and consultants for project designs and construction; c) Effective operational maintenance system	a) Well functioning and environmentally friendly irrigation system; b) infrequent breakdown of system	Number of times system breakdo in a given year
	Monitor malaria and bilharzias cases in project area	Hospital/clinical records of malaria cases in project area	Malaria/bilharzia cases before and during project implementation established	Trend in malaria/bilharzia ca during project implementation
	Make mosquito treated bed nets available at affordable prices to farmers and	Project malaria and bilharzia control plan	Non-significant increase in malaria/bilharzia cases under project	Frequency of repor malaria/bilharzia cases amo farmers and communities

Impact issue / Pest & pesticide threat/ risk	Mitigation Measures	Implementation tool	Expected result	Monitoring indicators
	local community members			
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	Number of cases of pestic poisoning occurring under project
	Control and supervise pesticide use on farms	Adoption of IPM approaches/ techniques	Farmers trained in IPM techniques	Number of farmers trained, Train records
	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 pestic residue in sampled crops 2. Num of times exported crops are rejec due to pesticide residues
Poisoning from 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	1. Pesticide hazards and use guide manual or leaflet for the project 2. Pesticide container cleaning and disposal plan	Farmers, farm assistants, 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	Number of cases of pestic poisoning through use of pestic containers; Number of farm returning empty pesticide contain at collection points; Number farmers,
Production and market losses from fruit fly pest and	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 train Training records 2. Number of tir exported crops rejected due to fr fly pest 3. Production losses fr crop pests

Impact issue / Pest & pesticide threat/ risk	Mitigation Measures	Implementation tool	Expected result	Monitoring indicators
armyworm outbreaks	Establish pest surveillance system	Early detection and warning system in place	Zero or minimal fruit fly/ armyworm cases	Incidence of fruit fly /armywo cases recorded
	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 each farm
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 train Training records 2. Incidence crop pests 3. Production los from crop pests
	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 each farm
Impact on post harvest losses due to pests	1. Provide adequate and proper storage facilities	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 harv storage; Number and condition storage facilities in use of farmers in IPM for post
	2. Monitor incidence of post harvest pests		principles	Number of cases of post harvest pests	PPRSD-MoFA
	3. Confirm	Inspection		Records of	PPRSD-

	status and integrity of pesticides at storage gate prior to use	of pesticides at farm/storage gate prior to use (Project Policy)		pesticides applied at storage sites/ rooms	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 decanting of pesticides under this project c) Inspection of pesticides at farm gate prior to use	a) Only approved and registered pesticides used under project b)Banned pesticides avoided c) Fake and expired pesticides avoided d)Integrity of pesticide guaranteed at farm gate level	a) List of pesticides supplied and used in line with Ghana EPA and USEPA list of registered and approved pesticides b) Cases of pesticides found in non-original containers c) inspection records for pesticides at farm gate prior to use	PPRSD-MoFA; MoFA-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	Educate farmers to	IPM techniques	Compliance with national IPM policy	Number of farmers trained in	WB/ MoFA-

and safety of farmers/ crops and environ mental hazards	adopt GAP based upon IPM techniques; and do not use chemical pesticides unless advised by PPRSD	with emphasis on cultural and biological forms of pest control	and WB policy on Pest/ pesticide management	IPM techniques; Number of farmers implementing IPM on their farms Frequency of chemical pesticides usage	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 pesticides required at a given time and to avoid long term storage of pesticides	Pesticide use policy/plan	Only pesticides needed are purchased; long term storage of pesticides by farmers avoided	Relationship between pesticide supply and usage	PPRSD-MoFA/CCMC-EPA
		Emergency	Pesticide accidents	Number of	PPRSD/G

	Provide emergency response to pesticide accidents and poisoning	response plan	and emergencies managed under the project	pesticide accidents emergencies and	HS/National Poisoning Control Centre